PROJECT MANUAL FOR

Riverview Junior High School Replacement

Project Location:
751 West Tripp Lane
Murray, Utah 84123

MURRAY CITY SCHOOL DISTRICT
We Are Murray!

Murray City School District
147 East 5065 South
Murray, Utah 84107

Bid Package 03
Bid Documents

Volume 2: Divisions 21 - 28

March 31, 2025

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SECTION 00 0110

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SECTION 21 1000

WATER-BASED FIRE SUPPRESSION SYSTEMS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following fire-suppression piping inside the building:
   1. Wet-pipe sprinkler systems.
B. Related Sections include the following:
   1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
   2. Division 22 Section "Facility Water Distribution Piping" for piping outside the building.
   3. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.
C. All black steel sprinkler pipe shall have a wall thickness equal to Schedule 40.
   1. Exception: Pipe with a nominal pipe size greater than 2-1/2 inches may be Schedule 10.
D. Summary Table:

Item	Summary
Underground service entrance piping	Ductile Iron, restrained as required, with thrust blocks, transitioned with bolted flange.
Interior pipe type	Piping 2-1/2 inches or less in diameter nominally: Schedule 40 Piping greater than 2-1/2 inches in diameter nominally: Schedule 10
Sprinkler Finish	Flat Plate Concealed, except uprights and storage
Extended Coverage	Allowed
Center of Tile	Required, Center thirds are acceptable for rectangular tiles
Flexible Sprinkler Drops	Designers' preference
FM Global	No
Calculations	Required, use reduced flow data
Alarm Device	Horn/Strobe
FDC	Flush Polished Brass 3-inlet Caps: Coordinate installation with local Fire Department
Coordination	All sprinkler piping exposed to view shall be coordinated with the architect prior to final design acceptance.

1.03 DEFINITIONS

A. CPVC: Chlorinated polyvinyl chloride plastic.
B. CR: Chlorosulfonated polyethylene synthetic rubber.

C. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig.
D. PE: Polyethylene plastic.
E. Underground Service-Entrance Piping: Underground service piping below the building.

1.04 SYSTEM DESCRIPTIONS

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

1.05 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
B. Design sprinkler piping according to the following and obtain approval from engineer, prior to submitting to other authorities having jurisdiction:
    1. Design sprinkler system with the following 15% reduced flow data:
        a. Flow data available at 751 Tripp Ln, Murray, UT.
        b. Static – 64 psi
        c. Residual – 60 psi @ 919 gpm flowing
        d. Date of Test – 09/25/2024.
        e. The test was performed by Gardner Engineering.
    2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
    3. Sprinkler Occupancy Hazard Classifications:
        a. Building Service Areas: Ordinary Hazard, Group 1.
        b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
        c. General Storage Areas: Ordinary Hazard, Group 1.
        d. Laundries: Ordinary Hazard, Group 1.
        e. Libraries, Except Stack Areas: Light Hazard.
        f. Library Stack Areas: Ordinary Hazard, Group 2.
        g. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
        h. Office and Public Areas: Light Hazard.
        i. Restaurant Service Areas: Ordinary Hazard, Group 1.
        j. Gym Areas: Light Hazard.
        k. Auditorium Areas: Light Hazard.
        l. Stages: Ordinary Hazard, Group 2.
        m. Classrooms: Light Hazard.
        n. Workshop Areas: Ordinary Hazard, Group 2.
        o. Printing Areas: Ordinary Hazard, Group 2.
    4. Minimum Density for Automatic-Sprinkler Piping Design:
        a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
        b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
        c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
        d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
        e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
        f. Special Occupancy Hazard: As determined by authorities having jurisdiction.
    5. Minimum Density for Deluge-Sprinkler Piping Design:
        a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over entire area.
        b. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over entire area.
        c. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over entire area.
        d. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over entire area.
        e. Special Occupancy Hazard: As determined by authorities having jurisdiction.

6. Maximum Protection Area per Sprinkler: Per UL listing
    a. Light Hazard: 225 sq. ft.
    b. Ordinary Hazard, Group 1: 130 sq. ft.
    c. Ordinary Hazard, Group 2: 130 sq. ft.
    d. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.
7. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
    a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
    b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
    c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.
8. Sprinklers are to be installed throughout the premises, as required by NFPA 13.

C. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13.

1.06 SUBMITTALS

A. Product Data: For the following:
1. Piping materials, including flexible connections and sprinkler specialty fittings.
2. Pipe hangers and supports, including seismic restraints.
3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
5. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
6. Alarm devices, including electrical data.

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

C. Fire-hydrant flow test report.

D. Seismic Calculations.

E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable. Drawings are to be approved by Engineer prior to submission to State Fire Marshal.
1. Installation and Fabrication drawings indicating the location of rigid and flexible couplings, seismic separation assemblies, planned clearance cut-outs between piping and solid structural members for seismic movement, and any additional anchoring points required for ceiling systems where sprinklers are fixed or supported in accordance with NFPA.

F. 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" and "Contractor's Material and Test Certificate for Underground Piping."

G. Welding certificates.

H. Field quality-control test reports.

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

1.07 QUALITY ASSURANCE

A. Installer Qualifications:

1. An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction. The Engineer requires evidence to support the ability of the contractor to perform work in the scope and volume as specified. A contractor, who cannot show such experience, may be found not suitable to perform the work. The following are the approved contractors for this project:
    a. PRE-APPROVED CONTRACTORS LIST
        1) A&D Fire
        2) Alta Fire
        3) Blazemaster Fire Protection
        4) Broken Arrow Fire Protection
        5) Certified Fire
        6) Delta Fire
        7) FireTrol
        8) FireFly Fire Protection
        9) Interwest Fire Protection
        10) Kimco Fire
        11) Quality Fire Protection
        12) Pye Barker Co.
        13) State Fire DC Specialties
        14) Summit Fire & Security
        15) The Safety Team (TST)
        16) Western Automatic Sprinkler Co.
        17) Or prior approved equal
    b. A contractor not listed in the “PRE-APPROVED CONTRACTORS LIST” must receive prior approval from the engineer to bid this project.

B. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
    1. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer or NICET Level III technician.

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

D. NFPA Standards: Fire-suppression-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."

E. International Conference of Building Code Officials codes and standards complying with the following:
    1. IBC-2021, “International Building Code.”
    2. IFC-2021, “International Fire Code.”

F. Utah Amendments
    1. Title 15A

1.08 COORDINATION

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

1.09 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. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, 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 on Project.

1.10 GENERAL ENGINEERING QUALITY

A. Unless noted otherwise the following applies:
   1. The maximum water velocity shall not exceed 32-fps.
   2. Submit the calculations using the reduced flow data.
   3. When calculating flexible drops, the contractor shall use the maximum number of bends for the associated length. The value is to be taken from the UL tests (unless the material is only FM approved).
   4. In the event of multiple (3) submittal rejections (including revise and resubmit) a meeting shall be held at the engineer's office at the engineer's time of choosing and the designer, fire sprinkler contractor, and general contractor shall be physically in attendance to discuss the required modifications to the design.

1.11 CONTRACT COMPLETION

A. Incomplete and Unacceptable work:
   1. If additional site visits or design work is required by the Engineer or Architect because of the use of incomplete or unacceptable work by the Contractor, then the Contractor shall reimburse the Engineer and Architect for all additional time and expenses involved.

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

2.02 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, Class 53, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell end and plain end.
   1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Gaskets: AWWA C111, rubber.

2.03 STAINLESS STEEL IN BUILDING RISER

A. Continuous from the factory, no field formed fittings in the stainless-steel riser. Field modifications are not allowed. Restrain with thrust block, per NFPA 24, rods as required by manufacture.
   1. Inlet: AWWA C900/DIP
   2. Outlet: AWWA 606

2.04 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A53/A53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.
   1. Cast-Iron Threaded Flanges: ASME B16.1.
   2. Malleable-Iron Threaded Fittings: ASME B16.3.
   3. Gray-Iron Threaded Fittings: ASME B16.4.
   4. Steel Threaded Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
   5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.

B. Plain-End, Standard-Weight Steel Pipe: ASTM A53/A53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe not allowed.
   1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting not allowed.

C. Plain-End, Standard-Weight Steel Pipe: ASTM A53/A53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe not allowed.
   1. Steel Welding Fittings: ASTM A234/A234M, and ASME B16.9 or ASME B16.11.
   2. Steel Flanges and Flanged Fittings: ASME B16.5.

D. Grooved-End, Standard-Weight Steel Pipe: ASTM A53/A53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed, roll-grooved ends.
   1. Grooved-Joint Piping Systems:
      a. Manufacturers:
         1) Anvil International, Inc.
         2) Bull Moose Tube Co.
         3) Grinnell (Tyco)
         4) Victaulic Co. of America.
         5) Wheatland Tube
      b. Grooved-End Fittings: UL-listed, ASTM A536, ductile-iron casting with OD matching steel-pipe OD.
      c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

E. Threaded-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness Schedule 40, and with factory- or field-formed threaded ends.
   1. Cast-Iron Threaded Flanges: ASME B16.1.
   2. Malleable-Iron Threaded Fittings: ASME B16.3.
   3. Gray-Iron Threaded Fittings: ASME B16.4.
   4. Steel Threaded Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A 106, Schedule 40, seamless steel pipe.
   5. Steel Threaded Couplings: ASTM A 865.

F. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, not allowed.
   1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting not allowed.

G. Plain-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, not allowed.
   1. Steel Welding Fittings: ASTM A234/A234M, and ASME B16.9 or ASME B16.11.
   2. Steel Flanges and Flanged Fittings: ASME B16.5.

H. Grooved-End, Threadable, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness Schedule 40 or Schedule 10, and with factory- or field-formed, roll-grooved ends.

1. Grooved-Joint Piping Systems:
    a. Manufacturers:
        1) Anvil International, Inc.
        2) Bull Moose Tube Co.
        3) Grinnell (Tyco)
        4) Victaulic Co. of America.
        5) Wheatland Tube
    b. Grooved-End Fittings: UL-listed, ASTM A536, ductile-iron casting with OD matching steel-pipe OD.
    c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

I. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 is not allowed.
J. Plain-End, Nonstandard OD, Thinwall Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 10 is not allowed.
K. Plain-End, Hybrid Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5 is not allowed.
L. Grooved-End, Hybrid Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with wall thickness less than Schedule 10 and greater than Schedule 5; with factory- or field-formed, roll-grooved ends are not allowed.
M. Schedule 5 Steel Pipe: ASTM A 135 or ASTM A 795, lightwall, with plain ends is not allowed.

2.05 FLEXIBLE SPRINKLER DROPS

A. Flexible connectors shall be exterior wire braid and have materials suitable for system fluid. Include 175-psig minimum working-pressure rating and ends according to the following:
    1. NPS 1: Threaded.
    2. NPS 1: Victaulic IGS.
B. Manufacturers:
    1. Flex-Head
    2. Victaulic
C. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.
D. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.06 FLEXIBLE PIPE CONNECTORS (SEISMIC)

A. Flexible connectors shall be exterior wire braid and have materials suitable for system fluid. Include 175-psig minimum working-pressure rating and ends according to the following:
    1. NPS 2 and Smaller: Threaded.
    2. NPS 2-1/2 and Larger: Flanged.
    3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.
B. Manufacturers:
    1. Flexicraft Industries.
    2. Flex-Pression, Ltd.
    3. Metraflex, Inc.
C. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.
D. Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

E. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

2.07 CORROSION-PROTECTIVE ENCASEMENT FOR PIPING

A. Encasement for Underground Metal Piping: ASTM A674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

2.08 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be 175-psig minimum working-pressure rating, and made of materials compatible with piping.
B. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body, with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
   1. Manufactures:
      a. Central Sprinkler Corp.
      b. Fire-End and Croker Corp.
      c. Viking Corp.
      d. Victaulic Co. of America.
C. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.
D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
E. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

2.09 LISTED FIRE-PROTECTION VALVES

A. Valves shall have 175-psig minimum pressure rating.
B. Gate Valves with Wall Indicator Posts:
   1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
   2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.
   3. Manufacturers:
      a. Grinnell Fire Protection.
      b. McWane, Inc.; Kennedy Valve Div.
      c. NIBCO.
      d. Stockham.
C. Ball Valves: Comply with UL 1091, except with ball instead of disc.
   1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
   2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
   3. NPS 3: Ductile-iron body with grooved ends.
   4. Manufacturers:
      a. NIBCO.
      b. Victaulic Co. of America.
D. Butterfly Valves: UL 1091.
   1. NPS 2 and Smaller: Bronze body with threaded ends.
      a. Manufacturers:
         1) Global Safety Products, Inc.
         2) Milwaukee Valve Company.

2. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
    a. Manufacturers:
        1) Central Sprinkler Corp.
        2) McWane, Inc.; Kennedy Valve Div.
        3) Mueller Company.
        4) NIBCO.
        5) Victaulic Co. of America.

E. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
1. Manufacturers:
    a. American Cast Iron Pipe Co.; Waterous Co.
    b. Central Sprinkler Corp.
    c. Clow Valve Co.
    d. Crane Co.; Crane Valve Group; Crane Valves.
    e. Crane Co.; Crane Valve Group; Jenkins Valves.
    f. Fivalco Inc. dba Aleum USA
    g. Globe Fire Sprinkler Corporation.
    h. Grinnell Fire Protection.
    i. Hammond Valve.
    j. McWane, Inc.; Kennedy Valve Div.
    k. Mueller Company.
    l. NIBCO.
    m. Potter-Roemer; Fire Protection Div.
    n. Reliable Automatic Sprinkler Co., Inc.
    o. Star Sprinkler Inc.
    p. Stockham.
    q. United Brass Works, Inc.
    r. Victaulic Co. of America.
    s. Watts Industries, Inc.; Water Products Div.

F. Gate Valves: UL 262, OS&Y type.
1. NPS 2 and Smaller: Bronze body with threaded ends.
    a. Manufacturers:
        1) Crane Co.; Crane Valve Group; Crane Valves.
        2) Fivalco Inc. dba Aleum USA.
        3) Hammond Valve.
        4) NIBCO.
        5) United Brass Works, Inc.
2. NPS 2-1/2 and Larger: Cast-iron body with flanged ends.
    a. Manufacturers:
        1) Clow Valve Co.
        2) Crane Co.; Crane Valve Group; Crane Valves.
        3) Crane Co.; Crane Valve Group; Jenkins Valves.
        4) Fivalco Inc. dba Aleum USA
        5) Hammond Valve.
        6) Milwaukee Valve Company.
        7) Mueller Company.
        8) NIBCO.
        9) United Brass Works, Inc.

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch and Visual.
2. NPS 2 and Smaller: Ball or butterfly valve with bronze body and threaded ends.
    a. Manufacturers:
        1) Fivalco Inc. dba Aleum USA
        2) Milwaukee Valve Company.
        3) NIBCO.
        4) Victaulic Co. of America.
3. NPS 2-1/2 and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
    a. Manufacturers:
        1) Central Sprinkler Corp.
        2) Fivalco Inc. dba Aleum USA
        3) Grinnell Fire Protection.
        4) McWane, Inc.; Kennedy Valve Div.
        5) Milwaukee Valve Company.
        6) NIBCO.
        7) Victaulic Co. of America.

H. Supervised Normally Closed Valve
1. Indicator: Electrical, 115-V ac, prewired, single-circuit, supervisory switch and visual to send signal on partial close.
    a. Manufactures:
        1) Fivalco Inc. dba Aleum USA
        2) NIBCO.
        3) Victaulic Co. of America.

2.10 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.
B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.
C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.
D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.11 SPECIALTY VALVES

A. Sprinkler System Control Valves: cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating.
1. Manufacturers:
    a. Globe Fire Sprinkler Corporation.
    b. Reliable Automatic Sprinkler Co., Inc.
    c. Victaulic Co. of America.
    d. Viking Corp.

B. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.
1. Manufacturers:
    a. Grinnell Fire Protection.

2.12 SPRINKLERS

A. Sprinklers shall be UL-listed with 175-psig minimum pressure rating.
B. Manufacturers:

1. Globe Fire Sprinkler Corporation.
2. Reliable Automatic Sprinkler Co., Inc.
3. Victaulic Co. of America.
4. Viking Corp.
5. Tyco Fire

C. Automatic Sprinklers: With heat-responsive element complying with the following:
   1. UL 199, for nonresidential applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.
   1. Open Sprinklers: UL 199, without heat-responsive element.
      a. Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
      b. Orifice: 17/32 inch, with discharge coefficient K between 7.4 and 8.2.

E. Sprinkler types, features, and options as follows:
   1. Concealed ceiling sprinklers, including cover plate.
   2. Extended-coverage sprinklers.
   3. Flush ceiling sprinklers, including escutcheon, not allowed.
   4. Institution sprinklers, made with a small, breakaway projection.
   5. Pendent sprinklers.
   6. Pendent, dry-type sprinklers.
   7. Quick-response sprinklers.
   8. Sidewall sprinklers.
   9. Sidewall, dry-type sprinklers.
   10. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Special Coatings: Wax, lead, and corrosion-resistant paint.

H. 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: Flat plate concealed, white.
   2. Sidewall Mounting: Flat plate concealed, white.

I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.13 FIRE DEPARTMENT CONNECTIONS

A. Manufacturers:
   1. Central Sprinkler Corp.
   2. Elkhart Brass Mfg. Co., Inc.
   3. Fire-End and Croker Corp.
   4. Fire Protection Products, Inc.
   5. Guardian Fire Equipment Incorporated.
   6. Potter-Roemer; Fire-Protection Div.
   7. Reliable Automatic Sprinkler Co., Inc.
   8. United Brass Works, Inc.

B. Wall-Type, Fire Department Connection: UL 405, 175-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR."
   1. Type: Flush, with three inlets and square or rectangular escutcheon plate.
   2. Finish: Polished brass.

2.14 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.
B. Electrically Operated Alarm: Horn/Strobe, NEMA 3R minimum suitable for outdoor use.
   1. Manufacturers:
      a. Potter Electric Signal Company.
      b. Safe Signal, formerly System Sensor.
C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include 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.
   1. Manufacturers:
      a. ADT Security Services, Inc.
      b. Grinnell Fire Protection.
      c. ITT McDonnell & Miller.
      d. Potter Electric Signal Company.
      e. Safe Signal, formerly System Sensor.
      f. Viking Corp.
      g. Watts Industries, Inc.; Water Products Div.
D. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts, and design that operates on rising pressure and signals water flow.
   1. Manufacturers:
      a. Grinnell Fire Protection.
      b. Potter Electric Signal Company.
      c. Safe Signal, formerly System Sensor.
      d. Viking Corp.
E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
   1. Manufacturers:
      a. McWane, Inc.; Kennedy Valve Div.
      b. Potter Electric Signal Company.
      c. Safe Signal, formerly System Sensor.
F. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.
   1. Manufacturers:
      a. Potter Electric Signal Company.
      b. Safe Signal, formerly System Sensor.

2.15 PRESSURE GAGES

A. Manufacturers:
   1. Brecco Corporation.
   2. Dresser Equipment Group; Instrument Div.
   3. Marsh Bellofram.
   4. WIKA Instrument Corporation.
B. Description: UL 393, 3-1/2- to 4-1/2-inch- diameter, dial pressure gage with range of 0 to 250 psig minimum.
   1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
   2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

2.16 DOUBLE CHECK VALVE ASSEMBLIES

A. Manufacturers
   1. Ames
   2. Backflow Direct
   3. Febco
   4. Wilkins
   5. Watts
B. Description: Resilient seated, spring loaded with testable outlets provided, as required by Authorities Having Jurisdiction.

PART 3 EXECUTION

3.01 PREPARATION

A. Obtain Engineer’s Water Analysis or fire-hydrant flow test. Use results for system design calculations required in "Quality Assurance" Article in Part 1 of this Section.
B. Engineer’s Water Analysis. See Flow Analysis provided by Van Boerum & Frank Associates.

3.02 EARTHWORK

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

3.03 EXAMINATION

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

3.04 PIPING APPLICATIONS

A. Shop weld pipe joints where welded piping is indicated.
B. Do not use welded joints for galvanized-steel pipe.
C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
D. 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.
E. Underground Service-Entrance Piping: Ductile-iron, push-on or mechanical-joint pipe and fittings and restrained joints. Include corrosion-protective encasement.
F. Sprinkler Piping: Use the following:
   1. NPS 2-1/2 and Smaller: Schedule 40 black steel pipe with threaded ends, or grooved ends. No plain ends allowed.
      a. Victaulic Brand Mechanical tee fittings may be used in lieu of welded outlets.
   2. NPS greater than 2-1/2: Schedule 10 black steel pipe with grooved ends.
      a. Victaulic Brand Mechanical tee fittings may be used
   3. Outlets shall be welded.

3.05 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Fire-Protection-Service Valves: UL-listed for applications where required by NFPA 13.
   2. General-Duty Valves: For applications where UL-listed valves are not required by NFPA 13.
      a. Shutoff Duty: Use gate, ball, or butterfly valves.

b. Throttling Duty: Use globe, ball, or butterfly valves.

3.06 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Common Work Result for HVAC" for basic piping joint construction.
B. Ductile-Iron-Piping, Grooved Joints: Use ductile-iron pipe with radius-cut-grooved ends; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
C. Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends and Schedule 30 or thinner steel pipe with roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.

3.07 WATER-SUPPLY CONNECTION

A. Install shutoff Backflow preventions assemblies, valve, pressure gages, drain, and other accessories at connection to water service.

3.08 PIPING INSTALLATION

A. Refer to Division 23 Section "Common Work Result for HVAC" for basic piping installation.
B. 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.
C. Install underground service-entrance piping according to NFPA 24 and with restrained joints.
D. Make connections between underground and above-ground piping using bolted flange.
E. Install mechanical sleeve seal at pipe penetrations in basement and foundation walls. Refer to Division 23 Section “Common Work Result for HVAC.”
F. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
G. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.
H. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.
I. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.
J. Install sprinkler piping with drains for complete system drainage.
K. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.
L. Install alarm devices in piping systems.
M. Hangers and Supports: Comply with NFPA 13 for hanger materials. Install according to NFPA 13 for sprinkler piping.
   1. No powder driven studs allowed.
N. Earthquake Protection: Install piping according to NFPA 13 chapter 18 requirements, to protect from earthquake damage. Seismic Bracing shall be designed to withstand vertical forces and movement.
O. Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated, or required by NFPA 13 for flexibility in seismic zones.

P. 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 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.

Q. When a fire pipe crosses a seismic expansion joint it shall have a Metraflex fire loop installed at the joint in accordance with NFPA 13 chapter 18.

3.09 SPECIALTY SPRINKLER FITTING INSTALLATION

A. Install specialty sprinkler fittings according to manufacturer's written instructions.

3.10 VALVE INSTALLATION

A. Refer to Division 23 Section "Valves" for installing general-duty valves. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions, and authorities having jurisdiction.

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

C. Double Check Valve Assemblies: Install valves in vertical up or horizontal position, per listings and for proper direction of flow.

3.11 SPRINKLER APPLICATIONS

A. General: All sprinklers are to be quick response type. Sprinkler heads shall be of the latest design closed spray type for 155°F unless specified otherwise or required by code. Extended coverage heads shall not be used. Orifices larger than 1/2" may be used as required by density and spacing demands. Use sprinklers according to the following applications:
   1. Rooms without Ceilings: Upright and/or pendent sprinklers. Provide mechanical guards on all heads at or below 7’-0” height above the floor or where damage from room occupant use may occur.
   2. Rooms with Ceilings: Concealed sprinklers unless indicated otherwise.
   3. Wall Mounting: Concealed sidewall sprinklers unless indicated otherwise.
   4. Institutional sprinklers shall be installed in areas of detention, correctional or mental health care facilities.
   5. Spaces Subject to Freezing: Upright; pendent, dry-type; and sidewall, dry-type sprinklers.
   6. Provide freeze proof type automatic sprinkler heads serving unconditioned spaces, areas subject to freezing and in other areas requiring their use.
   7. Heads located within the air streams of unit heaters or other heat-emitting equipment shall be selected for proper temperature rating.
   8. Sprinkler Finishes: Use sprinklers with the following finishes:
      a. Upright, Pendent, and Sidewall Sprinklers: Chrome in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.
      b. Concealed Sprinklers: Rough brass, with White cover plate to match ceiling color.

B. Sprinklers: Use the following:
   1. All sprinklers shall be listed, quick response type.
   2. Sprinkler in future finish spaces (shelled) 10’ x 10’ spacing shall be pendents/uprights installed with 1 x ½" bushing, to accommodate future finishes.
   3. Finish ceiling spaces shall have flat-plate concealed sprinklers.

3.12 SPRINKLER INSTALLATION

A. Every effort shall be required to ensure that the heads form a symmetrical pattern in the ceiling with the ceiling grid if included, as well as lights, diffusers, and grilles. Offsets shall be made in piping to accommodate ductwork in the ceiling. Heads shall be symmetrical in all ceilings and all piping run parallel or perpendicular to building lines. Heads shall be linearly aligned in corridors.
   1. In no case shall sprinkler heads be installed closer than approved distances from ceiling obstructions and HVAC ductwork.
   2. Sprinkler heads shall not conflict with tile grids.
   3. Sprinkler heads shall be located near center of corridors.

B. Where layout of sprinkler heads is shown on reflected ceiling plans the locations shall be followed unless approval is obtained from the Architect, or such locations shown do not meet the requirements of NFPA 13. In either case, approval of the Architect shall be obtained in writing before sprinkler head locations are changed. If the installation of additional heads is needed to conform to NFPA 13 requirements in areas where heads are shown on reflected ceiling plans, they shall be included in the contract price.

C. Install sprinklers in patterns indicated.

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

E. Future finish shelled and tenant finish; Shell spaces shall be piped to accommodate future. Install sprinklers with 1" x ½" bushings, and space heads at a maximum spacing of 100 sq. ft. per head. Occupancy shall be Ordinary-Hazard Group 1 Design.

F. Concealed type sprinkler shall be installed in the following areas:
   1. All finished areas.

3.13 FIRE DEPARTMENT CONNECTION INSTALLATION

A. When installing the Fire Department Connection, the contractor is to ensure that there are no permanent obstruction(s) as to the fire department access. If an obstruction is present immediately notify the designer and the design team before proceeding with the installation.

B. Coordinate the exact location with the Architect and the Authority Having Jurisdiction.

C. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

3.14 CONNECTIONS

A. Connect water-supply piping and standpipes and sprinklers where indicated.

B. Connect piping to specialty valves, specialties, fire department connections, and accessories.

C. Electrical Connections: Power wiring is specified in Division 28.

D. Connect alarm devices to fire alarm.

3.15 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and in Division 23 Section "Common Work Result for HVAC."

3.16 FIELD QUALITY CONTROL

A. Flush, test, and inspect sprinkler piping according to NFPA 13, "System Acceptance" Chapter.

B. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.

C. When making a mechanical tee connection the coupon shall be attached at the mechanical tee.

D. Report test results promptly and in writing to Architect and authorities having jurisdiction.

E. Whether the underground serving the sprinkler system is done by this contractor or another, this contractor will be responsible to assure and have in his possession a certificate that the underground has been flushed and tested by the contractor who installed it in accordance with NFPA 24 prior to connection of the underground piping to the overhead sprinkler system.

3.17 CLEANING

A. Clean dirt and debris from sprinklers.
B. Remove and replace sprinklers having paint other than factory finish.

3.18 PROTECTION

A. Protect sprinklers from damage until Substantial Completion.

3.19 COMMISSIONING

A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
B. Verify that specified tests of piping are complete, and that “Material Test Certificates” are complete.
C. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.
D. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.
E. Fill wet-pipe sprinkler piping with water.
F. Coordinate with fire alarm tests. Operate as required.

3.20 DEMONSTRATION & TESTS

A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.
B. All tests will be conducted as required by the local authority having jurisdiction, and in no case less than those required by NFPA standards. As a minimum, piping in the sprinkler system shall be tested at a water pressure at 200 psi for a period of not less two hours, or at 50 psi more than the normal pressure when the normal pressure is above 150 psi. Bracing shall be in place, and air shall be removed from the system through the hydrants and drain valves before the test pressure is applied. No apparent leaks will be permitted on interior or underground piping.
C. The local jurisdiction having authority and the Utah State Fire Marshal's office (where required) shall be notified at least three working days in advance of all tests and flushing. This includes any flushing of underground, hydrostatic testing, or flow testing that may be required.
D. This contractor shall make all the required tests to the sprinkler system as required by code. He shall be responsible to assure that the Contractor Test Certificates for the overhead, backflow and underground work are completed and delivered to the owner’s insurance underwriter to assure proper insurance credit.
E. All tests requiring the witnessing by local authorities will be the responsibility of this contractor. If tests are not run or do not have the proper witness, then they will be run later and all damage caused by the system, or caused in uncovering the system for such test, will be borne by this contractor.

3.21 WARRANTY

A. This contractor shall warranty the sprinkler system and all its components for one year from the date of acceptance by the owner. Any costs incurred to extend any warranties of materials to assure this time frame shall be borne by this contractor.

B. Provide Operation and Maintenance Manuals with correct as-builts test certificates and warranties included. A minimum 6 sets to be provided in red 3-ring binders. Include a current adopted version of NFPA 25 softbound copy left with owner.
C. Electronic copy of AutoCAD as-built drawings shall also be provided on CD, with each O&M Manual.

3.22 FIELD QUALITY CONTROL

A. Flush, test, and inspect sprinkler piping according to NFPA 13, “System Acceptance” Chapter.
B. Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
C. Report test results promptly and in writing to Architect and authorities having jurisdiction.

END OF SECTION 21 1000

SECTION 22 0500

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. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.
12. Link Seal
13. Lead Free requirements.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

C. Seismic Performance: Equipment, pipe hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.4 LEAD FREE REQUIREMENTS

A. For all projects within the United States, and when water is anticipated for human consumption, all pipes, pipe fittings, plumbing fittings and fixtures shall comply with PUBLIC LAW 111-380 “Reduction of Lead in Drinking Water Act” 124 STAT. 4131, 42-USC 1201, January 4th, 2011.

1.5 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, and crawlspaces.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms, accessible pipe shafts, accessible plumbing chases and accessible tunnels.

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.

G. Lead Free:
1. Not containing more than 0.2 percent lead when used with respect to solder and flux.
2. Not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings and fixtures.
3. Calculation: The weighted average lead content of a pipe, pipe fitting, plumbing fitting or fixture shall be calculated by using the formula prescribed in the law named in LEAD FREE REQUIREMENTS above.

1.6 SUBMITTALS

A. Product Data: For the following:
1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1.7 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.

1.8 DELIVERY, STORAGE, AND HANDLING

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

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

1.9 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 Section "Access Doors and 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. Manufacturers: Subject to compliance with requirements, provide products by 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. 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 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 thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

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

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

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

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

2.4 TRANSITION FITTINGS

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

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Fernco, Inc.
c. Mission Rubber Company.
d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

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

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

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

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Eclipse, Inc.
d. Epco Sales, Inc.
e. Hart Industries, International, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

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

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Metraflex Co.
    d. Pipeline Seal and Insulator, Inc.

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

2.7 SLEEVES

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

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

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

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

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

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

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

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

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

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.10 LINK SEAL

A. Link-Seal® Modular Seal Pressure Plates

1. Link-Seal® modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:

a. Izod Impact - Notched = 2.05ft-lb/in. per ASTM D-256
Flexural Strength @ Yield = 30,750 psi per ASTM D-790
Flexural Modulus = 1,124,000 psi per ASTM D-790
Elongation Break = 11.07% per ASTM D-638
Specific Gravity = 1.38 per ASTM D-792

2. Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-360-400-410-425-475-500-525-575-600 shall incorporate an integral recess known as a “Hex Nut Interlock” designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer’s name molded into it.
3. For fire and Hi-Temp service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.
4. Link-Seal® Modular Seal Hardware: All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be: 316 Stainless Steel per ASTM F593-95, with a 85,000 psi average tensile strength.

2.11 LEAD FREE PRODUCTS:

A. For all products to be purchased whenever water is anticipated for human consumption, all pipes, pipe fittings, plumbing fittings and fixtures shall comply with the LEAD FREE REQUIREMENTS in PART 1 above.

PART 3 - EXECUTION

3.1 SEISMIC REQUIREMENTS

A. Comply with SEI/ASCE 7 and with requirements for seismic seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3.2 LEAD FREE REQUIREMENTS

A. Installations where water is anticipated for human consumption, all pipes, pipe fittings, plumbing fittings and fixtures shall be Lead Free as given in PART 1 above.

3.3 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. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
    c. Insulated Piping: One-piece, stamped-steel type with spring clips.
    d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

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

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

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

      1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. 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 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

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

3.4 PIPING JOINT CONSTRUCTION

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

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

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

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

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

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

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

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

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

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

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

J. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. 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.

3.6 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.

3.7 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.9 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 plumbing materials and equipment.

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

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, 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.

3.11 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 220500

SECTION 22 0513

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

1.3 COORDINATION

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

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when the requirements in plumbing equipment schedules, other specification sections, drawing notes or in other contract documents are more stringent.

B. Comply with NEMA MG 1 unless otherwise indicated.

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

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of and at altitude of 3300 feet above sea level.

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

2.3 POLYPHASE MOTORS

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

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Rotor: Random-wound, squirrel cage.

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

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F.

H. Code Letter Designation:
1. Motors smaller than 15 HP: Manufacturer's standard starting characteristic.

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

2.4 SINGLE-PHASE MOTORS

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

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

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

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

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

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 22 0513

SECTION 22 0516

EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal-bellows packless expansion joints.
2. Pipe loops and swing connections.
3. Alignment guides and anchors.

1.2 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.3 ACTION SUBMITTALS

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

B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
1. Seismic calculations and detailed analysis: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices. Project specific design documentation and calculations shall be prepared and stamped by a registered professional engineer who is responsible for the seismic restraint design and who is licensed in the state where the project is being constructed (ASCE 7, 13.2.1.1).

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product certificates.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

A. Metal-Bellows Packless Expansion Joints:

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

a. Expansion Joint Systems, Inc.
b. Flex-Hose Co., Inc.
c. Flexicraft Industries.
d. Flex Pression Ltd.
e. Flo Fab inc.
f. Hyspan Precision Products, Inc.
g. Metraflex, Inc.

h. Tozen Corporation.
i. Unaflex.
j. Unisource Manufacturing, Inc.
k. Universal Metal Hose; a subsidiary of Hyspan Precision Products, Inc.
l. U.S. Bellows, Inc.

2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows with external tie rods.
4. Minimum Pressure Rating: 175 psi unless otherwise indicated.
5. Configuration: double joint with base class(es) unless otherwise indicated.
6. Expansion Joints for Copper Tubing: Single- or multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

   a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
   b. End Connections for Copper Tubing NPS 2-1/2 to NPS 8: Solder joint or threaded or flanged.

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

   a. Stud: Threaded, zinc-coated carbon steel.
   b. Expansion Plug: Zinc-coated steel.
   c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

   a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
   b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
   c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3.2 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.3 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.4 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 22 0516

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SECTION 22 0517

SLEEVES AND SLEEVE SEALS 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. Sleeves.
2. Sleeve-seal systems.
3. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

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

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

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Link-Seal
4. Metraflex Company (The).
5. Pipeline Seal and Insulator, Inc.
6. Proco Products, Inc.

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

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

2.3 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

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

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

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

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

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

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

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves
   b. Piping **NPS 6** and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

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

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system Retain first subparagraph below if using sleeve-seal systems; delete if using sleeve-seal fittings.

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

3. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system

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

   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system

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

4. Concrete Slabs above Grade:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves
   b. Piping and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

   a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 22 0517

SECTION 22 0518

ESCUTCHEONS 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. Escutcheons.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install escutcheons with ID to 2 inch, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type with polished, chrome-plated finish.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with chrome-plated finish
d. Bare Piping 2 inch and Smaller at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping Larger than 2 inch at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type with polished, chrome-plated finish**.**
f. Bare Piping 2 inch and Smaller at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping Larger than 2 inch at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type with polished, chrome-plated finish.
h. Bare Piping 2 inch and Smaller in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
i. Bare Piping Larger than 2 inch in Unfinished Service Spaces: One-piece, stamped-steel type with polished, chrome-plated finish**.**
j. Bare Piping 2 inch and Smaller in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated or rough-brass finish.
k. Bare Piping in Equipment Rooms Larger than 2 inch: One-piece, stamped-steel type with chrome- or cadmium-plated finish.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 22 0518

SECTION 22 0519

METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

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

1. Ashcroft Inc.
2. Ernst Flow Industries.
3. Marsh Bellofram.
4. Miljoco Corporation.
5. Nanmac Corporation.
6. Noshok.
7. Palmer Wahl Instrumentation Group.
8. REOTEMP Instrument Corporation.
9. Tel-Tru Manufacturing Company.
10. Trerice, H. O. Co.
11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
12. Weiss Instruments, Inc.

13. WIKA Instrument Corporation - USA.
14. Winters Instruments - U.S.
15. Weksler

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 5 inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass or plastic.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

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

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

    a. Flo Fab Inc.
    b. Miljoco Corporation.
    c. Palmer Wahl Instrumentation Group.
    d. Tel-Tru Manufacturing Company.
    e. Trerice, H. O. Co.
    f. Weiss Instruments, Inc.
    g. Winters Instruments - U.S.
    h. Weksler

2. Standard: ASME B40.200.
3. Case: Cast aluminum 7-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass or plastic.
8. Stem: Aluminum and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

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

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

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

    a. AMETEK, Inc.; U.S. Gauge.
    b. Ashcroft Inc.
    c. Ernst Flow Industries.
    d. Flo Fab Inc.
    e. Marsh Bellofram.
    f. Miljoco Corporation.
    g. Noshok.
    h. Palmer Wahl Instrumentation Group.
    i. REOTEMP Instrument Corporation.
    j. Tel-Tru Manufacturing Company.
    k. Trerice, H. O. Co.
    l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
    m. Weiss Instruments, Inc.
    n. WIKA Instrument Corporation - USA.
    o. Winters Instruments - U.S.
    p. Weksler

2. Standard: ASME B40.100.
3. Case: Liquid-filled Open-front, pressure relief type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.

4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Metal or Brass.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACH TEST PLUGS

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

1. Flow Design, Inc.
2. MG Piping Products Co.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Trerice, H. O. Co.
7. Weksler.
8. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for water service at 20 to 200 deg F shall be CR.
2. Insert material for water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer, and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

2.6 ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches into fluid one-third of pipe diameter to center of pipe and in vertical position in piping tees.

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

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

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

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlet and outlet of each domestic hot-water storage tank.

I. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

J. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

K. Adjust faces of meters and gages to proper angle for best visibility.

L. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinds. Use minimum tubing length.

M. Install test plugs in tees in piping.

N. Install permanent indicator on walls or brackets in accessible and readable positions.

3.2 THERMOMETER SCHEDULE

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

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

B. Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

C. Thermometer stems shall be of length to match thermowell insertion length.

3.3 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.

B. Scale Range for Domestic Hot-Water Piping**:** 20 to 240 deg F and 0 to 150 deg C.

3.4 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:

1. Liquid-filled Sealed Open-front, pressure-relief, direct-mounted, metal case.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

1. Liquid-filled Sealed Open-front, pressure-relief, direct mounted, metal case.

C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:

1. Liquid-filled Sealed Open-front, pressure-relief , direct-mounted, metal case.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping 0 to 160 psi and 0 to 1100 kPa.

B. Scale Range for Domestic Water Piping: 0 to 160 psi and 0 to 1100 kPa.

END OF SECTION 22 0519

SECTION 22 0523

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 angle valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze lift check valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Bronze globe valves.
8. Iron globe valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

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.

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

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 angle and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

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

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

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

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

D. Valve Actuator Types:
1. Handwheel: For valves other than quarter-turn types.
2. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.

3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inch 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.
2. Butterfly Valves: With extended neck.

F. Valve-End Connections:

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

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

2.2 BRONZE ANGLE VALVES

A. Class 125, Bronze Angle Valves with Bronze Disc:

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

a. Hammond Valve.
b. Milwaukee Valve Company.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

2.3 BRONZE BALL VALVES

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

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

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Hammond Valve.
e. Lance Valves; a division of Advanced Thermal Systems, Inc.
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-110.
    b. SWP Rating: 150 psig.
    c. CWP Rating: 600 psig.
    d. Body Design: Two piece.
    e. Body Material: Bronze.
    f. Ends: Threaded.
    g. Seats: PTFE or TFE.
    h. Stem: Bronze.
    i. Ball: Chrome-plated brass.
    j. Port: Full.

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.
    c. CWP Rating: 600 psig.
    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, vented.
    j. Port: Full.

C. Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

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

    a. Conbraco Industries, Inc.; Apollo Valves.
    b. DynaQuip Controls.
    c. Hammond Valve.
    d. Milwaukee Valve Company.
    e. NIBCO INC.
    f. Red-White Valve Corporation.

2. Description:

    a. Standard: MSS SP-110.
    b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.
d. Body Design: Three piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

D. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

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

a. Conbraco Industries, Inc.; Apollo Valves.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.

2. Description:

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

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

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

a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.
f. DeZurik Water Controls.
g. Flo Fab Inc.
h. Hammond Valve.
i. Kitz Corporation.
j. Milwaukee Valve Company.
k. NIBCO INC.
l. Norriseal; a Dover Corporation company.
m. Red-White Valve Corporation.
n. Spence Strainers International; a division of CIRCOR International, Inc.
o. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

    a. Standard: MSS SP-67, Type I.
    b. CWP Rating: 200 psig.
    c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
    e. Seat: EPDM.
    f. Stem: One- or two-piece stainless steel.
    g. Disc: Aluminum bronze.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:

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

    a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
    b. American Valve, Inc.
    c. Conbraco Industries, Inc.; Apollo Valves.
    d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
    e. Crane Co.; Crane Valve Group; Center Line.
    f. Crane Co.; Crane Valve Group; Stockham Division.
    g. DeZurik Water Controls.
    h. Flo Fab Inc.
    i. Hammond Valve.
    j. Kitz Corporation.
    k. Milwaukee Valve Company.
    l. Mueller Steam Specialty; a division of SPX Corporation.
    m. NIBCO INC.
    n. Norriseal; a Dover Corporation company.
    o. Spence Strainers International; a division of CIRCOR International, Inc.
    p. Sure Flow Equipment Inc.
    q. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

    a. Standard: MSS SP-67, Type I.
    b. CWP Rating: 200 psig.
    c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
    e. Seat: EPDM.
    f. Stem: One- or two-piece stainless steel.
    g. Disc: Nickel-plated or -coated ductile iron.

C. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

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

    a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
    b. American Valve, Inc.
    c. Conbraco Industries, Inc.; Apollo Valves.
    d. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
    e. Crane Co.; Crane Valve Group; Jenkins Valves.
    f. Crane Co.; Crane Valve Group; Stockham Division.

g. Flo Fab Inc.
h. Hammond Valve.
i. Milwaukee Valve Company.
j. Mueller Steam Specialty; a division of SPX Corporation.
k. NIBCO INC.
l. Red-White Valve Corporation.
m. Spence Strainers International; a division of CIRCOR International, Inc.
n. Sure Flow Equipment Inc.
o. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

2.5 BRONZE SWING CHECK VALVES

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

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

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

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:

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

a. American Valve, Inc.

b. Crane Co.; Crane Valve Group; Crane Valves.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Kitz Corporation.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Red-White Valve Corporation.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

2.6 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

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

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

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

2.7 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Milwaukee Valve Company.
f. NIBCO INC.
g. Red-White Valve Corporation.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

B. Class 250, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 500 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

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, butterfly, or valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service Globe, angle, ball or butterfly valves.
4. Pump-Discharge Check Valves:

    a. NPS 2 and Smaller: Bronze swing check valves with bronze 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, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

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

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: One, Two, or Three piece, full, regular or reduced port, with brass, bronze or stainless-steel trim.
3. Bronze Lift Check Valves: Class 125, bronze disc.
4. Bronze Swing Check Valves: Class 125, bronze disc.

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

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves: 200 CWP, NBR seat, aluminum-bronze, ductile-iron or stainless-steel disc.
3. Iron Swing Check Valves: Class 125, metal seats.

3.6 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125 or Class 150, bronze disc.
3. Ball Valves: One, Two or Three piece, full or, regular port, bronze with bronze or stainless-steel trim.
4. Bronze Swing Check Valves: Class 125 or Class 150, bronze disc.
5. Bronze Globe Valves: Class 125 or Class 150, bronze disc.

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

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Ball Valves: One, Two or Three piece, full or, regular port, bronze with bronze or stainless-steel trim.
3. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze, ductile-iron or stainless-steel disc.
4. Iron Swing Check Valves: Class 125 or Class 250, metal seats.
5. Iron Globe Valves: Class 125 or Class 250.

END OF SECTION 22 0523

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SECTION 22 0529

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. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Equipment supports.

B. Related Sections include the following:

1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
3. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
4. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

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 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.

2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

1.5 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. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.6 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.
4. Pipe positioning systems.
5. Mechanical Anchors: ICC-ES Evaluation Reports validating ‘Cracked Concrete’ testing per A.C. 193 must be provided for anchors resisting seismic loads and/or supporting life- safety systems including fire sprinkler systems.

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

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Pipe stands. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

D. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Seismic calculations and detailed analysis: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices. Project specific design documentation and calculations shall be prepared and stamped by a registered professional engineer who is responsible for the seismic restraint design and who is licensed in the state where the project is being constructed (ASCE 7, 13.2.1.1).

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel.", AWS D1.4, "Structural Welding Code--Reinforcing Steel." and ASME Boiler and Pressure Vessel Code: Section IX.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 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. Manufacturers:

1. Anvil International.
2. AAA Technology & Specialties Co., Inc.
3. Bergen-Power Pipe Supports.
4. B-Line Systems, Inc.; a division of Cooper Industries.
5. Carpenter & Paterson, Inc.

6. Empire Industries, Inc.
7. ERICO/Michigan Hanger Co.
8. FNW/Ferguson Enterprises
9. Globe Pipe Hanger Products, Inc.
10. Grinnell Corp.
11. GS Metals Corp.
12. National Pipe Hanger Corporation.
13. PHD Manufacturing, Inc.
14. PHS Industries, Inc.
15. Piping Technology & Products, Inc.
16. Tolco Inc.
17. Simpson Strong-Tie Co.

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

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

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

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

B. Manufacturers:

1. Anvil International.
2. B-Line Systems, Inc.; a division of Cooper Industries.
3. ERICO/Michigan Hanger Co.; ERISTRUT Div.
4. FNW/Ferguson Enterprises
5. GS Metals Corp.
6. Hilti, Inc.
7. Power-Strut Div.; Tyco International, Ltd.
8. Thomas & Betts Corporation.
9. Tolco Inc.
10. 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.

2.5 THERMAL-HANGER SHIELD INSERTS

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

B. 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 Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

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

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

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

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. Hilti, Inc.
b. MKT Fastening, LLC.
c. Powers Fasteners.
d. Simpson Strong-Tie Co.

B. Mechanical-Expansion Anchors and Concrete Screws: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. For anchors resisting seismic loads and/or supporting life- safety systems including fire sprinkler systems, Anchors shall have been tested for 'Cracked Concrete' per A.C. 193 per a valid ICC-ES Evaluation Report. Manufacturers with these anchors have been designated below with: '*'

1. Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head.
e. MKT Fastening, LLC.
f. Powers Fasteners.
g. Simpson Strong-Tie Co. *

2.7 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

1. Manufacturers:

a. Anvil International.
b. ERICO/Michigan Hanger Co.
c. MIRO Industries.
d. Unipure

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:

a. MIRO Industries.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:

a. Anvil International.
b. ERICO/Michigan Hanger Co.
c. MIRO Industries.
d. Portable Pipe Hangers.

2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturers:

a. Anvil International.
b. Portable Pipe Hangers.

2. Bases: One or more plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 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. Manufacturers:

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

2.9 EQUIPMENT SUPPORTS

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

2.10 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, 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 hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

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

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

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.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.

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

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

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18 or Simpson Blue Banger Concrete insert with UL & FM approvals): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

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

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

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

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

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

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

O. 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. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. 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.

C. 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 above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

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

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

F. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Powder actuated fasteners shall not be used for seismic bracing attachments.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. For anchors

resisting seismic loads and/or supporting life-safety systems including fire sprinkler systems, anchors shall have been tested for 'Cracked Concrete' per A.C. 193 and shall have a valid ICC-ES Evaluation Report

G. Pipe Stand Installation:

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

H. 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.

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

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

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

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

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

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

P. 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 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

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

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

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

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

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

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

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

C. Provide lateral bracing, to prevent swaying, for equipment supports. For applications where seismic bracing is required, 'Cracked Concrete' expansion anchors or concrete screws tested per A.C. 193 must be provided for seismic bracing anchorage where post-installed anchors are required.

3.4 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

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

3.6 PAINTING

A. 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.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

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

END OF SECTION 22 0529

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SECTION 22 0533

HEAT TRACING 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. This Section includes plumbing piping heat tracing for freeze prevention, rainwater-temperature maintenance, with the following electric heating cables:

1. Constant wattage.

1.3 SUBMITTALS

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

1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 WARRANTY

A. When warranties are required, verify with Owner's counsel that special warranties stated in this Article are not less than remedies available to Owner under prevailing local laws. Coordinate with Division 01 Section "Product Requirements."

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONSTANT-WATTAGE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Chromalox, Inc.; Wiegard Industrial Division; Emerson Electric Company.
2. Delta-Therm Corporation.
3. Easy Heat Inc.
4. Nelson Heat Trace.
5. Pyrotenax; a division of Tyco Thermal Controls.
6. Raychem; a division of Tyco Thermal Controls.

B. Heating Element: Pair of parallel No. 12 AWG, nickel-coated stranded copper bus wires with single-stranded resistor wire connected between bus wires. Terminate with waterproof, factory-assembled non-heating leads with connectors at one end, and seal the opposite end watertight.

C. Electrical Insulating Jacket: Flame-retardant fluoropolymer.

D. Cable Cover: Stainless-steel braid, and polyolefin outer jacket with UV inhibitor.

E. Maximum Operating Temperature (Power On): 392 deg F.

F. Capacities and Characteristics:

1. Maximum Heat Output: Provide capacities and characteristics as noted on the drawings.

2.2 CONTROLS

A. Pipe-Mounting Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Division 22 Section "Identification for Plumbing Piping."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:
1. Freeze protection for roof drainage piping: Constant-wattage.
2. Freeze protection for compressed air piping serving dust collector: Constant-wattage.

3.3 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written recommendations using cable protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install insulation over piping with electric cables according to Division 22 Section "Plumbing Insulation."
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

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

D. Protect installed heating cables, including non-heating leads, from damage.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

1. Test cables for electrical continuity and insulation integrity before energizing.
2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 22 0533

SECTION 22 0548

VIBRATION AND SEISMIC CONTROLS 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 restraints and vibration isolation as defined in Section 230548 “Vibration Isolation and Seismic Controls for HVAC” for the following:

1. Plumbing Piping.
2. Plumbing Equipment.

PART 2 - PRODUCTS

2.1 (NOT USED)

PART 3 - EXECUTION

3.1 (NOT USED)

END OF SECTION 22 0548

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SECTION 22 0553

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. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.
7. Ceiling grid

1.3 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.

1.4 COORDINATION

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

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

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Blue.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

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

B. Letter Color: Black.

C. Background Color: Yellow.

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

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

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

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

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

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

2.3 PIPE LABELS

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

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

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

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

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard or metal.
2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

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

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

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

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Yellow background with black lettering.

2.7 CEILING GRID

A. Provide valve identification for all plumbing and med gas valves located above the ceiling on the ceiling grid below the valve.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

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

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.

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

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

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:

1. Low-Pressure, Compressed-Air Piping:

   a. Background Color: Comply with ASME A13.1.
   b. Letter Color: Comply with ASME A13.1.

2. Medium-Pressure, Compressed-Air Piping:

   a. Background Color: Comply with ASME A13.1.
   b. Letter Color: Comply with ASME A13.1.

3. Domestic Water Piping:

   a. Background Color: Comply with ASME A13.1.
   b. Letter Color: Comply with ASME A13.1.

4. Sanitary Waste and Storm Drainage Piping:

   a. Background Color: Comply with ASME A13.1.
   b. Letter Color: Comply with ASME A13.1.

3.4 VALVE-TAG INSTALLATION

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

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

1. Valve-Tag Size and Shape:

   a. Cold Water: 1-1/2 inches, round.
   b. Hot Water: 1-1/2 inches, round.
   c. Low-Pressure Compressed Air: 1-1/2 inches, round.
   d. High-Pressure Compressed Air: 1-1/2 inches, round.

2. Valve-Tag Color:

   a. Cold Water: Comply with ASME A13.1.
   b. Hot Water: Comply with ASME A13.1.
   c. Low-Pressure Compressed Air: Comply with ASME A13.1.
   d. High-Pressure Compressed Air: Comply with ASME A13.1.

3. Letter Color:

a. Cold Water: Comply with ASME A13.1.
b. Hot Water: Comply with ASME A13.1.
c. Low-Pressure Compressed Air: Comply with ASME A13.1.
d. High-Pressure Compressed Air: Comply with ASME A13.1.

3.5 WARNING-TAG INSTALLATION

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

END OF SECTION 22 0553

SECTION 22 0700

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. Flexible elastomeric.
b. Mineral fiber.

2. Adhesives.
3. Lagging adhesives.
4. Sealants.
5. Factory-applied jackets.
6. Field-applied fabric-reinforcing mesh.
7. Field-applied jackets.
8. Tapes.
9. Securements.
10. Corner angles.

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. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.

C. Qualification Data: For qualified Installer.

D. 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.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

B. 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.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 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.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

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

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

G. 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 I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; All-Service Duct Wrap.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Commercial Board.
b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.
e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglass 700 Series.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of 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 Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; CrimpWrap.
    b. Johns Manville; MicroFlex.
    c. Knauf Insulation; Pipe and Tank Insulation.
    d. Manson Insulation Inc.; AK Flex.
    e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Aeroflex USA Inc.; Aeroseal.
    b. Armacell LCC; 520 Adhesive.
    c. Foster Products Corporation, H. B. Fuller Company; 85-75.
    d. RBX Corporation; Rubatex Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of 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.

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of 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.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Dow Chemical Company (The); 739, Dow Silicone.
    b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    c. P.I.C. Plastics, Inc.; Welding Adhesive.
    d. Red Devil, Inc.; Celulon Ultra Clear.
    e. Speedline Corporation; Speedline Vinyl Adhesive.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Products, Division of ITW; CP-35.
    b. Foster Products Corporation, H. B. Fuller Company; 30-90.
    c. ITW TACC, Division of Illinois Tool Works; CB-50.
    d. Marathon Industries, Inc.; 590.
    e. Mon-Eco Industries, Inc.; 55-40.
    f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Products, Division of ITW; Encacel.
    b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
    c. Marathon Industries, Inc.; 570.
    d. Mon-Eco Industries, Inc.; 55-70.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-52.
b. Foster Products Corporation, H. B. Fuller Company; 81-42.
c. Marathon Industries, Inc.; 130.
d. Mon-Eco Industries, Inc.; 11-30.
e. Vimasco Corporation; 136.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-76-8.
b. Foster Products Corporation, H. B. Fuller Company; 95-44.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

    a. Products: Subject to compliance with requirements, provide the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

5. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

    a. Products: Subject to compliance with requirements, provide the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

    a. Products: Subject to compliance with requirements, provide the following:

        1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.7 FIELD-APPLIED JACKETS

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

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of 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.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.

   a. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 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, provide one of 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.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of 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.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of 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.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    b. Compac Corp.; 120.
    c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide the following:

    a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.

6. Tensile Strength: 55 lbf/inch in width.

2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

   a. Products: Subject to compliance with requirements, provide one of 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, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

   a. Products: Subject to compliance with requirements, provide one of 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, provide one of 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 thick by 2 inches square.
c. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch- 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. Self-Sticking-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, provide one of the following:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
2) GEMCO; Press and Peel.
3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Aluminum or Stainless steel], fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, 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 in diameter.

a. Products: Subject to compliance with requirements, provide one of 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.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy or 0.062-inch soft-annealed, stainless steel.

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

a. C & F Wire.
b. Childers Products.
c. PABCO Metals Corporation.
d. RPR Products, Inc.

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.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation 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. Install multiple layers of insulation with longitudinal and end seams staggered.

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

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

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

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

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

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping"irestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

a. Do not weld anchor pins to ASME-labeled pressure vessels.

b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
d. Do not overcompress insulation during installation.
e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
f. Impale insulation over anchor pins and attach speed washers.
g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum or stainless steel, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular

surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe

insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 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 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, 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.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

D. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 Insulation shall have a k value that meets the minimum requirements of the latest International Energy Conservation Code (IECC).

3.12 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Unfired Hot Water Storage Tanks
1. Mineral-Fiber Board: 3.5 inches thick and 2-lb/cu. ft. nominal density.
2. Mineral-Fiber Pipe and Tank: 3.5 inches thick.

D. Domestic hot-water pump insulation shall be the following:

1. Mineral-Fiber Board: 1 inch thick and 2-lb/cu. ft. nominal density.

3.13 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.

3.14 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1-1/2 and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch

2. NPS 2 and Larger: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/2 and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch.

2. NPS 2 and Larger: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.

C. Stormwater and Overflow:

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

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch.

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.

E. Condensate and Equipment Drain Water below 60 Deg F:

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

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch.

F. Compressed Air Piping: Preformed Pipe Insulation, Type I: 1 inch.

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches.

1. Aluminum, Stucco Embossed: 0.016 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum, Stucco Embossed with 1-1/4-Inch- Deep Corrugations: 0.032 inch thick.

F. Piping, Concealed:

1. None.

G. Piping, Exposed:

1. PVC: 20 mils thick.

3.16 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

END OF SECTION 22 0700

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SECTION 22 1116

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. Aboveground domestic water pipes, tubes, and fittings inside buildings.

1.3 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Construction Manager or owner no fewer than two days in advance of proposed interruption of water service.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

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

C. All piping shall be American made and tested; no import pipe will be permitted.

2.2 COPPER TUBE AND FITTINGS

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

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

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

2.3 PIPING JOINING MATERIALS

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

B. Flux: ASTM B 813, water flushable.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

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

3.2 JOINT CONSTRUCTION

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

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

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

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

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

3.3 CONNECTIONS

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

3.4 PIPING SCHEDULE

A. Aboveground domestic water piping, NPS 2 and smaller shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast- copper, solder-joint fittings; and soldered joints.

END OF SECTION 22 1116

SECTION 22 1119

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. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose bibbs.
9. Wall hydrants.
10. Drain valves.
11. Water hammer arresters.
12. Trap-seal primer valves.
13. Trap-seal primer systems.

B. Related Sections include the following:

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

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, 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 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

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

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

a. Ames Co.
b. Cash Acme.
c. Conbraco Industries, Inc.
d. FEBCO; SPX Valves & Controls.
e. Rain Bird Corporation.
f. Toro Company (The); Irrigation Div.
g. Watts Industries, Inc.; Water Products Div.
h. Zurn Plumbing Products Group; Wilkins Div.

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

B. Hose-Connection Vacuum Breakers:

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

a. Arrowhead Brass Products, Inc.
b. Cash Acme.
c. Conbraco Industries, Inc.
d. MIFAB, Inc.
e. Prier Products, Inc.
f. Watts Industries, Inc.; Water Products Div.
g. Woodford Manufacturing Company.

h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Zurn Plumbing Products Group; Wilkins Div.

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

C. Pressure Vacuum Breakers:

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

a. Ames Co.
b. Conbraco Industries, Inc.
c. FEBCO; SPX Valves & Controls.
d. Flomatic Corporation.
e. Toro Company (The); Irrigation Div.
f. Watts Industries, Inc.; Water Products Div.
g. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Accessories:

a. Valves: Ball type, on inlet and outlet.

D. Spill-Resistant Vacuum Breakers:

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

a. Conbraco Industries, Inc.
b. Watts Industries, Inc.; Water Products Div.

2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Accessories:

a. Valves: Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved] for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Accessories:

   a. Valves: Ball type with threaded ends on inlet and outlet ofNPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
   b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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 maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; [flanged] <Insert type> for NPS 2-1/2 and larger.
7. Accessories:

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

C. Beverage-Dispensing-Equipment Backflow Preventers:

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

   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1022.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.
5. Body: Stainless steel.
6. End Connections: Threaded.

D. Dual-Check-Valve Backflow Preventers:

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

   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Flomatic Corporation.
   e. Ford Meter Box Company, Inc. (The).
   f. Honeywell Water Controls.
   g. McDonald, A. Y. Mfg. Co.
   h. Mueller Co.; Water Products Div.
   i. Watts Industries, Inc.; Water Products Div.
   j. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Body: Bronze with union inlet.

E. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:

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

   a. Cash Acme.
   b. Lancer Corporation.
   c. Watts Industries, Inc.; Water Products Div.

2. Standard: ASSE 1032.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.
5. Body: Stainless steel.
6. End Connections: Threaded.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators: (Direct Type)

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

   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Honeywell Water Controls.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze, provide chrome-plated finish if connected to chrome plated or stainless steel piping for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
5. Valves for Booster Heater Water Supply: Include integral bypass.

6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

B. Water Control Valves: (Pilot type)

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

   a. CLA-VAL Automatic Control Valves.
   b. Mifab Corp; Beeco.
   c. Watts Industries, Inc.; Ames Fluid Control Systems.
   d. Watts Industries, Inc.; Watts ACV.
   e. Zurn Plumbing Products Group; Wilkins Div.

2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.
3. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

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

   a. Armstrong International, Inc.
   b. Flo Fab Inc.
   c. ITT Industries; Bell & Gossett Div.
   d. NIBCO INC. Model S/T/PC-1810-LF
   e. TAC Americas.
   f. Taco, Inc.
   g. Victaulic
   h. Watts Industries, Inc.; Water Products Div.

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.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:

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

   a. Armstrong International, Inc.
   b. Flo Fab Inc.
   c. ITT Industries; Bell & Gossett Div.
   d. NIBCO INC. (F-737 or F-739)
   e. TAC Americas.
   f. Watts Industries, Inc.; Water Products Div.

2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2.

C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

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

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

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
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. Manufacturers: Subject to compliance with requirements, provide products by one of 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 1070, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig 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.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.020 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
    c. Strainers NPS 5 and Larger: 0.10 inch.

6. Drain: Factory-installed, hose-end drain valve.

2.7 OUTLET BOXES

A. Icemaker Outlet Boxes:

1. Basis of Design: Guy Gray model FR1212SHACP fire rated washing machine box with one ¼ turn valve with water hammer arrestor and 1-1/2" drain connection.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Acorn Engineering Company.
    b. Guy Gray Manufacturing Co., Inc.
    c. IPS Corporation.
    d. LSP Products Group, Inc.
    e. Oatey.
    f. Plastic Oddities; a division of Diverse Corporate Technologies.
    g. Symmons Industries, Inc.
    h. Watts Industries, Inc.; Water Products Div.
    i. Zurn Plumbing Products Group; Light Commercial Operation.

3. Mounting: Recessed.
4. Material and Finish: Enameled-steel or epoxy-painted-steel or plastic box and faceplate.
5. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
6. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
7. Drain: [NPS 1-1/2] [NPS 2] standpipe and P-trap for direct waste connection to drainage piping.
8. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
9. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

B. Water Outlet Boxes:

1. Basis of Design: Water-Tite model W9200HA 6" diameter outlet box with ¼ turn valve and water hammer arrestor.

2. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

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

2.8 HOSE BIBBS

A. Hose Bibbs HB-1:

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

2.9 WALL HYDRANTS

A. Nonfreeze Wall Hydrants NFH-1:

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

    a. Josam Company.
    b. MIFAB, Inc.
    c. Prier Products, Inc.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    e. Tyler Pipe; Wade Div.
    f. Watts Drainage Products 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 concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.
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.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Operating Keys: Two with each wall hydrant.

2.10 DRAIN VALVES

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

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.11 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

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

2.12 TRAP-SEAL PRIMER VALVES

A. TP-1 Trap Seal Primer Valves: Electric water-supply-fed trap priming manifold with the following characteristics:

1. 125-psig minimum working pressure.
2. Bronze body with atmospheric-vented drain chamber.
3. Inlet and Outlet Connections: 3/4-inch inlet and 1/2-inch outlet threaded, union, or solder joint.
4. Gravity Drain Outlet Connection: 1/2-inch threaded or solder joint.
5. Electric solenoid valve 120 volt.
6. Water hammer arrestor.
7. Vacuum breaker.
8. Factory fabricated. 4 outlets to 30 outlets as shown on drawings.

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

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

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

1. Install thermometers and water regulators if specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

G. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

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

I. 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.

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 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

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

1. Pressure vacuum breakers.
2. Reduced-pressure-principle backflow preventers.
3. Double-check backflow-prevention assemblies.
4. Carbonated-beverage-machine backflow preventers.
5. Dual-check-valve backflow preventers.
6. Water pressure-reducing valves.
7. Calibrated balancing valves.
8. Primary, thermostatic, water mixing valves.
9. Primary water tempering valves.
10. Outlet boxes.
11. Trap-seal primer systems.

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

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each backflow preventer 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.

3.5 ADJUSTING

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

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

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

END OF SECTION 22 1119

SECTION 22 1123

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. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic cold- and hot-water circulation:

1. Separately-coupled, horizontally mounted, in-line centrifugal pumps.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.4 SUBMITTALS

A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

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

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

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Protect bearings and couplings against damage.

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

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 SEPARATELY COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:

1. Armstrong.
2. Bell & Gossett Domestic Pump; ITT Industries.
3. Grundfos Pumps Corp.
4. Taco, Inc.
5. Weinman Div.; Crane Pumps & Systems.

B. Description: Factory-assembled and -tested, overhung-impeller, single-stage, separately coupled, horizontally mounted, in-line centrifugal pumps as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.

1. Pump Construction: All bronze.

   a. Casing: Radially split, cast iron, with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
   b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
   c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
   d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
   e. Bearings: Oil-lubricated; bronze-journal or ball type.

2. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
3. Motor: Single speed, with grease-lubricated ball bearings; and resiliently mounted to pump casing. Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

2.3 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Anamet, Inc.
2. Flex-Hose Co., Inc.
3. Flexicraft Industries.
4. Flex-Pression, Ltd.
5. Flex-Weld, Inc.
6. Fugate
7. Hyspan Precision Products, Inc.
8. Mercer Rubber.
9. Metraflex, Inc.
10. Proco Products, Inc.
11. Tozen America Corporation.
12. Twin City Hose.
13. Unaflex Inc.

B. Description: Corrugated, bronze inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze-welded to tubing. Include 125-psig minimum working-pressure rating and ends matching pump connections.

2.4 BUILDING-AUTOMATION-SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:

1. On-off status of each pump.
2. Alarm status.

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 SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with HI 1.4.

C. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

E. Install separately coupled, horizontally mounted, in-line centrifugal pumps with motor and pump shafts horizontal.

F. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight. Vibration isolation devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

3.3 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 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. Refer to Division 22 Section "Domestic Water Piping."

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

    a. Separately coupled, horizontally mounted, in-line centrifugal pumps.

2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.
3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and

discharge piping around pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and gage connectors.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. Interlock pump with water heater burner and time delay relay.

3.4 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

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

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

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 22 1123

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SECTION 22 1223

FACILITY INDOOR POTABLE-WATER STORAGE TANKS

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. Steel, pressure, potable-water storage tanks.
2. Steel, precharged, potable-water storage tanks.

1.3 DEFINITIONS

A. HDPE: High-density polyethylene plastic.

B. LDPE: Low-density polyethylene plastic.

1.4 ACTION SUBMITTALS

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

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water storage tanks.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For steel water storage tanks, accessories, and components, from manufacturer.

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

B. Product Certificates: For each type of potable-water storage tank, from manufacturer.

C. Source quality-control reports.

D. Purging and disinfecting reports.

1.6 QUALITY ASSURANCE

A. ASME Compliance for Steel Tanks: Fabricate and label steel, ASME-code, potable-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

B. Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for potable-water storage tanks. Include appropriate NSF marking.

1.7 COORDINATION

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

PART 2 - PRODUCTS

2.1 STEEL, PRESSURE, POTABLE-WATER STORAGE TANKS

A. Description: Steel, vertical, pressure-rated tank with cylindrical sidewalls.

B. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

C. Construction: ASME code, steel, constructed with nontoxic welded joints, for 125-psig working pressure.

D. Manhole: Watertight, for tank more than 36 inches in diameter; same pressure rating as tank.

E. Tappings: Factory-fabricated stainless steel, welded to tank before testing and labeling.

1. NPS 2 and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 and Larger: ASME B16.5, flanged.

F. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure relief valve.
2. Pressure gage.
3. Thermometer.
4. Air-charging connection.
5. Gage glass, brass fittings, compression stops, and gage-glass guard.

G. Horizontal Tank Supports: Factory-fabricated steel saddles, welded to tank before testing and labeling.

H. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank before testing and labeling.

I. Tank Interior Finish: Materials and thicknesses complying with NSF 61 Annex G barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

1. Lining Material: Cement.
2. Coating: Glass.

J. Exterior Coating: Manufacturer's standard enamel paint.

2.2 STEEL, PRECHARGED, POTABLE-WATER STORAGE TANKS

A. Steel, Precharged, Diaphragm, Water Storage Tanks:
1. Description: Steel, vertical, pressured-rated tank with cylindrical sidewalls and with air-charging valve and air precharge.
2. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.
3. Operation: Factory-installed, butyl-rubber diaphragm.

B. Construction: ASME code, steel, constructed with nontoxic welded joints, for 125-psig working pressure.

C. Tappings: Factory-fabricated stainless steel, welded to tank before testing and labeling.

1. NPS 2 and Smaller: ASME B1.20.1, with female thread.
2. NPS 2-1/2 and Larger: ASME B16.5, flanged.

D. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure gage.

E. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank before testing and labeling.

F. Tank Interior Finish: Materials and thicknesses complying with NSF 61 Annex G barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

1. Lining Material: Cement.
2. Coating: Glass.

G. Exterior Coating: Manufacturer's standard enamel paint.

2.3 SOURCE QUALITY CONTROL

A. Test and inspect potable-water storage tanks according to the following tests and inspections and prepare test reports:

1. Pressure Testing for ASME-Code, Potable-Water Storage Tanks: Hydrostatically test to ensure structural integrity and freedom from leaks. Fill tanks with water, vent air, pressurize to 1-1/2 times tank pressure rating, disconnect test equipment, hold pressure for 30 minutes with no drop in pressure, and check for leaks.

B. Repair or replace tanks that fail test with new tanks, and repeat until test is satisfactory.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install water storage tanks on concrete bases, level and plumb, firmly anchored. Arrange so devices needing servicing are accessible.

B. Install tank seismic restraints.

C. Install thermometers and pressure gages on water storage tanks and piping if indicated. Thermometers and pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."

D. Install the following devices on tanks where indicated:

1. Pressure relief valves.
2. Temperature and pressure relief valves.
3. Vacuum relief valves.
4. Tank vents on nonpressure tanks.
5. Connections to accessories.

E. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

3.2 CONNECTIONS

A. Piping installation requirements are specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to potable-water storage tanks to allow service and maintenance.

C. Connect water piping to water storage tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.

1. General-duty valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping."

a. Valves NPS 2 and Smaller: Gate or ball.
b. Valves NPS 2-1/2 and Larger: Gate or butterfly.
c. Drain Valves: NPS 3/4 ball valve. Include outlet with, or nipple in outlet with, ASME B1.20.7, 3/4-11.5NH thread for garden-hose service, threaded cap, and chain.

2. Water Piping Connections: Make connections to dissimilar metals with dielectric fittings. Dielectric fittings are specified in Section 221116 "Domestic Water Piping."
3. Connect air piping to hydropneumatic tanks with unions or flanges and gate or ball valves. Make connections to dissimilar metals with dielectric fittings, which are specified in Section 221513 "General-Service Compressed-Air Piping."

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following final checks before filling:

1. Verify that air precharge in precharged tanks is correct.
2. Test operation of tank accessories and devices.
3. Verify that pressure relief valves have correct setting.

    a. Manually operate pressure relief valves.
    b. Adjust pressure settings.

4. Verify that vacuum relief valves are correct size.

    a. Manually operate vacuum relief valves.
    b. Adjust vacuum settings.

B. Filling Procedures: Follow manufacturer's written procedures. Fill tanks with water to operating level.

3.5 CLEANING

A. Clean and disinfect potable-water storage tanks.

B. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, use procedure described in AWWA C652 or as described below:

1. Purge water storage tanks with potable water.
2. Disinfect tanks by one of the following methods:

    a. Fill tanks with water-chlorine solution containing at least 50 ppm of chlorine. Isolate tanks and allow to stand for 24 hours.
    b. Fill tanks with water-chlorine solution containing at least 200 ppm of chlorine. Isolate tanks and allow to stand for three hours.

3. Flush tanks, after required standing time, with clean, potable water until chlorine is not present in water coming from tank.
4. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination made by authorities having jurisdiction shows evidence of contamination.

C. Prepare written reports for purging and disinfecting activities.

END OF SECTION 22 1223

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SECTION 22 1316

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. Section Includes:

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

B. Related Sections:

1. Division 22 Section "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Division 22 Section "Chemical-Waste Systems for Laboratory " for chemical-waste and vent piping systems.

1.3 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.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, 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. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

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

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

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 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: All cast-iron waste, vent and sewer pipe and fittings shall conform to the requirements of CISPI Standard 301 and ASTM A 888. All products shall be marked with the collective trademark of the Cast Soil Pipe Institute and shall be listed by NSF International or receive prior approval of the engineer. All cast-iron pipe and fittings shall be American made and tested. Non-compliant import cast-iron products will not be permitted. Any non-compliant cast-iron product installed by the contractor on this project will be replaced at the contractor's expense and shall include all repairs, patching, painting and other incidental work required to return the project to its pre-remediation state.

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

a. AB&I Foundry
b. Charoltte Pipe
c. Tyler Pipe

B. CISPI, Hubless-Piping Couplings:

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

a. ANACO.
b. Ideal
c. Mission Rubber Company; a division of MCP Industries, Inc.
d. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Listing: Couplings shall be listed by NSF International. Each coupling shall be embossed with the NSF seal.

C. Heavy-Duty, Hubless-Piping Couplings:

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

   a. Husky SD 4000.
   b. Clamp-All Corp HI-TORQ 125.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

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

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

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

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

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

L. 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.

M. 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.
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.

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

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install underground PVC piping according to ASTM D 2321.

P. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

Q. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with

requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."

2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
3. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

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

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

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

3.3 JOINT CONSTRUCTION

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

B. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

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

1. Install carbon-**s**teel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting and coupling or valve and coupling.

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

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inchod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

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

3.5 CONNECTIONS

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

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

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Comply with requirements for cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make fixture and equipment connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

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

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

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

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

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

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

3.8 CLEANING AND PROTECTION

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

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

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

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 3 and smaller shall be the following:

1. Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 4 and larger shall be the following:

1. Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 3 and smaller shall be the following:

1. Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

E. Aboveground, vent piping NPS 4 and larger shall be the following:

1. Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 3 and smaller shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings CISPI hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

G. Underground, soil and waste piping NPS 4 and larger shall be the following:

1. Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 22 1316

SECTION 22 1319

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. Through-penetration firestop assemblies.
5. Miscellaneous sanitary drainage piping specialties.
6. Flashing materials.
7. Barrier type floor drain trap seal protection devices.

B. Related Sections include the following:

1. Division 22 Section "Storm Drainage Piping Specialties" for storm water, and roof drains.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1.4 DEFINITIONS

A. FOG: Fats, oils, and greases.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.5 SUBMITTALS

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

1.6 QUALITY ASSURANCE

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

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

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.
    g. Sun Drainage Products

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

B. Metal Floor Cleanouts:

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

    a. Josam Company; Josam Div.
    b. Oatey.
    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; Light Commercial Operation.
    g. Zurn Plumbing Products Group; Specification Drainage Operation.
    h. Sun Drainage Products

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

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.
    g. Sun Drainage Products

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.

5. Closure: Countersunk, brass 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, stainless-steel wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: See Schedule at end of this Section:

    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.
    g. Sun Drainage Products

3. Standard: ASME A112.6.3.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Not required.
7. Outlet: Bottom.
8. Trap Material: Cast iron>.
9. Trap Pattern: Deep-seal P-trap>.
10. Trap Features: Trap-seal primer valve drain connection>.

2.3 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ProSet Systems Inc.

3. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
4. Size: Same as connected soil, waste, or vent stack.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
7. Special Coating: Corrosion resistant on interior of fittings.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

    a. NPS 2: 4-inch- minimum water seal.
    b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

B. Floor-Drain, 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 side inlet.

C. Barrier Type Floor Drain Trap Seal Protection Devices:
1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
    a. Green Drain
    b. Rector Seal
    c. Jay R Smith; Quad Close Stink Stopper
    d. IPS Corp; Trap-Tite
    e. Provent System; Proset
    f. Zurn; Z-Shield
2. Description: Device consisting of a membrane that allows the flow of drainage to enter the plumbing drainage system. The device shall close when there is no flow.
3. Standard: ASSE 1072, Performance Requirements for Barrier Type Seal Protection for Floor Drains.
4. Size: The device shall be sized according to the nominal pipe size of the device it installs into, except for the 3-1/2-in device which installs into the inside of a floor drain fitting that complies with ASME A112.6.3. Sizes shall include 1-1/2 NPS through 6 NPS.
5. Flow Capacity: The device shall permit the flow of drainage as stipulated in Std ASSE-1072. Minimum flow rates shall be equivalent to drainage piping flowing one half full flow with a roughness coefficient of 0.011 and a pitch of ¼-inch per foot.

D. 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.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch > above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Cap Filters:

1. Description: Activated carbon filter in housing for installation at vent terminal as manufactured by Sweet Filter.
2. Size: Same as connected stack vent or vent stack.

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., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

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

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

E. 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. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

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 the following drainage area radii:

    a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install deep-seal traps on floor drains and other waste outlets, if indicated.

G. 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.

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

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

J. Install vent cap filters on each vent pipe passing through roof.

K. Install wood-blocking reinforcement for wall-mounting-type specialties.

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.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

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

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

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

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

3.4 LABELING AND IDENTIFYING

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

1. Trap Primer devices.

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

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled trap primer devices and their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

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

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.7 FLOOR DRAIN SCHEDULE (See Plumbing Fixture Schedule for Fixture Descriptions)

END OF SECTION 22 1319

SECTION 22 1413

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.
2. Special pipe fittings.

B. Related Sections include the following:

1. Division 22 Section "Sump Pumps."

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

1.4 DEFINITIONS

A. LLDPE: Linear, low-density polyethylene plastic.

B. PE: Polyethylene plastic.

C. PVC: Polyvinyl chloride plastic.

D. TPE: Thermoplastic elastomer.

1.5 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.

B. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 “Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.6 SUBMITTALS

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

B. Shop Drawings:
1. Controlled-Flow Storm Drainage System: Include calculations, plans, and details.

C. Field quality-control inspection and test reports.

D. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

1.7 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. Manufacturers: Subject to compliance with requirements, provide products by one of the 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 or CISPI 301. All waste, vent, sewer and storm lines shall be soil pipe and fittings that conform to the requirements of CISPI Standard 301, ASTM A ** and shall be marked with the collective trademark of the Cast Soil Pipe Institute or Receive Prior approval of the engineer and manufactured by AB&I Foundry, Tyler Pipe, or Charlotte Pipe. **In addition all Cast iron shall be American made and tested, no "non compliant" import cast iron will be permitted.**

A. CISPI, Hubless-Piping Couplings:

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

a. ANACO.
b. Ideal
c. Mission Rubber Company; a division of MCP Industries, Inc.
d. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Listing: Couplings shall be listed by NSF International. Each coupling shall be embossed with the NSF seal.

B. Heavy-Duty, Hubless-Piping Couplings:

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

a. Husky HD 2000.
b. Clamp-All Corp HI-TORQ 80.
c. Ideal HD
d. Mission HW.
e. Tyler Pipe Widebody.

2. Standards: ASTM C 1277 and ASTM C 1540.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

2.5 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Dallas Specialty & Mfg. Co.
b. Fernco, Inc.
c. Logan Clay Products Company (The).
d. Mission Rubber Co.
e. NDS, Inc.
f. Plastic Oddities, Inc.

2. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: 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.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Mission Rubber Co.

PART 3 - EXECUTION

3.1 EXCAVATION

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

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground storm drainage piping shall be the following:

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

C. Underground storm drainage piping shall be the following (to 6" above finished floor):

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Hub-and spigot cast-iron soil pipe, hub-and spigot cast-iron soil pipe fittings, neoprene rubber gasket, and compression joints.

3.3 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Utility Drainage Piping."

B. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

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

D. 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."

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Fire Plumbing."

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

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

G. 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.

H. 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.

I. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm-Drainage Piping: 1 percent downward in direction of flow.

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

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

L. Install underground PVC storm drainage piping according to ASTM D 2321.

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

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results 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. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. 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 and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer than 100 Feet, if indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

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

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

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

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6: 60 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. 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 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. 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 22 1413

SECTION 22 1423

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. This Section includes the following storm drainage piping specialties:

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

B. Related Sections include the following:

1. Division 22 Section "Sanitary Waste Piping Specialties" for floor drains, connected to sanitary sewer, air admittance valves, grease interceptors and solid interceptors.

1.3 DEFINITIONS

A. PUR: Polyurethane plastic.

B. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:

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

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

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

B. Metal Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.
    i. Sun Drainage Products

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

15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

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

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

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, 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.

2.2 ROOF DRAINS

A. Metal Roof Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: See Schedule at end of this section for drain descriptions:

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

3. Standard: ASME A112.21.2M.
4. Body Material Cast iron.
5. Combination Flashing Ring and Gravel Stop: Required.
6. Dome Material: Cast iron.
7. Extension Collars: Required.
8. Underdeck Clamp Required.
9. Sump Receiver: Required.

B. Conductor Nozzles DSN-1:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

2.3 FLASHING MATERIALS

A. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

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

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

D. 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. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

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 roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.

1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Position roof drains for easy access and maintenance.

F. Install manufactured, gray-iron downspout boots at grade with top [6 inches] [12 inches] [18 inches] above grade. Secure to building wall.

G. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

H. 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.

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., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. 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.

3.5 ROOF DRAIN SCHEDULE (See Plumbing Fixture Schedule for Fixture Description)

END OF SECTION 22 1423

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SECTION 22 1513

GENERAL-SERVICE COMPRESSED-AIR 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 piping and related specialties for general-service compressed-air systems operating at 200 psig or less.

B. Related Sections include the following:

1. Division 22 Section "General-Service Packaged Air Compressors and Receivers" for general-service air compressors and accessories.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

1.4 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene rubber.

D. PE: Polyethylene plastic.

E. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig.

F. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

1.5 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.6 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Flexible pipe connectors.
3. Safety valves.
4. Pressure regulators. Include rated capacities and operating characteristics.
5. Automatic drain valves.
6. Filters. Include rated capacities and operating characteristics.
7. Quick couplings.
8. Hose assemblies.

B. Manufacturer Seismic Qualification Certification: Submit certification that plumbing equipment and components will withstand seismic forces defined in Division 22 Section "Mechanical Vibration and Seismic Controls." Include the following:

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

C. Brazing certificates.

D. Qualification Data: For Installers.

E. Field quality-control test reports.

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

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Tube: ASTM B 88, Type L 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. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
3. Copper Unions: ASME B16.22 or MSS SP-123.

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

2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

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/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

2.3 VALVES

A. Metal Ball, Butterfly, Check, and Globe Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping."

2.4 DIELECTRIC FITTINGS

A. General Requirements for Dielectric Fittings: Combination fitting of copper alloy and ferrous materials with insulating material; suitable for system fluid, pressure, and temperature. Include threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Dielectric Unions: Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

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

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Hart Industries International, Inc.
e. Watts Water Technologies, Inc.; Water Products Div.
f. Zurn Plumbing Products Group; Wilkins Div.

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, Inc.
6. Proco Products, Inc.
7. Unaflex, Inc.
8. Universal Metal Hose; a Hyspan Company

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 minimum.
2. End Connections, NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections, NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: 200 psig minimum.
2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.
3. End Connections, NPS 2-1/2 and Larger: Flanged steel nipple.

2.6 SLEEVES

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

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

1. Underdeck Clamp: Clamping ring with set screws.

2.7 ESCUTCHEONS

A. General Requirements: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and 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, Cast-Brass Escutcheons: With set screw.

1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

1. Finish: Polished chrome-plated.

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

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

G. One-Piece, Floor-Plate Escutcheons: Cast iron.

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

2.8 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Line Pressure Regulators: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.

C. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate

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

E. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock

2.9 QUICK COUPLINGS

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

1. Aeroquip Corporation; Eaton Corp.
2. Bowes Manufacturing Inc.
3. Foster Manufacturing, Inc.
4. Milton Industries, Inc.
5. Parker Hannifin Corp.; Fluid Connectors Group; Quick Coupling Div.
6. Rectus Corp.
7. Schrader-Bridgeport; Amflo Div.
8. Schrader-Bridgeport/Standard Thomson.
9. Snap-Tite, Inc.; Quick Disconnect & Valve Division.
10. TOMCO Products Inc.
11. Tuthill Corporation; Hansen Coupling Div.

B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.

1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
2. Plug End: Straight-through type with barbed outlet for attaching hose.

D. Valveless Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.

1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
2. Plug End: With barbed outlet for attaching hose.

2.10 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, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SEISMIC REQUIREMENTS

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

3.2 PIPING APPLICATIONS

A. Compressed-Air Piping between Air Compressors and Receivers: Use the following piping materials for each size range:

1. NPS 2 and Smaller: Type L, copper tube; wrought-copper fittings; and brazed joints.

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

1. NPS 2 and Smaller: Type L, copper tube; wrought-copper fittings; and brazed or soldered joints.

C. Drain Piping: Use the following piping materials:

1. NPS 2 and Smaller: Type L copper tube; wrought-copper fittings; and brazed or soldered joints.

3.3 VALVE APPLICATIONS

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for metal general-duty valves. Use metal valves, unless otherwise indicated.

1. Metal General-Duty Valves: Use valve types specified in "Valve Applications" Article in Division 22 Section "General-Duty Valves for Plumbing Piping" according to the following:

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

3.4 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. Equipment and Specialty Flanged Connections:

1. Use steel companion flange with gasket for connection to steel pipe.

2. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

I. Flanged joints may be used instead of specified joint for any piping or tubing system.

J. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F 2014.

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

L. 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.

M. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."

N. Install piping to permit valve servicing.

O. Install piping free of sags and bends.

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

Q. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

3.5 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.

3.6 VALVE INSTALLATION

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

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

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

D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.7 DIELECTRIC FITTING INSTALLATION

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

B. NPS 2 and Smaller: Use dielectric unions.

3.8 FLEXIBLE PIPE CONNECTOR INSTALLATION

A. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter 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.

3.9 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 aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.

E. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters.

F. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters.

G. Install quick couplings at piping terminals for hose connections.

3.10 CONNECTIONS

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

3.11 SLEEVE INSTALLATION

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

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

C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe.

D. Install sleeves for pipes passing through concrete and masonry walls, gypsum board partitions, and concrete floor and roof slabs.

1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

E. Install sleeves in new walls and slabs as new walls and slabs are constructed.

F. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

1. Steel Pipe Sleeves: For pipes smaller than NPS 6.

a. Seal space outside of sleeve fittings with grout.

G. 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 Section "Penetration Firestopping."

3.12 ESCUTCHEON INSTALLATION

A. 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.
b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
e. Bare Piping in Equipment Rooms: One piece, cast brass.
f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.13 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment " for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

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

D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet or Less: MSS Type 1, adjustable, steel clevis hangers.
2. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches of each fitting and coupling.

H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

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

1. NPS 1/4: 60 inches with 3/8-inch rod.
2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
3. NPS 3/4: 84 inches with 3/8-inch rod.
4. NPS 1: 96 inches with 3/8-inch rod.
5. NPS 1-1/4: 108 inches with 3/8-inch rod.
6. NPS 1-1/2: 10 feet with 3/8-inch rod.
7. NPS 2: 11 feet with 3/8-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

3.14 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.15 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less

than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

2. Repair leaks and retest until no leaks exist.
3. Inspect filters and pressure regulators for proper operation.

C. Prepare test reports.

END OF SECTION 22 1513

SECTION 22 1519

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. Oilless, reciprocating air compressors.
2. Inlet-air filters.
3. Refrigerant compressed-air dryers.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

1.4 DEFINITIONS

A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.

B. 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.

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

1.5 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design compressed-air equipment mounting, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.6 SUBMITTALS

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

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

B. Delegated-Design Submittal: For compressed-air equipment mounting indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of supports.
2. Seismic calculations and detailed analysis: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices. Project specific design documentation and calculations shall be prepared and stamped by a registered professional engineer who is responsible for the seismic restraint design and who is licensed in the state where the project is being constructed (ASCE 7, 13.2.1.1).

A. Manufacturer Seismic Qualification Certification: Submit certification that plumbing equipment and components will withstand seismic forces defined in Division 22 Section "Mechanical Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

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

1.7 QUALITY ASSURANCE

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

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

1.8 COORDINATION

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

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. Air-Compressor, Inlet-Air-Filter Elements: Equal to 10 percent of amount installed, but no fewer than 2 units.
2. Belts: Two for each belt-driven compressor.

PART 2 - PRODUCTS

2.1 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. Automatic control switches to alternate lead-lag compressors for duplex air compressors.
7. Instrumentation: Include discharge-air pressure gage, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gages, and control transformer.
8. Alarm Signal Device: For connection to alarm system to indicate when backup air compressor is operating.

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.

2.2 OILLESS, RECIPROCATING AIR COMPRESSORS

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

1. Curtis-Toledo.
2. Ingersoll-Rand; Air Solutions Group.
3. Kaeser Compressors, Inc.
4. Powerex, Inc.
5. Quincy Compressor; an EnPro Industries company.
6. Squire-Cogswell/Aeros Instruments, Inc.

B. Compressors: Oilless (nonlubricated), reciprocating-piston type, with sealed oil-free bearings, that will deliver air of quality equal to intake air.

1. High discharge-air temperature switch.
2. Belt guard totally enclosing pulleys and belts.

C. Capacities and Characteristics:

1. Air Compressors: Two, single or two stage.

    a. Intercooler between stages of two-stage units.

2. Receiver: ASME construction steel tank.

    a. Arrangement: Horizontal.
    b. Interior Finish: Epoxy coating.
    c. Pressure Rating: 125 psig minimum.
    d. Drain: Automatic valve.

2.3 INLET-AIR FILTERS

A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for multiple air compressors.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.4 REFRIGERANT COMPRESSED-AIR DRYERS

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

1. Air/Tak, Inc.
2. Atlas Copco.

3. Hankison International.
4. Ingersoll-Rand; Air Solutions Group.
5. Kaeser Compressors, Inc.
6. Wilkerson Operations; Pneumatic Division.

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

2.5 COMPUTER INTERFACE CABINET

A. Description:

1. Wall mounting.
2. Welded steel with white enamel finish.
3. Gasketed door.
4. Grounding device.
5. Factory-installed, signal circuit boards.
6. Power transformer.
7. Circuit breaker.
8. Wiring terminal board.
9. Internal wiring capable of interfacing 20 alarm signals.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Equipment Mounting: Install air compressors, aftercoolers, and air dryers on vibration isolation inertia bases. Comply with requirements specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

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

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

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

1. Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
2. Pressure Regulators: Install downstream from air compressors[and dryers].
3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

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

3.3 IDENTIFICATION

A. Identify general-service air compressors and components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 STARTUP SERVICE

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

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

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors , aftercoolers, and air dryers.

END OF SECTION 22 1519

SECTION 22 3100

DOMESTIC WATER SOFTENERS

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 commercial water softeners.

1. Chemicals.
2. Water testing kits.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor. All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

C. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.4 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Water Softeners. Include rated capacities, operating characteristics, furnished specialties, and accessories.
2. Water testing kits.

B. Shop Drawings: For water softeners. Include plans, elevations, sections, details, and connections to piping systems.

1. Wiring Diagrams: Power, signal, and control wiring.

A. Manufacturer Seismic Qualification Certification: Submit certification that plumbing equipment and components will withstand seismic forces defined in Division 22 Section "Mechanical Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Manufacturer Certificates: Signed by manufacturers certifying that water softeners comply with requirements.

C. Source quality-control test reports.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

G. Maintenance service agreement.

1.6 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water softeners and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance for Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, where indicated.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softener that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures of mineral and brine tanks.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.
d. Attrition loss of resin exceeding 3 percent per year.
e. Mineral washed out of system during service run or backwashing period.
f. Effluent turbidity greater and color darker than incoming water.
g. Fouling of underdrain system, gravel, and resin, with turbidity or by dirt, rust, or scale from softener equipment or soft water, while operating according to manufacturer's written operating instructions.

2. Commercial Water Softener, Warranty Period: From date of Substantial Completion.

a. Mineral Tanks: 10 years.
b. Brine Tanks: Five years.
c. Controls: 10 years.
d. Underdrain Systems: Five years.

1.9 MAINTENANCE SERVICE

A. Maintenance: Submit four copies of manufacturer's "Agreement for Continued Service and Maintenance," before Substantial Completion, for Owner's acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing to include replacing materials and equipment. Include one-year term of agreement with option for one-year renewal.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 COMMERCIAL WATER SOFTENERS

A. Description: Factory-assembled, pressure-type water softener.

1. Manufacturers:

a. Culligan International Company.
b. Kinetico Incorporated.
c. Marlo, Inc.
d. Water Specialties, Inc.
e. Northstar
f. CSI Water Treatment Systems, Inc.
g. ECI

2. Comply with NSF 61, "Drinking Water System Components--Health Effects."
3. Configuration: Twin unit with two mineral tanks and one brine tank, factory mounted on skid.

4. Mineral Tanks: Steel, electric welded; pressure-vessel quality.

a. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.
b. Construction: Fabricated and stamped to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels."
c. Pressure Rating125 psig > minimum.
d. Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F.
e. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
f. Handholes: 4 inches round or 4 by 6 inches elliptical, in top head and lower sidewall of tanks 30 inches and smaller in diameter.
g. Manhole: 11 by 15 inches in top head of tanks larger than 30 inches in diameter.
h. Support Legs or Skirt: Constructed of structural steel, welded to tank before testing and labeling.
i. Finish: Hot-dip galvanized on exterior and interior of tank after fabrication unless tank is stainless steel.
j. Finish: Exterior of tank spray painted with rust-resistant prime coat, 2- to 3-mil dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, 8- to 10-mil dry film thickness.
k. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
l. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers; arranged for even flow distribution through resin bed.
m. Liner: PE, ABS, or other material suitable for potable water.

5. Controls: Fully automatic; factory mounted on unit and factory wired.

a. Adjustable duration of various regeneration steps.
b. Push-button start and complete manual operation.
c. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.

d. Sequence of Operation: Program multiport pilot-control valve to automatically pressure-actuate main operating valve through steps of regeneration and return to service.
e. Pointer on pilot-control valve shall indicate cycle of operation.
f. Means of manual operation of pilot-control valve if power fails.
g. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

1) Slow opening and closing, nonslam operation.
2) Diaphragm guiding on full perimeter from fully open to fully closed.
3) Isolated dissimilar metals within valve.
4) Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
5) Valve for single mineral-tank unit with internal automatic bypass of raw water during regeneration.
6) Sampling cocks for soft water.
7) Special tools are not required for service.

h. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressures, and that does not require field adjustments.

1) Meter Control: Equip each mineral tank with signal-register-head water meter that will produce electrical signal indicating need for regeneration on reaching hand-set total in gallons. Design so signal will continue until reset.
2) Demand-Initiated Control: Equip single mineral-tank units with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons. Design so head automatically resets to preset total in gallons for next service run.
3) Demand-Initiated Control: Equip each mineral tank of multiple mineral-tank units with automatic-reset-head water meters that electrically activate cycle controllers to automatically regenerate at preset total in gallons. Design so heads automatically reset to preset total in gallons for next service run. Include electrical lockouts to prevent simultaneous regeneration of more than one tank.
4) Demand-Initiated Control: Equip each mineral tank of multiple mineral-tank units with automatic-reset-head water meter in common outlet header that electrically activates cycle controller to automatically regenerate one mineral tank at preset total in gallons and divert flow to other tanks. Set to repeat with other tanks. Include electrical lockouts to prevent simultaneous regeneration of more than one tank.

6. Brine Tank: Combination measuring and wet-salt storing system.

a. Tank and Cover Material: Fiberglass, 3/16 inch thick; or molded PE, 3/8 inch thick.
b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
c. Size: Large enough for at least four regenerations at full salting.

7. Factory-Installed Accessories:

a. Piping, valves, tubing, and drains.
b. Sampling cocks.
c. Main-operating-valve position indicators.
d. Water meters.

2.3 WATER TESTING SETS

A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

2.4 SOURCE QUALITY CONTROL

A. Hydrostatically test mineral tanks before shipment to minimum of one and one-half times pressure rating.

B. Prepare test reports.

PART 3 - EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated for commercial water softeners. Refer to Division 22 Section "Common Work Results for Plumbing."

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

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.2 WATER SOFTENER INSTALLATION

A. Install commercial water softener equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor mineral and brine tanks and floor-mounting accessories to substrate.

B. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.

D. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

E. Install water testing sets mounted on wall, unless otherwise indicated, and near water softeners.

3.3 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.

C. Make piping connections between water-softener-unit headers and dissimilar-metal water piping with dielectric fittings. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."

D. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank, and on inlet and outlet headers.

1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
3. Exception: Water softeners with factory-installed shutoff valves at locations indicated.

E. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."

1. Exception: Water softeners with factory-installed pressure gages at locations indicated.
2. Exception: Water softeners in hot-water service.

F. Install valved bypass water piping around water softeners.

1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
2. Water piping is specified in Division 22 Section "Domestic Water Piping."
3. Exception: Household water softeners.
4. Exception: Water softeners in hot-water service.

G. Install drains as indirect wastes to spill into open drains or over floor drains.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning water softeners that do not pass tests and inspections and retest as specified above.

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.

B. Add water to brine tanks and fill with salt.

1. Commercial Water Softeners: Food-grade salt pellets.

C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:

1. ASTM D 859, "Test Method for Silica in Water."
2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
3. ASTM D 1068, "Test Methods for Iron in Water."
4. ASTM D 1126, "Test Method for Hardness in Water."
5. ASTM D 1129, "Terminology Relating to Water."
6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water softeners. Refer to Division 01 "Demonstration and Training" Section

END OF SECTION 22 3100

SECTION 22 3400

FUEL-FIRED, DOMESTIC-WATER 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:
1. Commercial, gas-fired, high-efficiency direct vent, storage, domestic-water heaters.
2. Domestic-water heater accessories.
3. Water heaters to come with orifice sized for the site elevation.

1.3 SEISMIC REQUIREMENTS

A. Component Importance Factor: All plumbing components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Plumbing equipment, hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 220548 " Vibration and Seismic Controls for Plumbing Piping and Equipment.

1. For components with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For components with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:

1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."

C. Shop Drawings:

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

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.

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

B. Product Certificates: For each type of domestic-water heater, from manufacturer.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

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

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.9 COORDINATION

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

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.
2) Controls and Other Components: Two year(s).

b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-Fired, STORAGE, domestic-WATER HEATERS

A. Commercial, Gas-Fired, High-Efficiency Direct Vent, Storage, Domestic-Water Heaters:

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

a. AERCO International, Inc.
b. Lochinvar Corporation.
c. PVI Industries, LLC.
d. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
e. State Industries.

2. Standard: ANSI Z21.10.3/CSA 4.3.

3. Description: Manufacturer's proprietary design to provide at least 88 percent combustion efficiency at optimum operating conditions.
4. Storage-Tank Construction: 150-psig minimum working-pressure rating.

    a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

        1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
        2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

    b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Lining: Glass complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

5. Factory-Installed Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
    c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
    d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
    e. Jacket: Steel with enameled finish.
    f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.
    g. Temperature Control: Adjustable thermostat.
    h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
    i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

6. Direct-vent System: Manufacture’s standard through-wall or roof, double channel vent assembly with outside intake/exhaust screen. See drawings on vent locations room or wall.

B. Capacity and Characteristics: See drawings.

2.2 WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

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

    a. Amtrol Inc.
    b. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
    c. State Industries.
    d. Taco, Inc.

e. Bell & Gossett

2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
3. Construction:

   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

4. Capacity and Characteristics: See drawings

   a. Working-Pressure Rating: 150 psig.
   b. Capacity Acceptable: See drawings 4 gallon minimum.
   c. Air Precharge Pressure:

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, or butterfly-, type shutoff valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.

   1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
   2. Comply with requirements for balancing valves specified in Division 22 Section "Domestic Water Piping Specialties."

D. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

E. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include required pressure regulators as required to match gas supply and equipment being served.

F. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

G. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

H. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

J. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Division 03 Section " Miscellaneous Cast-in-Place Concrete."
1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Division 23 Section "Facility Natural-Gas Piping."

D. Install commercial domestic-water heaters with seismic-restraint devices. Comply with SEI/ASCE 7 and with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

G. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

H. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

I. Fill domestic-water heaters with water.

J. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Division 22 Section "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Division 23 Section "Facility Natural-Gas Piping."

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

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

E. Install a brass nipple fitting on the inlet and outlet of all water heaters.

3.3 IDENTIFICATION

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

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

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

END OF SECTION 22 3400

SECTION 22 4000

PLUMBING FIXTURES

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 conventional plumbing fixtures and related components:

1. Faucets for lavatories bathtub/showers showers and sinks.
2. Flushometers.
3. Toilet seats.
4. Protective shielding guards.
5. Fixture supports.
6. Water closets.
7. Lavatories.
8. Commercial sinks.
9. Service sinks.
10. Lead Free fixtures.

B. Related Sections include the following:

1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
3. Division 22 Section "Emergency Plumbing Fixtures."
4. Division 22 Section "Drinking Fountains and Water Coolers."

1.3 LEAD FREE REQUIREMENTS

A. For all projects within the United States, and when water is anticipated for human consumption, all pipes, pipe fittings, plumbing fittings and fixtures shall comply with PUBLIC LAW 111-380 “Reduction of Lead in Drinking Water Act” 124 STAT. 4131, 42-USC 1201, January 4th, 2011.

1.4 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

C. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

D. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

E. FRP: Fiberglass-reinforced plastic.

F. PMMA: Polymethyl methacrylate (acrylic) plastic.

G. PVC: Polyvinyl chloride plastic.

H. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

I. Lead Free:
1. Not containing more than 0.2 percent lead when used with respect to solder and flux.
2. Not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings and fixtures.
3. Calculation: The weighted average lead content of a pipe, pipe fitting, plumbing fitting or fixture shall be calculated by using the formula prescribed in the law named in LEAD FREE REQUIREMENTS above.

1.5 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

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

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

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

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
3. Slip-Resistant Bathing Surfaces: ASTM F 462.
4. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
5. Stainless-Steel Residential Sinks: ASME A112.19.3.
6. Vitreous-China Fixtures: ASME A112.19.2M.
7. Water-Closet, Flushometer Tank Trim: ASSE 1037.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Potable-Water Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply Fittings: ASME A112.18.1.
12. Brass Waste Fittings: ASME A112.18.2.
13. NSF61 Appendage G-AB 1953. Lead free potable drinking faucets.

I. Comply with the following applicable standards and other requirements specified for shower and shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.
4. Faucets: ASME A112.18.1.
5. Hand-Held Showers: ASSE 1014.
6. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
7. Hose-Coupling Threads: ASME B1.20.7.
8. Manual-Control Antiscald Faucets: ASTM F 444.
9. Pipe Threads: ASME B1.20.1.
10. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
12. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Dishwasher Air-Gap Fittings: ASSE 1021.
4. Manual-Operation Flushometers: ASSE 1037.
5. Plastic Tubular Fittings: ASTM F 409.
6. Brass Waste Fittings: ASME A112.18.2.
7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
8. NSF61 Appendage G-AB 1953. Lead free potable drinking faucets.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Dishwasher Air-Gap Fittings: ASSE 1021.
3. Flexible Water Connectors: ASME A112.18.6.
4. Floor Drains: ASME A112.6.3.
5. Grab Bars: ASTM F 446.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Off-Floor Fixture Supports: ASME A112.6.1M.
8. Pipe Threads: ASME B1.20.1.
9. Plastic Toilet Seats: ANSI Z124.5.
10. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.7 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. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
5. Toilet Seats: Equal to 5 percent of amount of each type installed.

PART 2 - PRODUCTS

2.1 LEAD FREE PRODUCTS:

A. For all products purchased that where water is anticipated for human consumption, all pipes, pipe fittings, plumbing fittings and fixtures shall comply with the LEAD FREE REQUIREMENTS in PART 1 above.

2.2 LAVATORY FAUCETS

A. Lavatory Faucets:

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

a. Chicago Faucets.
b. T & S Brass and Bronze Works, Inc.
c. Moen, Inc.

2.3 SHOWER FAUCETS

A. Shower Faucets:

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

a. Chicago Faucets.
b. Leonard Valve Company.
c. Moen, Inc.
d. Powers; a Watts Industries Co.
e. Symmons Industries, Inc.
f. T & S Brass and Bronze Works, Inc.

2.4 SINK FAUCETS

A. Sink Faucets:

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

a. Chicago Faucets.
b. T & S Brass and Bronze Works, Inc.
c. Moen, Inc.

2.5 FLUSHOMETERS

A. Flushometers:

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

a. Sloan Valve Company.
b. Zurn Plumbing Products Group; Commercial Brass Operation.
c. Moen, Inc.

2.6 TOILET SEATS

A. Toilet Seats:

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

    a. Bemis Manufacturing Company.
    b. Centoco Manufacturing Corp.
    c. Church Seats.
    d. Olsonite Corp.
    e. Sperzel.

2. Description: Toilet seat for water-closet-type fixture.

    a. Material: Molded, solid plastic with antimicrobial agent.
    b. Configuration: Open front without cover.
    c. Size: Elongated.
    d. Hinge Type: CK, check.
    e. Class: Heavy-duty commercial.
    f. Color: White.

2.7 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

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

    a. Engineered Brass Co.
    b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
    c. McGuire Manufacturing Co., Inc.
    d. Plumberex Specialty Products Inc.
    e. TCI Products.
    f. TRUEBRO, Inc.
    g. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements. Product shall also meet the ASTM E 84 25/450 smoke and flame rating.

B. Protective Shielding Piping Enclosures:

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

    a. TRUEBRO, Inc.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.8 FIXTURE SUPPORTS

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

1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Lavatory Supports:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

2.9 WATER CLOSETS

A. Water Closets:

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

a. American Standard Companies, Inc.
b. Kohler Co.
c. Sloan

2.10 LAVATORIES

A. Lavatories:

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

a. American Standard Companies, Inc.
b. Kohler Co.
c. Sloan

2.11 COMMERCIAL SINKS

A. Commercial Sinks:

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

a. Acorn-Sinks Co.
b. Elkay Manufacturing Co.
c. Just Manufacturing Company.

2.12 SERVICE SINKS

A. Service Sinks:

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

    a. American Standard Companies, Inc.
    b. Commercial Enameling Company.
    c. Kohler Co.

2.13 KITCHEN EQUIPMENT

A. Kitchen Equipment (as noted on Kitchen Equipment Schedule):

1. Rough-in and connect to Kitchen equipment as per the Kitchen Equipment Rough-in drawings. Provide all "P" traps required, chrome-plated cast brass. Tail pieces and trap arms shall be chrome-plated 17 ga. brass tubing.
2. Provide Precision Plumbing Products water hammer arrestors upstream of all quick-closing valves, such as on disposers and dishwasher.
3. Gas and water services to portable and countertop appliances shall be connected to equipment with flexible tubing and quick-disconnect fittings. Gas fittings and hoses shall be A.G.A. approved for commercial kitchen equipment.
4. All exposed piping and fittings shall be chrome-plated or stainless steel. Furnish and install stops on all hot and cold water lines at equipment.
5. Provide shut-off valves and unions in all gas, steam and condensate lines at each connection to equipment.
6. All piping penetrations through walls shall be a minimum of 6" above the floor.
7. Provide 3/4" Watts model U5BLP pressure reducing valve on supply line to dishwasher.
8. Provide check valves on supplies to hose sprays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Installations where water is anticipated for human consumption, all pipes, pipe fittings, plumbing fittings and fixtures shall be Lead Free as given in PART 1 above.

B. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

C. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.

3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

D. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

E. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

F. Install wall-mounting fixtures with tubular waste piping attached to supports.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install toilet seats on water closets.

N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install shower flow-control fittings with specified maximum flow rates in shower arms.

R. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

S. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

T. Set service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

U. All plumbing fixtures are to be mounted at the height specified on the Architectural drawings.

3.3 CONNECTIONS

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

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

3.8 PLUMBING FIXTURE SCHEDULE (See Plumbing Fixture Schedule for Fixture Description)

END OF SECTION 22 4000

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SECTION 22 4716

PRESSURE WATER COOLERS

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 pressure water coolers and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pressure water cooler.

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

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

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pressure water coolers 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. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no fewer than 2 of each.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

A. Pressure Water Coolers:

1. Wall mounted:

a. Wheelchair accessible.

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

   a. Elkay Manufacturing Co.
   b. Halsey Taylor.
   c. Haws Corporation.
   d. Larco Inc.
   e. Tri Palm International, LLC.
   f. Murdock Inc,

3. Cabinet:
   a. Bi-level with two attached cabinets
      1) All stainless steel

4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
5. Control:
   a. Push bar.
6. Drain: Grid with NPS 1-1/4 tailpiece.
7. Supply: NPS 3/8 with shutoff valve.
8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
9. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
10. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

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

11. Support: ASME A112.6.1M, Type I water-cooler carrier.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4716

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SECTION 23 0100

MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 GENERAL CONDITIONS

A. The General Conditions of the Contract, with the amendments, supplements, forms and requirements in Division 1, and herewith made a part of this Division.

B. All sections of Division 21, 22, & 23 shall comply with the Mechanical General Requirements. The standards established in this section as to quality of materials and equipment, the type and quality of workmanship, mode of operations, safety rules, code requirements, etc., shall apply to all sections of this Division as though they were repeated in each Division.

1.02 SCOPE OF WORK

A. This work shall include all labor, materials, equipment, fixtures, and devices for the entire mechanical work and a complete operating and tested installation as required for this project.

B. The Specifications and Plans are a complete set. Any contractor, subcontractor, vendor or any one person participating in or bidding on this project shall be responsible for the information contained in any and all Sheets of Drawings and Sections of the Specifications. If any person elects to submit bids for any portion, or all of this project, that person, party or entity shall be responsible for any and all information contained in these Drawings and Specifications, including but not limited to, any subsequent Addenda and Clarifications that may be issued.

C. This Division will schedule the boiler inspection and pay for all costs associated with certifying the boiler with the State.

1.03 CODES & ORDINANCES

A. All work shall be executed in accordance with all underwriters, public utilities, local and state rules and regulations applicable to the trade affected. Should any change in the plans and Specifications be required to comply with these regulations, the Contractor shall notify the Architect before the time of submitting his bid. After entering into contract, the Contractor will be held to complete all work necessary to meet these requirements without extra expense to the Owner. Where work required by drawings or specifications is above the standard required, it shall be done as shown or specified.

B. Current applicable codes:
1. Utah Boiler and Pressure Vessel Rules and Regulations
2. International Building code
3. International Mechanical Code
4. International Plumbing Code
5. International Fire Code
6. International Energy Code
7. International Fuel Gas Code

1.04 INDUSTRY STANDARDS

A. All work shall comply with the following standards.
1. Associated Air Balance council (AABC)
2. Air Conditioning and Refrigeration Institute (ARI)
3. Air Diffusion council (ADC)
4. Air Movement and Control Association (AMCA)
5. American Gas Association (AGA)
6. American National Standards Institute (ANSI)
7. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
8. American Society of Mechanical Engineers (ASME)
9. American Society of Testing Materials (ASTM)
10. American Water Works Association (AWWA)
11. Cooling Tower Institute (CTI)
12. ETL Testing Laboratories (ETL)
13. Institute of Electrical and Electronic Engineers (IEEE)
14. Hydronics Institute (HI)
15. Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
16. National Fire Protection Association (NFPA)
17. National Electrical Code (NEC)
18. National Electrical Manufacturers Association (NEMA)
19. National Electrical Safety code (NESC)
20. Utah safety Standard (OSHA), Utah State Industrial Council.
21. Sheet Metal and Air Conditioning Contractor=s National Association (SMACNA)
22. Underwriters Laboratories (UL)
23. Tubular Exchanger Manufacturers Association, Inc. (TEMA)
24. Heat Exchanger Institute (HEI)
25. Hydraulic Institute (HI)
26. Thermal Insulation Manufacturer=s Association (TIMA)
27. Scientific Apparatus Makers Association (SAMA)

B. Compliance Verification:
1. All items required by code or specified to conform to the ASME code shall be stamped with the ASME seal.
2. Form U-1, the manufacturer's data report for pressure vessels, is to be included in the Operation and Maintenance Manuals. National Board Register (NBR) numbers shall be provided where required by code.
3. Manufactured equipment which is represented by a UL classification and/or listing, shall bear the UL or equivalent ETL label.

1.05 UTILITIES & FEES

A. All fees for permits required by this work will be paid by this division. The contractor shall obtain the necessary permits to perform this work. Unless noted otherwise, all systems furnished and or installed by this Contractor, shall be complete with all utilities, components, commodities and accessories required for a fully functioning system. This Contractor shall furnish smoke generators when required for testing, furnish glycol for glycol piping systems, full load of salt to fill brine tank for water softening system, furnish cleaners and water treatment additives.

1.06 SUBMITTALS AND SHOP DRAWINGS

A. Submittals: As soon as possible after the contract is awarded, but in no case more than 45 calendar days thereafter, the Contractor shall submit to the Architect six (6) copies of the descriptive literature covering products and materials to be used in the installation of mechanical systems for

this project. **The review of the submitted data will require a minimum of 14 business days.** The first day starts after the day they are received in the engineers office to which the project is being constructed from. If the Contractors schedule requires return of submitted literature in less than the allotted time, the Contractor shall accelerate his submittal delivery date. The Contractor shall resubmit all items requiring re-review within 14 days of returned submittals. Refer to each specification section for items requiring submittal review. Written approval of the Owner's Representative shall be obtained before installing any such equipment or materials for the project. The submittals shall be prepared in an orderly manner, contained in a 3-ring loose-leaf binder with index and identification tabs each item or group of items and for each specification section. All items shall be submitted at one time except automatic temperature control drawings and seismic restraint drawings which may be submitted separately within 120 days of the contract award date. Partial submittals will not be reviewed until the complete submittal is received.

B. Submitted literature shall bear the Contractor's stamp, indicating that he has checked all equipment being submitted; that each item will fit into the available space with the accesses shown on the drawings; and, further, that each item conforms to the capacity and quality standards given in the contract documents.

C. Submitted literature shall clearly indicate performance, quality, and utility requirements; shall show dimension and size of connection points; and shall include derating factors that were applied for each item of equipment to provide capacity at job site elevation. Temperature control submittals shall include piping and wiring diagrams, sequence of operation and equipment. Equipment must fit into the available space with allowance for operation, maintenance, etc. Factory piped and wired equipment shall include shop drawings for all internal wiring and piping furnished with the unit.

D. Submitted literature shall clearly show all required field install wiring, piping, and accessory installations required by the Contractor to provide a complete operating system.

E. Review by the Owner's Representative is for general conformance of the submitted equipment to the project specification. In no way does such review relieve this Contractor of his obligation to furnish equipment and materials that comply in detail to the specification nor does it relieve the Contractor of his obligation to determine actual field dimensions and conditions that may affect his work. Regardless of any items overlooked by the submittal review, the requirements of the contract drawings and specifications must be followed and are not waived or superseded in any way by the review.

F. By description, catalog number, and manufacturer's names, standards of quality have been established by the Architect and the Engineer for certain manufactured equipment items and specialties that are to be furnished by this Division. Alternate products and equipment may be proposed for use only if specifically named in the specifications or if given written prior approval in published addenda. Design equipment is the equipment listed on the drawings or if not listed on the drawings is the equipment first named in the specifications.

G. If the Engineer is required to do additional design work to incorporate changes caused by submitting equipment or products, different than the design equipment specified, as defined above, the contractor shall reimburse the engineer for additional time and expenses at the engineer’s current, recognized, hourly rates.

1.07 DRAWINGS AND MEASUREMENTS

A. Construction Drawings: The contract document drawings show the general design, arrangements, and extent of the system. In certain cases, the drawings may include details that show more nearly exact locations and arrangements; however, the locations, as shown diagrammatically, are to be regarded as general.

B. It shall be the work of this Section to make such slight alterations as may be necessary to make adjustable parts fit to fixed parts, leaving all complete and in proper shape when done. All dimensions given on the drawings shall be verified as related to this work and with the Architect's office before work is started.

C. This Section shall carefully study building sections, space, clearances, etc., and then provide offsets in piping or ductwork as required to accommodate the building structure without additional cost to the Owner. In any case and at any time during the construction process, a change in location required by obstacles or the installation of other trades not shown on the mechanical plans shall be made without charge.

D. The drawings shall not be scaled for roughing in measurements nor shall they be used as shop drawings. Where drawings are required for these purposes or where drawings must be made from field measurements, the Contractor shall take the necessary measurements and prepare the drawings. Shop drawings of the various subcontractors shall be coordinated to eliminate all interferences and to provide sufficient space for the installation of all equipment, piping, ductwork, etc.

E. The drawings and specifications have been prepared to supplement each other and they shall be interpreted as an integral unit with items shown on one and not the other being furnished and installed as though shown and called out on both.

F. Coordination Drawings: The contractor shall provide coordination drawings for mechanical rooms, fan rooms, equipment rooms, and congested areas to eliminate conflicts with equipment, piping, or work of other trades. The drawings shall be a minimum scale of 1/4 inch= 1 foot and of such detail as may be required by the Engineer to fully illustrate the work. These drawings shall include all piping, conduit, valves, equipment, and ductwork.

G. Sheet-metal shop drawings will be required for all ductwork in the entire building. These drawings will show all ductwork in the entire building and shall be coordinated with architectural, structural and electrical portions of the project. The contractor shall specifically obtain copies of the structural shop drawings and shall coordinate the ductwork shop drawings with approved structural members. These drawings shall be submitted to the engineer for review prior to any fabrication. The contractor is responsible for all modifications necessary to accommodate duct installation within the structural, architectural and electrical restrictions. These drawings, once reviewed by the engineer, will be made available to all mechanical, electrical, and fire sprinkler subcontractors to coordinate installation of their work.

H. Record Drawings: Refer to Division 1.

1.08 CONTRACTOR'S USE OF BUILDING EQUIPMENT

A. The Contractor may use equipment such as electric motors, fans, heat exchangers, filters, etc., with the written permission of the Owner. As each piece of equipment is used (such as electric motors and fans), maintenance procedures approved by the manufacturer are to be followed. A careful record is to be kept of the length of the time the equipment is used, maintenance procedures followed, and any difficulty encountered. The record is to be submitted to the Owner upon acceptance. All fan belts and filter media (such as bearings) shall be carefully inspected just prior to acceptance. Any excessive wear noted shall require replacement. New filter media shall be installed in air handlers at the time systems are turned over to the owner.

1.09 EXISTING CONDITIONS

A. The Contractor shall carefully examine all existing conditions that might affect the mechanical system and shall compare these conditions with all drawings and specifications for work included under this contract. He shall, at such time, ascertain and check all conditions that may affect his work. No allowance shall subsequently be made in his behalf for an extra expense incurred as a result of his failure or neglect to make such examination. This Contractor shall include in his bid proposal all necessary allowances to repair or replace any item that will remain or will be removed, and any item that will be damaged or destroyed by new construction.

B. The Contractor shall remove all abandoned piping, etc., required by new construction and cap or plug openings. No capping, etc., shall be exposed in occupied areas. All openings of items removed shall be sealed to match adjacent surfaces.

C. The Contractor shall verify the exact location of all existing services, utilities, piping, etc., and make connections to existing systems as required or as shown on the drawings. The exact location of each utility line, together with size and elevation, shall be established before any on-site lines are installed. Should elevation or size of existing main utility lines make connections to them impossible as shown on drawings, then notification of such shall immediately be given to the Owners Representative for a decision.

1.10 EQUIPMENT CAPACITIES

A. Capacities shown for equipment in the specifications and on the drawings are the minimum acceptable. No equipment shall be considered as an alternate that has capacities or performance less than that of design equipment.

B. All equipment shall give the specified capacity and performance at the job-site elevation. Manufacturers' standard ratings shall be adjusted accordingly. All capacities and performances listed on drawings or in specifications are for job-site conditions.

1.11 SEISMIC REQUIREMENTS FOR EQUIPMENT

A. All equipment shall be furnished structurally adequate to withstand seismic forces as outlined in the International Building Code. Refer to section Mechanical Vibration Controls and Seismic Restraints. Equipment bases shall be designed for direct attachment of seismic snubbers and/or seismic anchors.

1.12 COOPERATION WITH OTHER TRADES

A. The Contractor shall refer to other drawings and parts of this specification that cover work of other trades that is carried on in conjunction with the mechanical work such that all work can proceed without interference resulting from lack of coordination.

B. The Contractor shall properly size and locate all openings, chases, sleeves, equipment bases, and accesses. He shall provide accurate wiring diagrams to the Electrical Contractor for all equipment furnished under this Division.

C. The ceiling cavity must be carefully reviewed and coordinated with all trades. In the event of conflict, the installation of the mechanical equipment and piping shall be in the following order: plumbing, waste, and soil lines; supply, return, and exhaust ductwork; water piping; medical gases; fire protection piping; and pneumatic control piping.

D. The mechanical Contractor shall insure that the installation of all piping, ducts and equipment is in compliance with Articles 110-16 and 384-4 of the National Electrical Code relative to proper clearances in front of and over all electrical panels and equipment. No piping or ductwork will be allowed to run over electrical panel.

1.13 RESPONSIBILITY OF CONTRACTOR

A. The Contractor is responsible for the installation of a satisfactory piece of work in accordance with the true intent of the drawings and specifications. He shall provide, as a part of his work and without expense, all incidental items required even though these items are not particularly specified or indicated. The installation shall be made so that its several component parts will function together as a workable system and shall be left with all equipment properly adjusted and in working order. The Contractor shall familiarize the Owner's Representative with maintenance and lubrication instructions as prepared by the Contractor and shall explain and fully instruct him relative to operating, servicing, and maintenance of them.

B. If a conflict arises between the drawings and the specifications the most stringent procedure/action shall be followed. A clarification to the engineer will help to determine the course of action to be taken. If a conflict arises between specification sections the engineer will determine which course of action is to be followed.

1.14 PIPE AND DUCT OPENINGS AND EQUIPMENT RECESSES

A. Pipe and duct chases, openings, and equipment recesses shall be provided by others only if shown on architectural or structural drawings. All openings for the mechanical work, except where plans and specifications indicate otherwise, shall be provided as work of this Division. Include openings information with coordination drawings.

B. Whether chases, recesses, and openings are provided as work of this Division or by others, this Contractor shall supervise their construction and be responsible for the correct size and location even though detailed and dimensioned on the drawings. This Contractor shall pay for all necessary cutting, repairing, and finishing if any are left out or incorrectly made. All necessary openings thru existing walls, ceilings, floors, roofs, etc. shall be provided by this Contractor unless indicated otherwise by the drawing and/or specifications.

1.15 UNFIT OR DAMAGED WORK

A. Any part of this installation that fails, is unfit, or becomes damaged during construction, shall be replaced or otherwise made good. The cost of such remedy shall be the responsibility of this Division.

1.16 WORKMANSHIP

A. Workmanship shall be the best quality of its kind for the respective industries, trades, crafts, and practices, and shall be acceptable in every respect to the Owner's representative. Nothing contained herein shall relieve the Contractor from making good and perfect work in all details in construction.

1.17 SAFETY REGULATION

A. The Contractor shall comply with all local, Federal, and OSHA safety requirements in performance with this work. (See General Conditions). This Contractor shall be required to provide equipment, supervision, construction, procedures, and all other necessary items to assure safety to life and property.

1.18 ELECTRICAL SERVICES

A. All equipment control wiring and all automatic temperature control wiring including all necessary contacts, relays, and interlocks, whether low or line voltage, except power wiring, shall be furnished and installed as work of this Division unless shown to be furnished by Division 26. All such wiring shall be in conduit as required by electrical codes. Wiring in the mechanical rooms, fans rooms and inaccessible ceilings and walls shall be installed in conduit as well. Installation of any and all wiring done under Division 21, 22 and 23 shall be in accordance with the requirements of Division 26, Electrical.

B. All equipment that requires an electrical connection shall be furnished so that it will operate properly and deliver full capacity on the electrical service available.

C. Refer to the electrical control equipment and wiring shown on the diagrams. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the Contractor furnishing the equipment.

D. The Mechanical Contractor must coordinate with the Electrical Contractor to insure that all required components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.

1.19 WORK, MATERIALS, AND QUALITY OF EQUIPMENT

A. Unless otherwise specified, all materials shall be new and of the best quality of their respective kinds and all labor shall be done in a most thorough and workmanlike manner.

B. Products or equipment of any of the manufacturers cited herein or any of the products approved by the Addenda may be used. However, where lists of products are cited herein, the one first listed in the design equipment used in drawings and schedules to establish size, quality, function, and capacity standards. If other than design equipment is used, it shall be carefully checked for access to equipment, electrical and control requirements, valving, and piping. Should changes or additions occur in piping, valving, electrical work, etc., or if the work of other Contractors would be revised by the alternate equipment, the cost of all changes shall be borne as work of this Division.

C. The Execution portions of the specifications specify what products and materials may be used. Any products listed in the Product section of the specification that are not listed in the Execution portion of the specification may not be used without written approval by the Engineer.

D. The access to equipment shown on the drawings is the minimum acceptable space requirements. No equipment that reduces or restricts accessibility to this or any other equipment will be considered.

E. All major items of equipment are specified in the equipment schedules on the drawings or in these specifications and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory installation.

F. All welders shall be certified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code, latest Edition.

1.20 PROTECTION AGAINST WEATHER AND STORING OF MATERIALS

A. All equipment and materials shall be properly stored and protected against moisture, dust, and wind. Coverings or other protection shall be used on all items that may be damaged or rusted or may have performance impaired by adverse weather or moisture conditions. Damage or defect developing before acceptance of the work shall be made good at the Contractor's expense.

B. All open duct and pipe openings shall be adequately covered at all times.

1.21 INSTALLATION CHECK

A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule and the seismic supplier shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.

B. Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it operated satisfactorily.

C. All costs for this work shall be included in the prices quoted by equipment suppliers.

1.22 EQUIPMENT LUBRICATION

A. The Contractor shall properly lubricate all pieces of equipment before turning the building over to the Owner. A linen tag shall be attached to each piece of equipment, showing the date of lubrication and the lubricant used. No equipment shall be started until it is properly lubricated.

B. Necessary time shall be spent with the Owner's Representative to thoroughly familiarize him with all necessary lubrications and maintenance that will be required of him.

C. Detergent oil as used for automotive purposes shall not be used for this work.

1.23 CUTTING AND PATCHING

A. No cutting or drilling in structural members shall be done without written approval of the Architect. The work shall be carefully laid out in advance, and cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces necessary for the mechanical work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by professional plasterers, masons, concrete workers, etc., and all such work shall be paid for as work of this Division.

B. When concrete, grading, etc., is disturbed, it shall be restored to original condition as described in the applicable Division of this Specification.

1.24 EXCAVATION AND BACKFILLING

A. All necessary excavations and backfilling for the Mechanical phase of this project shall be provided as work of this Division. Trenches for all underground pipelines shall be excavated to the required depths. The bottom of trenches shall be compacted hard and graded to obtain required fall. Backfill shall be placed in horizontal layers, not exceeding 12 inches in thickness, and properly moistened. Each layer shall be compacted, by suitable equipment, to a density of not less than 95 percent as determined by ASTM D-1557. After pipelines have been tested, inspected, and approved, the trench shall be backfilled with selected material. Excess earth shall be hauled from the job site. Fill materials approved by the Architect shall be provided as work of this Division.

B. No trenches shall be cut near or under any footings without consultation first with the Architect's office. Any trenches or excavations more than 30 inches deep shall be tapered, shored, covered, or otherwise made absolutely safe so that no vehicle or persons can be injured by falling into such excavations, or in any way be harmed by cave-ins, shifting earth, rolling rocks, or by drowning. This protection shall be extended to all persons approaching excavation related to this work whether or not such persons are authorized to be in the vicinity of the construction.

1.25 ACCESS

A. Provide access doors in walls, ceilings and floors by this division unless otherwise noted. For access to mechanical equipment such as valves, dampers, VAV boxes, fans, controls, etc. Refer to Division 8 for door specifications. All access doors shall be 24" x 24" unless otherwise indicated or required. Coordinate location of doors with the Architect prior to installation. . If doors are not specified in Division 8, provide the following: Doors in ceilings and walls shall be equal to JR Smith No. 4760 bonderized and painted. Doors in tile walls shall be equal to JR Smith No. 4730 chrome plated. Doors in floors shall be equal to JR Smith No. 4910.

B. Valves: Valve must be installed in locations where access is readily available. If access is compromised, as judged by the Mechanical Engineer, these valves shall be relocated where directed at the Contractors expense.

C. Equipment: Equipment must be installed in locations and orientations so that access to all components requiring service or maintenance will not be compromised. If access is compromised, as judged by the Mechanical Engineer, the contractor shall modify the installation as directed by the Engineer at the Contractors expense.

D. It is the responsibility of this Division to install terminal boxes, valves and all other equipment and devices so they can be accessed. If any equipment or devices are installed so they cannot be accessed on a ladder, a catwalk and ladder system shall be installed above the ceiling to access and service this equipment.

1.26 CONCRETE BASES AND INSERTS

A. Bases: The concrete bases shall be provided and installed as work by this divsion. This Division shall be responsible for the proper size and location of bases and shall furnish all required anchor bolts and sleeves with templates to be installed as work of Division 3, Concrete.

B. All floor-mounted mechanical equipment shall be set on 6-inch high concrete bases, unless otherwise noted or shown on drawings. Such bases shall extend 6 inches beyond equipment or mounting rails on all sides or as shown on the drawings and shall have a 1-inch beveled edge all around.

C. Inserts: Where slotted or other types of inserts required for this work are to be cast into concrete, they shall be furnished as work of this Division

D. Concrete inserts and pipe support systems shall be equal to Unistrut P3200 series for all piping where more than one pipe is suspended at a common location. Spacing of the inserts shall match the size and type of pipe and of ductwork being supported. The Unistrut insert and pipe support system shall include all inserts, vertical supports, horizontal support members, clamps, hangers, rollers, bolts, nuts, and any other accessory items for a complete pipe-supporting system.

1.27 CLEANING AND PAINTING

A. Cleaning: After all tests and adjustments have been made and all systems pronounced satisfactory for permanent operation, this Contractor shall clean all exposed piping, ductwork, insulated members, fixture, and equipment installed under this Section and leave them ready for painting. He shall refinish any damaged finish and leave everything in proper working order. The Contractor shall remove all stains or grease marks on walls, floors, glass, hardware, fixtures, or elsewhere, caused by his workman or for which he is responsible. He shall remove all stickers on plumbing fixtures, do all required patching up and repair all work of others damaged by this division of the work, and leave the premises in a clean and orderly condition.

B. Painting: Painting of exposed pipe, insulated pipe, ducts, or equipment is work of Division 9, Painting.

C. Mechanical Contractor: All equipment which is to be furnished in factory prefinished conditions by the mechanical Contractor shall be left without mark, scratch, or impairment to finish upon completion of job. Any necessary refinishing to match original shall be done. Do not paint over nameplates, serial numbers, or other identifying marks.

D. Removal of Debris, etc: Upon completion of this division of the work, remove all surplus material and rubbish resulting from this work, and leave the premises in a clean and orderly condition.

1.28 CONTRACT COMPLETION

A. Incomplete and Unacceptable Work: If additional site visits or design work is required by the Engineer or Architect because of the use of incomplete or unacceptable work by the Contractor, then the Contractor shall reimburse the Engineer and Architect for all additional time and expenses involved.

B. Maintenance Instructions: The Contractor shall furnish the Owner complete printed and illustrated operating and maintenance instructions covering all units of mechanical equipment, together with parts lists.

C. Instructions To Owner's Representatives: In addition to any detailed instructions called for, the mechanical Contractor must provide, without expense to the Owner, competent instructors to train the Owner's representatives who will be in charge of the apparatus and equipment, in the care, adjustment, and operation of all parts on the heating, air conditioning, ventilating, plumbing, fire protection, and automatic temperature control equipment. Instruction dates shall be scheduled at time of final inspection. A written report specifying times, dates, and name of personnel instructed shall be forwarded to the Architect. A minimum of four 8-hour instruction periods shall be provided. The instruction periods will be broken down to shorter periods when requested by the Owner. The total instruction hours shall not be reduced. The ATC Contractor shall provide 4 hours of instructions. The remaining hours shall be divided between the mechanical and sheet metal Contractors.

D. Guarantee: By the acceptance of any contract award for the work herein described or shown on the drawings, the Contractor assumes the full responsibility imposed by the guarantee as set forth herein and in the General Conditions, and should protect himself through proper guarantees from equipment and special equipment Contractors and from subcontractors as their interests may appear.

E. The guarantee so assumed by the Contractor and as work of this Section is as follows:

1. That the entire mechanical system, including plumbing, heating, and air-conditioning system shall be quiet in operation.
2. That the circulation of water shall be complete and even.
3. That all pipes, conduit, and connections shall be perfectly free from foreign matter and pockets and that all other obstructions to the free passage of air, water, liquid, sewage, and vent shall be removed.
4. That he shall make promptly and free of charge, upon notice from the Owner, any necessary repairs due to defective workmanship or materials that may occur during a period of one year from date of Substantial Completion.
5. That all specialties, mechanical, and patent devices incorporated in these systems shall be adjusted in a manner that each shall develop its maximum efficiency in the operation of the system; i.e., diffusers shall deliver the designed amount of air shown on drawings, thermostats shall operate to the specified limits, etc.
6. All equipment and the complete mechanical, ductwork, piping and plumbing systems shall be guaranteed for a period of one year from the date of the Architect's Certificate of Substantial Completion, this includes all mechanical, ductwork, piping and plumbing equipment and products and is not limited to boiler, chillers, coils, fans, filters etc. Any equipment supplier not willing to comply with this guarantee period shall not submit a bid price for this project. The Contractor shall be responsible for a 100-percent guarantee for the system and all items of equipment for this period. If the contractor needs to provide temporary heating or cooling to the building and/or needs to insure systems are installed properly and or to meet the project schedule the guaranteed of all systems and equipment shall be as indicated above, one-year from the date of the Architect’s Certificate of Substantial Completion.
7. All filters used during construction shall be replaced just before equipment is turned over to the Owner, and all required equipment and parts shall be oiled and lubricated. Any worn parts shall also be replaced.
8. If any systems or equipment is used for temporary heating or cooling the systems shall be protected so they remain clean. I.e. if the ductwork systems are used, temporary filters and a filter holder (not duct-taped to ducts or grilles) shall be installed to insure the systems and the equipment remain clean.

1.29 CURBS

A. Unless otherwise noted in these specifications or on the documents all roof curbs for all equipment are to be provided by Division 22 and 23.

1.30 TEST RUN

A. The Mechanical Contractor shall operate the mechanical system for a minimum of 30 days to prove the operation of the system.

1.31 EQUIPMENT STARTUP AND CHECKOUT:

A. Each major piece of equipment shall be started and checked out by an authorized representative of the equipment manufacturer. A certificate indicating the equipment is operating to the satisfaction of the manufacturer shall be provided and shall be included in the commissioning report.

END OF SECTION

SECTION 23 0500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 22 &23 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Concrete base construction requirements.
3. Escutcheons.
4. Dielectric fittings.
5. Flexible connectors.
6. Mechanical sleeve seals.
7. Equipment nameplate data requirements.
8. Labeling and identifying mechanical systems and equipment is specified in Division 23 Section "Mechanical Identification."
9. Non-shrink grout for equipment installations.
10. Field-fabricated metal equipment supports.
11. Installation requirements common to equipment specification sections.
12. Mechanical demolition.
13. Cutting and patching.
14. Touch up painting and finishing.
15. Link Seal

B. Pipe and pipe fitting materials are specified in Division 23 piping system Sections.

1.03 DEFINITIONS

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

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

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

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

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

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. NP: Nylon plastic.
4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. EPDM: Ethylene propylene diene terpolymer rubber.

1.04 SUBMITTALS

A. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.

B. Shop Drawings: Detail fabrication and installation for metal supports and anchorage for mechanical materials and equipment.

C. Coordination Drawings: For access panel and door locations.

D. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement.
2. Clearances for installing and maintaining insulation.
3. Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
4. Equipment and accessory service connections and support details.
5. Exterior wall and foundation penetrations.
6. Fire-rated wall and floor penetrations.
7. Sizes and location of required concrete pads and bases.
8. Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
9. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
10. Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, and other ceiling-mounted items.

E. Samples: Of color, lettering style, and other graphic representation required for each identification material and device.

1.05 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

B. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

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

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

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

1.07 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

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

C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

1. Dielectric Unions:

    a. Capitol Manufacturing Co.
    b. Central Plastics Co.
    c. Eclipse, Inc.; Rockford-Eclipse Div.
    d. Epco Sales Inc.
    e. Hart Industries International, Inc.
    f. Watts Industries, Inc.; Water Products Div.
    g. Zurn Industries, Inc.; Wilkins Div.

2. Dielectric Flanges:

    a. Capitol Manufacturing Co.
    b. Central Plastics Co.
    c. Epco Sales Inc.
    d. Watts Industries, Inc.; Water Products Div.

3. Dielectric-Flange Insulating Kits:

    a. Calpico, Inc.
    b. Central Plastics Co.

4. Dielectric Couplings:

    a. Calpico, Inc.
    b. Lochinvar Corp.

5. Dielectric Nipples:

    a. Grinnell Corp.; Grinnell Supply Sales Co.
    b. Perfection Corp.
    c. Victaulic Co. of America.

6. Metal, Flexible Connectors:

    a. ANAMET Industrial, Inc.
    b. Central Sprink, Inc.
    c. Flexicraft Industries.
    d. Flex-Weld, Inc.
    e. Grinnell Corp.; Grinnell Supply Sales Co.
    f. Hyspan Precision Products, Inc.
    g. McWane, Inc.; Tyler Pipe; Gustin-Bacon Div.
    h. Mercer Rubber Co.
    i. Metraflex Co.
    j. Proco Products, Inc.
    k. Uniflex, Inc.

7. Rubber, Flexible Connectors:

a. General Rubber Corp.
b. Mercer Rubber Co.
c. Metraflex Co.
d. Proco Products, Inc.
e. Red Valve Co., Inc.
f. Uniflex, Inc.

8. Mechanical Sleeve Seals:

a. Calpico, Inc.
b. Metraflex Co.
c. Thunderline/Link-Seal.
d. Linkseal

9.

2.02 PIPE AND PIPE FITTINGS

A. Refer to individual Division 22 & 23 piping Sections for pipe and fitting materials and joining methods.

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

2.03 JOINING MATERIALS

A. Refer to individual Division 22 & 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch 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 thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

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

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.
3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.10 percent maximum lead content.
4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.10 percent maximum lead content.

5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.

F. Brazing Filler Metals: AWS A5.8.

1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

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

H. Solvent Cements: Manufacturer's standard solvent cements for the following:

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

I. Plastic Pipe Seals: ASTM F 477, elastomeric gasket.

J. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.

K. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.

1. Sleeve: ASTM A 126, Class B, gray iron.
2. Followers: ASTM A 47 malleable iron or ASTM A 536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel paint.

2.04 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

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

D. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.

G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

H. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.05 FLEXIBLE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:

1. 2-Inch NPS and Smaller: Threaded.
2. 2-1/2-Inch NPS and Larger: Flanged.
3. Option for 2-1/2-Inch NPS and Larger: Grooved for use with keyed couplings.

B. Bronze-Hose, Flexible Connectors: Corrugated, bronze, inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze welded to hose.

C. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

D. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 deg F. Units may be straight or elbow type, unless otherwise indicated. Limited to non-potable water use.

2.06 MECHANICAL SLEEVE SEALS

A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve.

Under this section there shall be furnished and installed a complete Link-Seal® modular seal assembly, manufactured by PSI-Thunderline/Link-Seal® located at 6525 Goforth Street, Houston, TX 77021, as shown on drawings and specifications. For clarification, complete assembly is defined as a combined:

Wall opening (i.e. steel sleeve, Thermoplastic (HDPE) sleeve, cored hole or formed hole). The wall opening size and/or type shall be selected according to recommendations found in the most recent Link-Seal® modular seal catalog.

Sufficient quantity and type of Link-Seal® modular seals required to effectively provide a hydrostatic and/or fire-rated seal.

Each individual link shall be conspicuously and permanently identified with the name of the manufacturer and model number. Manufacturers other than the above-named company wishing to quote equipment in this section shall submit detail drawings of their proposed equipment and suitable evidence of a minimum of 25 years of experience and results to the engineer to obtain written approval to quote at least ten (10) days prior to bid opening.

Link-Seal® Modular Seal Rubber Links
Shall be modular, mechanical type, consisting of inter-locking synthetic rubber links shaped

to continuously fill the annular space between the pipe and the wall opening. The elastomeric element shall be sized and selected per manufacturer's recommendations and have the following properties as designated by ASTM. Coloration shall be throughout elastomer for positive field inspection. Each link shall have a permanent identification of the size and manufacturer's name molded into it.

For Standard Service Applications
-40 to +250ºF (-40 to +121ºC)
EPDM = ATSM D2000 M3 BA510
Color = Black

For Hydrocarbon Service Applications
-40 to +210ºF (-40 to +99ºC)
Nitrile = ASTM D2000 M1BF510
Color = Green

For High Temperature or Fire Seal Applications
-67 to +400ºF (-55 to +204ºC)
Silicone = ASTM D2000 M1GE505
Color = Gray
Reference shall always be made to the latest published Link-Seal® modular seal selection guide for the service intended.

Link-Seal® Modular Seal Pressure Plates

Link-Seal® modular seal pressure plates shall be molded of glass reinforced Nylon Polymer with the following properties:
Izod Impact - Notched = 2.05ft-lb/in. per ASTM D-256
Flexural Strength @ Yield = 30,750 psi per ASTM D-790
Flexural Modulus = 1,124,000 psi per ASTM D-790
Elongation Break = 11.07% per ASTM D-638
Specific Gravity = 1.38 per ASTM D-792

Models LS200-275-300-315 shall incorporate the most current Link-Seal® Modular Seal design modifications and shall include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Models 315-325-340-360-400-410-425-475-500-525-575-600 shall incorporate an integral recess known as a "Hex Nut Interlock" designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates shall have a permanent identification of the manufacturer's name molded into it.

For fire and Hi-Temp service, pressure plates shall be steel with 2-part Zinc Dichromate Coating.

Link-Seal® Modular Seal Hardware
All fasteners shall be sized according to latest Link-Seal® modular seal technical data. Bolts, flange hex nuts shall be:

316 Stainless Steel per ASTM F593-95, with a 85,000 psi average tensile strength.

2.07 PIPING SPECIALTIES

A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:

1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.

1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
2. OD: Completely cover opening.
3. Cast Brass: One piece, with set screw.

    a. Finish: Polished chrome-plate.

4. Cast Brass: Split casting, with concealed hinge and set screw.

    a. Finish: Polished chrome-plate.

5. Stamped Steel: One piece, with spring clips and chrome-plated finish.
6. Stamped Steel: Split plate, with concealed hinge, set screw, and chrome-plated finish.
7. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
8. Cast-Iron Floor Plate: One-piece casting.

2.08 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.

Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
Design Mix: 5000-psig, 28-day compressive strength.
Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 23 piping Sections specify unique piping installation requirements.

B. General Locations and Arrangements: 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 at indicated slope.

D. Install components with pressure rating equal to or greater than system operating pressure.

E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

F. Install piping free of sags and bends.

G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

I. Install piping to allow application of insulation plus 1-inch clearance around insulation.

J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

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

L. Install couplings according to manufacturer's written instructions.

M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:

1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.

2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with set screw.

3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.

4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.

5. Piping in Utility Areas: Cast brass or stamped steel, with set-screw or spring clips.

N. Sleeves are not required for core drilled holes.

O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Build sleeves into new walls and slabs as work progresses.
3. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

    a. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS.
    b. Steel, Sheet-Metal Sleeves: For pipes 6-inch NPS and larger, penetrating gypsum-board partitions.
    c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 7 Section "Joint Sealants" for materials.
5. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.

P. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches in diameter and larger.
3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.

Q. Underground, Exterior-Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber sealing elements to expand and make watertight seal.

R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials. Refer to Division 7 Section "Firestopping" for materials.

S. Verify final equipment locations for roughing-in.

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

U. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
4. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
5. 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:

a. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
b. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
c. Align threads at point of assembly.

d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
e. 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.

6. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.

7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

8. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:

   a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   b. ABS Piping: ASTM D 2235 and ASTM D 2661.
   c. CPVC Piping: ASTM D 2846 and ASTM F 493.
   d. PVC Pressure Piping: ASTM D 2672.
   e. PVC Nonpressure Piping: ASTM D 2855.
   f. PVC to ABS Nonpressure Transition Fittings: Procedure and solvent cement according to ASTM D 3138.

9. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 procedures and manufacturer's written instructions.

   a. Plain-End Pipe and Fittings: Use butt fusion.
   b. Plain-End Pipe and Socket Fittings: Use socket fusion.

V. Piping Connections: Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

W. Wall Opening

1. Century-Line® Sleeves - for openings to 24.81” diameter.
   Where pipes must pass through walls and floors of new structures, unless otherwise shown or specified, install molded non-metallic high density polyethylene Model CS Century-Line® sleeves as manufactured by PSI-Thunderline/Link-Seal®. Model CS sleeves shall have integrally formed hollow water stop sized having a minimum of four inches larger than the outside diameter of the sleeve itself and allowing 1/2” movement between wall forms to resist pour forces. Each sleeve assembly shall have end caps manufactured of the same material as the sleeve itself and installed at each end of the sleeve so as to prevent deformation during the initial concrete pour, and to facilitate

attaching the sleeve to the wall forms. End caps shall remain in place to protect the opening from residual debris and rodent entry prior to pipe insertion.

Link-Seal® Modular Seal components and systems shall be domestically manufactured at a plant with a current ISO-9002 registration. Copy of ISO-9002 registrations shall be a submittal item.

3.02 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

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

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

E. Install equipment giving right of way to piping installed at required slope.

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.03 PAINTING AND FINISHING

A. Refer to Division 9 Section "Painting" for paint materials, surface preparation, and application of paint.

B. Apply paint to exterior exposed piping, interior and exterior stands, supports and frames according to the following, unless otherwise indicated:

1. Interior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer.
2. Exterior, Ferrous Frames, stands and Piping: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.
3. Exterior, Ferrous Supports: Use semigloss, acrylic-enamel finish. Include two finish coats over rust-inhibitive metal primer.

C. Do not paint piping specialties with factory-applied finish.

D. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates

for anchor bolt and tie locations. Use 3000-psig, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.05 ERECTION OF METAL SUPPORTS AND ANCHORAGE

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

B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.06 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

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

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

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

3.07 DEMOLITION

A. Disconnect, demolish, and remove Work specified in Division 23 Sections.

B. If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

D. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.

E. Removal: Remove indicated equipment from Project site.

F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.08 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair cut surfaces to match adjacent surfaces.

3.09 GROUTING

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

B. Provide forms as required for placement of grout.

C. Avoid air entrapment during placing of grout.

D. Place grout, completely filling equipment bases.

E. Place grout on concrete bases to provide smooth bearing surface for equipment.

F. Place grout around anchors.

G. Cure placed grout according to manufacturer's written instructions.

END OF SECTION

SECTION 23 0513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes general requirements for single-phase and poly-phase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems.
   1. Motors are to be of the NEMA Premium efficiency Design

1.03 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

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

B. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

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

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

C. Basic requirements apply to mechanical equipment motors, unless otherwise indicated.

D. Motors 3/4 HP and Larger: Poly-phase.

E. Motors Smaller than 3/4 HP: Single phase.

F. Frequency Rating: 60 Hz.

G. Voltage Rating: Determined by voltage of circuit to which motor is connected.

H. Service Factor: According to NEMA MG 1 – 2003, unless otherwise indicated.

I. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

J. Enclosure: Open drip-proof, unless otherwise indicated.

K. All motors shall have ASTM Grade 5 hardware that is Yellow Zinc-dichromate plated.

2.03 POLYPHASE MOTORS

A. Motors Used in Across the Line Starters or with Reduced-Inrush Controllers: Match wiring connection requirements for the indicated controller. Motor leads connections that are brought to motor terminal box shall be suitable with controller or starting method.

Description: EPACT NEMA MG 1, Low Voltage Induction Motor – Single Speed Application.

1. Design Characteristics: NEMA MG 1, Design B, unless otherwise indicated.
2. EPACT Energy-Efficient Design: As indicated by application.
3. Stator: Copper windings, unless otherwise indicated. Multispeed motors shall have separate winding for each speed.
4. Rotor: Squirrel cage, unless otherwise indicated.
5. Design Classification: NEMA Design B
6. Temperature Rise: Class F rise, unless otherwise indicated.
7. Insulation: Class F, unless otherwise indicated.
8. Minimum vibration: Each motor shall not exceed 0.5 G vibration peek/peek.
9. Bearings: Motor bearings shall be rated for an L-10 life 40,000 hours with an external load per NEMA MG 1-14 and an L-10 life of 100,000 hours in direct coupled applications for continuous duty and shall be of the re-greasable type with grease relief fitting or Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading Per the motor manufactures standards.

B. Motors Used with Variable-Frequency Controllers shall meet the following: Current Ratings, characteristics, and features shall be rated for a minimum of 10:1 turndown ratio and the motor that is provided will be coordinated and approved by controller manufacturer. A Variable Frequency driven motor shall have the following characteristics:
1. Critical vibration frequencies shall be minimized so that motor will operate throughout the range of controller output based on the system requirements.
2. Temperature Rise: Class B rise.
3. Insulation: Class F.
4. Thermal Protection: Where indicated, conform to NEMA MG 1 requirements for thermally protected motors and inverter duty rated for NEMA MG-1-31 1998.
5. Bearings: Motor bearings shall be rated for an L-10 life 50,000 hours with an external load per NEMA MG 1-14 and an L-10 life of 100,000 hours in direct coupled applications

for continuous duty and shall be of the re-greasable type with automatic grease relief valve.

6. Motors shall be sized with respect to horsepower rating without using the service factor. All motors being operated by adjustable or variable frequency drives shall have a service factor 1.15 at equipments elevation.
7. The winding insulation system shall have an insulation rating of 1860 volt, peak with a 0.1 micro second rise time.
8. Motor stator and rotor steel shall be low-loss C-5 electrical grade silicon steel with interlaminated insulation system capable of withstanding a minimum 1000°F burnout.
9. Motors are to be of the NEMA Premium efficiency Design
10. All motor nameplates shall have raised letters stamped on stainless steel and be fastened to the motor frame with four stainless steel drive pins. Name plate shall meet applicable NEMA MG1standards.
11. Shaft Grounding Ring: Microfiber type.
    a. Provide grounded discharge path for VFD induced voltage in the shaft to prevent arching in the motor bearings.

C. Severe-Duty Motors: Where indicated, motors are (TEFC) totally enclosed with 1.15 minimum service factors at altitude, and shall have greased bearings, integral condensate drains, and capped relief vents. Windings shall be insulated with non-hygroscopic material class H insulation. External finish shall be chemical-resistant paint over corrosion-resistant primer. The minimum performance and construction requirements are outline in part B of this specification.

D. Source Quality Control: Perform the following routine tests according to NEMA MG 1-12 and shall consist of:

1. No load watts input, current and speed (RPM).
2. Winding resistance test.
3. High-potential test.
4. Locked rotor watts input and current.
5. Stator insulation resistance test.
6. Visual inspection and factory approval.
7. Each motor shall have a factory certified test report forwarded with each motor and included in O&M Manual.

2.04 SINGLE-PHASE MOTORS

A. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.

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

B. Shaded-Pole Motors: Do not use, unless motors are smaller than 1/20 hp.

C. Thermal Protection: Where indicated or required, internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range, unless otherwise indicated.

D. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, pre-lubricated sleeve bearings for other single-phase motors.

E.

F. Motors are to have the ECM label where variable speed with variable input (0-5vDC) is indicated.

PART 3 - EXECUTION (Not Applicable)

PART 4 - END OF SECTION

SECTION 23 0514

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The drawings and general provisions of this contract, including general and supplementary conditions and Division 1 specification sections, apply to work of this section.

B. Information contained on the drawings and/or schedules shall detail the additional specific requirements for the Variable Frequency Drive (VFD) system equipment.

1.2 SCOPE OF WORK

A. It is the intent of this specification to set the minimum acceptable requirements for the design, construction, installation, commissioning and vendor support requirements for the VFD systems herein specified.

B. The VFD installation, harmonic mitigation, and associated equipment coordination and interface shall be provided by the ATC contractor. Mounting VFD and connecting 4-20mA control signal shall be by the ATC contractor. Power wiring to and from the VFD to the motor shall coordinated with Division 26.

1.3 CODE AND STANDARDS

A. The equipment supplied under this specification shall conform to the latest applicable codes and standards of the following:

1. NEC - (NFPA 70) - National Electric Code.
2. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
3. NEMA AB 1 - Molded Case Circuit Breakers.
4. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
5. IEEE Standard 519-1992 - Recommended Practices for Harmonic Control in Electrical Power Systems.
6. ANSI C37 - Standards for Circuit Breakers, Switchgear, Relays, Substations and Fuses.
7. ANSI C57 - Distribution, Power, and Regulating Transformers (includes Reactors).

B. The fully assembled VFD system shall carry the UL label certifying UL-508 standards. An equivalent safety labeling program by ETL or CSA documenting compliance with these industry standards shall be acceptable.

1.4 VENDOR QUALIFICATIONS

A. All vendors supplying equipment and/or services under this specification, shall pre-qualify and be listed.

B. Division 23 shall coordinate and assume system responsibility and compatibility between the various approved supplier's equipment and services required to meet these specifications.

C. Division 23 shall be responsible for the coordination with qualified vendors of equipment and services outside the scope of this specification (but required for the proper operation of the system).

1.5 ACCEPTABLE SUPPLIERS

A. The following VFD manufacturer's equipment have been pre-approved to meet the products section of this specification:

B. ABB, Toshiba, Mitsubishi, Honeywell, Siemens, Danfoss, Yaskawa, Schneider

1.6 SUBMITTALS

A. The following information shall be included with the bid package:

1. Description of equipment and tests included in bid to meet power quality requirements
2. Qualifications and name of engineering and technical persons responsible for support and warranty on this project.
3. Extended warranty/service contract bid.

B. The following shall be included in the submittal package in the quantities required under the general provisions of this project:

1. Completed Data Sheet.
2. Set of outline drawings giving complete mounting and conduit entry and exit dimensions.
3. Set of complete electrical drawings for power and control wiring.
4. Detailed drawings of filter equipment and sample graphs and data to meet IEEE 519-1992 compliance for voltage and current distortion.
5. Manufacturer's literature giving detailed information of equipment being supplied including part numbers, model numbers and ratings.

C. The following compliance and approval forms shall be submitted for approval:

1. Sample installation approval form.
2. Sample VFD system commissioning approval form.
3. Sample VFD system training approval form.
4. Sample VFD quality assurance program and sample factory test and certification report forms.

PART 2 - PRODUCTS

This portion of the specification outlines the overall fabrication, performance and functional requirements of VFDs supplied for positive speed control of standard NEMA design B induction motors.

It is the intent of this section to specify non-proprietary designs and hardware that assure modern "state of the art" equipment which provides a high level of performance and reliability for the greatest long term, total value to the owner.

2.1 SYSTEM DESCRIPTION

A. The VFD system shall be supplied as a complete, pre-integrated, stand-alone package produced by a single manufacturer regularly engaged in the production of same and who maintains full system support responsibility.

B. The VFD system manufacturer shall integrate all components and equipment required to meet these specification features and functions as a single UL (or equivalent) labeled system. Vendors providing equipment requiring panel shop or job site modifications or additions that would not be valid under the original equipment manufacturer's (OEM's) safety labeling will not be acceptable.

C. Pre-integrated equipment shall include but not be limited to incoming line filters, rectifier units, inverter units, control circuitry, operator interfaces, protective equipment, and other accessories and auxiliary items necessary to meet the highest standards for the type of service specified herein.

D. VFD shall be connected to the ATC system through native BacNet interface using an MD/TP communication trunk.

2.2 CONSTRUCTION

A. Space and Environment:

1. All VFD system components shall be housed in a grounded, dead front, free-standing or wall-mounting, NEMA 1 enclosure. The VFD system size shall not exceed the size allotments specified on the drawings nor shall any portion of the system exceed a height of 90 inches. Entry shall be provided for incoming line and load cables as required or as shown on the drawings.
2. VFD systems mounted indoors shall be properly ventilated and sized to operate continuously at the job site elevation in an ambient environment of 0^{o}C. to 40^{o}C, 0-90% RH. VFD systems mounted outdoors shall include environment control provisions as required (or as shown on the plans) to operate in an ambient of -30^{o}C to 50^{o}C, 0-100% RH.

B. Supply Power:

1. All components of the VFD system shall be selected to operate continuously without any system trip or damage based on the nominal power specifications and requirements shown on the drawings or schedules. The above conditions must be maintained under the following expected variations:
   a. Plus or minus 10% voltage fluctuation.
   b. Plus or minus 3% frequency variation (5% if served by a back-up generator).
   c. Distorted voltage waveform with up to 7% total voltage harmonic distortion.
2. The VFD system shall employ voltage sag ride-through coordination under normal operating (average load) conditions to prevent nuisance trips with the following utility interruptions (based on preliminary IEEE working group P1346 data):
   a. 0% voltage for 1 cycle.
   b. 60% voltage for 10 cycles.
   c. 87% voltage continuous.

2.3 VFD FEATURES

A. Provide an internal disconnect with each VFD.

B. All inverters shall be manufactured in the United States.

C. The variable volume inverter duty motors and variable speed drives shall be manufactured by a single source. This will ensure total responsibility should a motor fail.

D. The inverter manufacturer shall have a minimum of 15 years experience in manufacturing inverters and shall have a minimum of 8 years experience with IGBT transistors used in the inverter to produce the output PWM waveform, allowing for quiet motor operation. Inverters with carrier frequencies below 8kHz are not acceptable.

E. The 3 through 30 HP, 230VAC, and 5 through 150 HP, 460VAC adjustable speed drive shall be a pulse width modulated (PWM) design that has a carrier frequency of 8kHz or higher so no acoustic noise will be produced onto the motor. The adjustable speed drive shall maintain a 120% current overload capability for 60 seconds with automatic stall prevention and voltage boost to prevent nuisance tripping during load or line side transient conditions. The adjustable speed drive shall maintain a displacement power factor of not less than 0.95 throughout its speed range.

F. The inverters shall be rated for continuous duty at a 8kHz carrier frequency on the motor full load currents listed below (from NEC Table 430-150). If derating of the inverter is necessary to run at 8kHz, then the units must be derated and their new derated currents must equal or exceed the motor full load currents listed in the table below.

G. The Insulated Gate Bipolar Transistors (IGBTs) shall have a minimum rating of 1200VDC on 460VAC and 600VDC on 230VAC units. The manufacturer of the inverter must have a minimum of 8 years experience in the manufacture and use of IGBTs.

H. Enclosure: The VFD shall have a metal NEMA 1 enclosure for reduction of radio and electromagnetic frequency interference. Plastic enclosures are not acceptable. The enclosure shall be wall mount 125HP and below and floor mount 200HP and above .

I. The adjustable speed drive shall have, as a minimum, the following design features as standard:

1. 8KHz sine-coded, pulse width modulated output.
2. Overload capability of 120% for 60 seconds, 110% continuous.
3. Process follower 4-20mADC, 0-5VDC, or 0-10VDC input.
4. An LED digital readout displaying output frequency, status, percent current, percent voltage, and response signal.
5. Output signals proportional to current and frequency 0-1mADC / 0-7.5VDC.
6. Current limiting circuit.
7. Adjustable acceleration and deceleration.
8. In addition to the inverter's self diagnostic features, the drive shall have a form C contact (1NO, 1NC) for remote indication of fault.
9. Customer interlock for remote starting and stopping.
10. On loss of speed reference signal, the drive shall operate at a preset minimum speed so that the inverter will not drive the fan at a speed capable of causing system problems.
11. The drive shall provide a 24VDC open collector output signal which will indicate when the drive is running, and when the drive is at speed.
12. The drive shall be capable of restarting into a rotating motor by sensing the frequency of the rotating motor and starting into the motor at that frequency.

13. The drive shall have a digital keypad for performing all parameter adjustments and programming which shall include the following features:
    a. Quick setup key to allow for simple setup and expeditious startup.
    b. Manual/Off/Auto keys for selection of control mode.
    c. Fault clear/reset key.
    d. Run and stop keys for starting and stopping in manual mode.
    e. Up and Down arrow keys for adjustment of motor speed and adjustment of programming parameters.
    f. Program key for entering program mode for adjustment of parameters.
    g. Read/write key for changing parameters in program mode.
14. The drive shall have PID (set point) control.
15. The inverter shall have a DC link reactor which will reduce harmonics at the input. If a DC link reactor is not provided, an AC input line reactor or isolation transformer shall be provided (20HP and larger, 460V).
16. The drive shall be equipped with critical frequency avoidance where it shall be capable of avoiding up to three resonant points in the mechanical system.
17. A user programmable personal lockout code shall prevent unauthorized programming of the inverter.

J. The adjustable speed drive shall have, as a minimum, the following protective features:

1. Ground fault protection.
2. Electronic motor overload protection.
3. Current limit adjustable 10 - 120%.
4. Current limited stall prevention during acceleration, deceleration, and run conditions.
5. Automatic restart after momentary power loss or momentary overvoltage. The drive shall not restart into faults other than overvoltage, undervoltage, or overcurrent due to acceleration rate set too fast, because other faults, such as an overcurrent due to a blown transistor or a short circuit on the output, could cause damage to the inverter.
6. Fault indicators shall indicate the following fault conditions (Faults should be displayed by flashing on the LED display on the front panel of the inverter. When a fault occurs, the drive shall have built in diagnostic functions that assist in determining the cause and source of the fault. The drive shall also indicate the level of current and voltage and the frequency at the time of the fault):
    a. Overcurrent during acceleration (OC1).
    b. Overcurrent during deceleration (OC2).
    c. Overcurrent while running (OC3).
    d. Overcurrent on output (OCL).
    e. Overcurrent detected at startup (OCA).
    f. Overload (OL).
    g. Overvoltage while deceleration (OP2).
    h. Overvoltage due to power surge (OP).
    i. Over temperature (OH).
    j. Ground Fault (EF).
    k. Emergency Stop (E).
    l. Frequency Setting Fault (EFF).
    m. EEPROM Abnormality (EEP).
    n. EEPROM Abnormality (EEP2).
    o. EEPROM Abnormality (EEP3).
    p. Computer Link Abnormality (Err.t).
    q. Power Supply Undervoltage (POFF).
    r. DC Main Circuit Undervoltage (nOFF).
7. Current limiting DC bus fuse.
8. Phase-to-phase short circuit protection.

K. The adjustable speed drive shall have the following adjustments available under the quick SETUP key:

1. Acceleration - 0.1 to 1200 seconds.
2. Deceleration - 0.1 to 1200 seconds.
3. Maximum frequency range.
4. Maximum frequency (0 to 100% speed).
5. Bias and gain adjustment for 4-20mA, 0-5VDC, 0-10VDC follower (Can be direct or indirect acting).
6. Electronic thermal overload adjustment (10-100%).

L. The adjustable speed drive shall be designed to operate within the following environmental and service conditions:

1. Ambient service temperature: -10EC to 40EC.
2. Ambient storage temperature: -20EC to 60EC.
3. Humidity: non-condensing to 95%.
4. Altitude to 4400 feet.
5. Service factor: 1.1.
6. Input voltage: three phase, 208/230VAC -/+ 10% for 230VAC series and 380/400/460VAC +/- 10% for 460VAC series.
7. Input frequency: 50/60 hertz +/- 2 Hz.

M. The adjustable speed drive shall be designed and built to the following standards:

1. UL
2. CSA
3. ISO 9001
4. IEEE 587

N. Inverter manufacturer shall have the following available:

1. Service engineer.
2. Training/Service schools.
3. Twenty-four hour phone service.

O. Accessories to be furnished and mounted by the drive manufacturer:

P. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of freeze, fire, smoke contacts, fault contact output, input reference signal, and external start command. All external interlocks shall remain fully functional whether the drive is in Hand or Auto modes. External start command shall be active when in the Auto mode only.

Q. <u>Manual bypass circuit:</u>

1. The bypass circuit shall allow the user to manually bypass the drive and transfer control of the motor across the line, running the motor at full speed. While in the bypass operation, the motor shall be protected by an overload relay. A three position selector switch to control the bypass contactor and the drive output contactor is to be mounted on the enclosure door. When in the Inverter mode, the bypass contactor is open and the drive output contactor is closed. In the Off position, power will be removed from both the inverter and the bypass circuits. In the Bypass position, the drive output contactor is open and the bypass contactor is closed. All safety interlocks will work in both the drive and bypass modes. The contactors shall have auxiliary contacts connected to a terminal strip for indication of bypass or inverter modes.

2. A service contactor shall be provided to electrically isolate the drive while in bypass operation without having to remove power from the motor. This will allow the drive to be serviced during bypass operation. The service contactor shall be controlled by a two position selector switch on the drive enclosure.
3. A motor overload relay shall be provided to protect the motor in the bypass mode.
4. Run Relay - Provides 1 N.O. and 1 N.C. form C contact for indication of inverter running.
5. RS232 Computer Interface - Allows inverter to be controlled by a local computer terminal. Only one inverter may be controlled by each computer. All programming, monitoring, and control functions which are possible at the inverter may be performed through the computer terminal.
6. Floating Point Control - This option allows control of the inverter through three sets of external contacts. When Contact #1 closes, the inverter will ramp up in speed (accelerate). When Contact #1 opens, the inverter will stay at its current speed. When Contact #2 closes, the inverter will ramp down in speed (decelerate). When Contact #2 opens, the inverter will stay at its current speed. When Contact #3 closes, the inverter will stop.
7. Isolated Input Option - This option will optically isolate a 4-20mA input signal from the inverter. This can prevent ground loops from occurring which may interfere with the control signal.
8. Isolated 4-20mA Output Option - This option will provide a 4-20mA isolated output signal that is proportional to either frequency OR current. It converts the inverter's 0-1mA output signal into a 4-20mA signal.

2.4 QUALITY ASSURANCE

A. The VFD system manufacturer shall have a quality assurance program acceptable to the engineer. An outline of this program shall be submitted for approval.

B. Prior to shipping any equipment, the manufacturer shall individually test and certify each unit to document compliance. This certification report shall be submitted as part of the operation and maintenance manual and include the following minimum testing:

1. A visual inspection shall be made consisting of all system components, wiring connections, and safety mechanisms.
2. High pot testing shall be conducted on the completed VFD system including all accessory power components as a complete package. This test shall be conducted per UL 508 (two times the rated voltage plus 1000 volts AC for 60 seconds) using regularly calibrated high pot test equipment.
3. A system run test shall be conducted using an actual motor accelerated and decelerated through the entire speed range.
4. All control panel devices, including switches, pilot lamps, keypad and special control devices shall be functional tested.
5. Special tests shown on the drawings or schedules or as later required by the engineer to demonstrate compliance with any specification herein shall be conducted upon request (either witnessed or not) at no additional cost.

2.5 POWER QUALITY REQUIREMENTS

A. IEEE STD. 519-1992 COMPLIANCE

1. Compliance with IEEE STD. 519-1992 (Recommended Practices for Harmonic Control in Electrical Power Systems) shall be a requirement of this project. Harmonic filters (passive or active), phase multiplication devices, or any other components required to mitigate harmonic voltage and current to IEEE STD. 519-1992 published levels shall be an integral part of the VFD system. Designs which are not pre-integrated and factory wired as part of the UL (or equal) labeled VFD system shall not be acceptable under this specification.
2. Designs which employ shunt tuned filters must be designed to prevent the importation of outside harmonics which could cause system resonance or filter failure. Calculations supporting the design, including a system harmonic flow analysis, must be provided as part of shunt tuned filter design documentation.
3. Designs which cause voltage rise at the VFD terminals must document coordination with the total system voltage variation to eliminate nuisance tripping.
4. Designs which do not provide both true and displacement power factor (measured at the VFD system input terminals) of at least 95% or better at full load are not acceptable. Designs that allow leading power factor at minimum loads which create voltage rise on the line side of the VFD system are not acceptable.

B. Relevant data for VFD system vendor calculations to meet IEEE Std. 519-1992 requirements are as follows:

1. For the purpose of this specification, the Point of Common Coupling (PCC) as identified in IEEE Std. 519-1992, shall be the connection at which each individual VFD system (the offending non-linear load) is connected to the electrical distribution system (linear loads). Required voltage and current harmonic distortion measurements shall be taken at each individual VFD system PCC.
2. The load current (I_L) is used to calculate the IEEE Std. 519-1992 I_{SC}/I_L ratio required for determining acceptable maximum harmonic current distortion table values as reproduced in 3.1.B.4. For the purposes of this specification, this calculated current (I_L) shall be the total combined full load current of each VFD system supplied as part of this project or the total combined amperage of loads designated as "non-linear" on the drawings or schedules.
3. The VFD system vendor is responsible to determine the short circuit current (I_{SC}) available at the PCC through the drawings, through coordination with other equipment suppliers, from the electric utility, and/or from actual job site electrical equipment nameplate or measurement data.
4. As a convenience, the IEEE Std. 519-1992 table of current distortion limits for general distribution systems (120 V through 69,000 V) is given below:

Current Distortion Limits for General Distribution Systems
(120 V through 69,000 V)

Maximum Harmonic Current Distortion in percent of I_L

I_{SC}/I_L	<11	11£h<17	17£h<23	23£h<35	35£h	TDD
Individual Harmonic Order (Odd Harmonics)						
<20	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0

50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

C. Even harmonics are limited to 25% of the odd harmonic limits above.

D. Documentation of IEEE Std. 519-1992 compliance shall be part of the commissioning required be the VFD supplier. Actual job site measurement testing shall be conducted at one half and full load and documented in the operation and maintenance manuals. Reports shall include the following data:

1. Data (text and graphical) shall be supplied showing voltage and current waveforms, THD (or TDD) and individual harmonic spectrum analysis in compliance with the above standards.
2. Power quality reports including transformer derate analysis, telephone influence factor, true and displacement power factor, and voltage and current imbalance reports shall also be supplied.

E. All VFD suppliers shall obtain pre-approval based on satisfactory completion of previous VFD projects meeting the above requirements. Pre-approval requests to bid shall include calculations, test reports and other sufficient data to show the owner/engineer how compliance to IEEE Std. 519-1992 requirements have been met on previous projects and how compliance will be accomplished on this project.

2.6 INSTALLATION

A. Division 23 shall be responsible for installing and mounting VFD. Division 26 shall wire the VFD’s.

B. The VFD system equipment shall be installed and tested under the direction of factory trained personnel.

2.7 SYSTEM COMMISSIONING AND CERTIFICATION

A. The VFD system start-up shall be performed by a service technician or engineer certified by the manufacturer. It shall include a minimum of 3 hours per VFD to work with Division 23 to start-up and commission the VFD's during system and building start-up. The following adjustments and tests shall be performed as a minimum with certified copies included in the maintenance and operation manual:

1. Verify that the input voltage is within the manufacturer's specification tolerances.
2. Verify that the motor rotation is correct in all modes of operation.
3. Verify all operator devices, programming and monitoring functions to be fully operational.
4. Verify operation of all field signal control connections.
5. Measure and record system output voltage and current at 50% and 100% speed. Tune the output voltage to correspond to motor nameplate rating at full speed. Check full load current measurements against nameplate data.
6. Make all parameter adjustments to tune and optimize the VFD system to the application. Record all configuration values as part of this report.
7. Conduct harmonic tests. Measurements shall be recorded for each unit with the VFD system off, running at 50% speed, and running at full speed and load.

B. Owner training shall be provided for each model and type of VFD system provided. Training shall consist of both classroom and actual equipment hands-on training. The training shall be certified on the approved form and included in the operation and maintenance manuals.

2.8 DOCUMENTATION

A. The VFD system vendor shall supply certified as-built drawings based on the required drawings and approved drawing formats included as part of the submittal process.

1. The drawings shall be included as part of the operation and maintenance manual and be of a reproducible quality.
2. Autocad format files of each drawing shall also be included on a floppy disk.

B. The operation and maintenance manuals shall consist of the following instructions and information:
1. Uploading, handling, installation, and special consideration instructions.
2. Operating functional descriptions and operating instructions.
3. Bill of materials with all spare parts ordering information and availability.
4. Factory test reports.
5. Start-up and system commissioning reports.
6. Training certification per.
7. Power quality and harmonic test reports.

2.9 WARRANTY

A. The VFD system vendor shall supply a complete parts and labor warranty (including travel expenses) for 1 year from the date of substantial completion.

1. The warranty shall cover the entire VFD system including power devices, controllers, filters, etc. enclosed as part of the system package.

END OF SECTION

SECTION 23 0516

EXPANSION FITTINGS AND LOOPS FOR HVAC 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. Flexible-hose packless expansion joints.
2. Metal-bellows packless expansion joints.
3. Pipe loops and swing connections.
4. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 ACTION SUBMITTALS

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

B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of expansion joint, from manufacturer.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

A. Flexible-Hose Packless Expansion Joints:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flex-Hose Co., Inc.
b. Flexicraft Industries.
c. Flex Pression Ltd.
d. Flex-Weld
e. Fugate
f. Metraflex, Inc.
g. Twin City Hose
h. Unisource Manufacturing, Inc.

2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with threaded end connections.

a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.

5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.

6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.

7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.

8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel with flanged end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg Fand 90 psig at 600 deg Fratings.

9. Expansion Joints for Steel Piping NPS 14 and Larger: Carbon-steel fittings with flanged end connections.

a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

B. Metal-Bellows Packless Expansion Joints:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flex-Hose Co., Inc.
b. Flexicraft Industries.
c. Flex Pression Ltd.
d. Flex-Weld, Inc.
e. Flo Fab inc.
f. Hyspan Precision Products, Inc.
g. Metraflex, Inc.

2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows with external tie rods.
4. Minimum Pressure Rating: 175 psig unless otherwise indicated.
5. Configuration: Single joint class unless otherwise indicated.
6. Expansion Joints for Copper Tubing: Single-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds. Single- or multi-ply.

a. End Connections for Copper Tubing NPS 2 and Smaller: Threaded.
b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.

7. Expansion Joints for Steel Piping: Single-ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud. Single- or multi-ply.

a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged.

2.2 ALIGNMENT GUIDES AND ANCHORS

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

a. Adsco Manufacturing LLC.
b. Advanced Thermal Systems, Inc.
c. Flex-Hose Co., Inc.

d. Flexicraft Industries.
e. Flex-Weld, Inc.
f. Hyspan Precision Products, Inc.
g. Metraflex, Inc.
h. Piping Technology & Products, Inc.
i. Senior Flexonics Pathway.
j. Twin City Hose.

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

a. Stud: Threaded, zinc-coated carbon steel.
b. Expansion Plug: Zinc-coated steel.
c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

a. Bonding Material: ASTM C 881, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

SECTION 23 0517
SLEEVES AND SLEEVE SEALS FOR HVAC 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. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

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

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

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

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

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

2.2 STACK-SLEEVE FITTINGS

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

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

1. Smith, Jay R. Mfg. Co.
2. Zurn Industries, LLC.

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

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

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

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

2.4 SLEEVE-SEAL FITTINGS

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

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

1. HOLDRITE.

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

2.5 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

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

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

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

D. Install sleeves for pipes passing through interior partitions.

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

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

3.2 STACK-SLEEVE-FITTING INSTALLATION

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

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

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

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

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

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

3.4 SLEEVE-SEAL-FITTING INSTALLATION

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

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

C. Secure nailing flanges to concrete forms.

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

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:
   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves.
   b. Piping NPS 6 and Larger: Cast-iron wall sleeves.
2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.

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

b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:
a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
5. Interior Partitions:
a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 23 0517

SECTION 23 0518
ESCUTCHEONS FOR HVAC 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. Escutcheons.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type with polished, chrome-plated finish.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type with chrome-plated finish.
d. Bare Piping 2 inch and Smaller at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping Larger than 2 inch at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type with polished, chrome-plated finish, Retain one of first two subparagraphs below.
f. Bare Piping 2 inch and Smaller at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping Larger than 2 inch at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type with polished, chrome-plated finish.
h. Bare Piping 2 inch and Smaller in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated.
i. Bare Piping Larger than 2 inch in Unfinished Service Spaces: One-piece, stamped-steel type with polished, chrome-plated finish.
j. Bare Piping 2 inch and Smaller in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
k. Bare Piping in Equipment Rooms Larger than 2 inch: One-piece, stamped-steel type with chrome- or cadmium-plated finish.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 220518

SECTION 23 0519

METERS AND GAGES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Thermometers.
2. Gages.
3. Test plugs.
4. Flowmeters.

1.03 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

PART 2 - PRODUCTS

2.01 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, are limited to, the following:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Die-cast aluminum or brass, 9 inches long.

C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.02 THERMOWELLS

A. Manufacturers: Subject to compliance with requirements, are limited to, the following:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.
4. Marsh Bellofram.
5. Miljoco Corp.
6. NANMAC Corporation.
7. Noshok, Inc.
8. Palmer - Wahl Instruments Inc.
9. REO TEMP Instrument Corporation.
10. Tel-Tru Manufacturing Company.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Manufacturers: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.03 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, are limited to, the following:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
3. Ernst Gage Co.

4. Eugene Ernst Products Co.
5. KOBOLD Instruments, Inc.
6. Marsh Bellofram.
7. Miljoco Corp.
8. Noshok, Inc.
9. Palmer - Wahl Instruments Inc.
10. REO TEMP Instrument Corporation.
11. Trerice, H. O. Co.
12. Weiss Instruments, Inc.
13. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
14. WIKA Instrument Corporation.
15. Winters Instruments.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Liquid-filled type, drawn steel or cast aluminum, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Glass.
8. Ring: Stainless steel.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.04 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, [are limited to, the following:

1. Flow Design, Inc.
2. MG Piping Products Co.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Co.
6. Trerice, H. O. Co.
7. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.

1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.

1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

2.05 VENTURI FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, are limited to, the following

1. Armstrong Pumps, Inc.
2. Badger Meter, Inc.; Industrial Div.
3. Bailey-Fischer & Porter Co.
4. Flow Design, Inc.
5. Gerand Engineering Co.
6. Hyspan Precision Products, Inc.
7. Leeds & Northrup.
8. McCrometer, Inc.
9. Preso Meters Corporation.
10. Victaulic Co. of America.

B. Description: Differential-pressure design for installation in piping; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid.

C. Construction: Bronze, brass, or factory-primed steel; with brass fittings and attached tag with flow conversion data.

D. Pressure Rating: 250 psig.

E. Temperature Rating: 250 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged or welded.

H. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.

I. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.

1. Scale: Gallons per minute.
2. Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.

J. Operating Instructions: Include complete instructions with each flowmeter.

PART 3 - EXECUTION

3.01 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler, chiller and cooling tower.
3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.

B. Provide the following temperature ranges for thermometers:

1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
2. Condenser Water: 0 to 160 deg F, with 2-degree scale divisions.
3. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.
4. Air Ducts: Minus 40 to plus 110 deg F, with 2-degree scale divisions.

3.02 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install liquid-filled-case-type pressure gages at chilled- and condenser-water inlets and outlets of chillers.

C. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.03 INSTALLATIONS

A. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.

B. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

C. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).

D. Install needle-valve and syphon fitting in piping for each pressure gage for steam.

E. Install test plugs in tees in piping.

F. Install flow indicators, in accessible positions for easy viewing, in piping systems.

G. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.

H. Install flowmeter elements in accessible positions in piping systems.

I. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.

J. Install wafer-orifice flowmeter elements between pipe flanges.

K. Install permanent indicators on walls or brackets in accessible and readable positions.

L. Install connection fittings for attachment to portable indicators in accessible locations.

M. Install flowmeters at discharge of hydronic system pumps and at inlet of hydronic air coils.

N. Mount meters on wall if accessible; if not, provide brackets to support meters.

3.04 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy-meter transmitters to meters.

END OF SECTION

SECTION 23 0523

GENERAL PIPING VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes general duty valves common to several mechanical piping systems.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Special purpose valves are specified in Division 23 Section “Hydronic Piping”.
2. Valve tags and charts are specified in Division 23 Section "Identification for HVAC Piping and Equipment".

1.03 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.

C. Maintenance data for valves to include in the operation and maintenance manual specified in Division 1. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.04 QUALITY ASSURANCE

A. Single-Source Responsibility: Comply with the requirements specified in Division 1 Section "Materials and Equipment," under "Source Limitations" Paragraph.

B. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

C. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

1.05 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 globe and gate valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

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

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. APCO Willamette Valve and Primer Corp.
2. Babbitt Steam Specialty Company.
3. Bray Controls.
4. Center Line.
5. Cla-Val Company.
6. Conbraco Industries Inc.
7. Crane Co.; Crane Valve Group.
8. Fisher Valve by Emerson.
9. Flo Fab Inc.
10. Flow-Tek Inc.
11. Grinnell Corporation.
12. Hammond Valve.
13. Jamesbury; a subsidiary of Metso Automation.
14. Jomar International LTD.
15. Keystone Valve USA, Inc.
16. Kitz Corp. Per Jay Gonzales, Chris Capson
17. Legend Valve. Per Chris Capson
18. Metraflex Company.
19. Milwaukee Valve Company.
20. Mueller Steam Specialty.
21. NIBCO Inc.
22. Red-White Valve Corp.
23. Spence Strainers International.
24. Stockham Valves and Fittings, Inc.
25. Tyco Fire/Shurjoint Piping Products.
26. Tyco/Pentair LTD.
27. Val-Matic Valve & Mfg. Corp.
28. Victaulic Company.
29. Watts Regulator Company.

2.02 BASIC, COMMON FEATURES

A. Design: Rising stem or rising outside screw and yoke stems, except as specified below.

1. Nonrising stem valves may be used only where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators: Use specified operators and handwheels, except provide the following special operator features:

1. Handwheels: For valves other than quarter turn.
2. Lever Handles: For quarter-turn valves 6 inches and smaller, except for plug valves, which shall have square heads. Furnish Owner with 1 wrench for every 10 plug valves.
3. Chain-Wheel Operators: For valves 4 inches and larger, installed 120-inches or higher above finished floor elevation.
4. Gear-Drive Operators: For quarter-turn valves 8 inches and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

G. Threads: ASME B1.20.1.

H. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24for bronze valves.

I. Solder Joint: ASME B16.18.

1. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

2.03 GATE VALVES

A. No gate valves will be used on this project.

2.04 BALL VALVES, HEAT PUMP WATER

A. Ball Valves, 4 Inches and Smaller: MSS SP-110, 600-psi CWP, ASTM B 584 ,B 61 or B 62 bronze body (containing no more than 15% zinc), 2-piece construction; chrome-plated, full port, brass ball; blowout proof; silicon- bronze or silicon-brass stem; teflon seats and seals; threaded or soldered end connections, valves for HVAC:

1. Operator: Vinyl-covered steel lever handle for sizes 2-1/2” and smaller.
2. Operator: Lever operators with lock for sizes 3” and larger.
3. Valves shall be equipped with 2” extended handles of non-thermal conductive material. Also provide a protective sleeve that allows operation of the valve without breaking the vapor seal or disturbing the insulation. Supply with memory stops, which are fully adjustable after insulation is applied.
4. Memory Stop: For operator handles.

2.05 PLUG VALVES

A. Plug Valves: MSS SP-78, 175-psi CWP, ASTM A 126 cast-iron body and bonnet, cast-iron plug, Viton, or teflon packing, flanged or grooved end connections:

1. Operator: Square head with 1 wrench for every 10 valves.
2. Operator: Worm and gear with handwheel, sizes 6 inches and larger.
3. Operator: Worm and gear with chain wheel, sizes 6 inches and larger, 120 inches or higher above floor.

2.06 GLOBE VALVES

A. Globe Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 150, 300-psi CWP; ASTM B 62 cast-bronze body and screwed bonnet, rubber, bronze, or teflon disc, silicon bronze-alloy stem, teflon-impregnated packing with bronze packing nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

B. Globe Valves, 3 Inches and Larger: MSS SP-85, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted bonnet with bronze fittings, renewable bronze seat and disc, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with cast-iron follower, flanged end connections; and with cast-iron handwheel.

2.07 BUTTERFLY VALVES

A. Butterfly Valves: MSS SP-67 150/175 CWP, ASTM A126 Class B Cast Iron full lug body, 2 inch extended neck, 316 stainless steel or ductile iron coated with Nylon 11 certified to ANS/NSF 61 water service, slide through one piece 400 series stainless steel stem design with double “D” connection to disc no taper pins, food grade peroxide cured EPDM tongue-and –groove seat to body retention method liner for field replacements, stem assembly to consists of stainless steel spirolox retaining ring, thrust washers, acetal bushing, U-cup self adjusting stem seal. Valves must be suitable for bi-directional dead end service at valves dead and rated pressure service with out the need for downstream flanges. The disk can be made of stainless steel for chilled water valves.

Operator for sizes 2-1/2” to 6”: Lever handle with latch lock.
Operator for sizes 8” to 24”: Weather-proof Handwheel gear operator.
Operator for 8” and larger, 120-inches or higher above floor: Chain-wheel operator assembly.

2.08 CHECK VALVES

A. Swing Check Valves, 2-1/2 Inches and Smaller: MSS SP-80; Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and bonnet cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections:

B. Swing Check Valves, 3 Inches and Larger: MSS SP-71 Type 1, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted bonnet cap, horizontal-swing bronze disc, flanged or grooved end connections.

1. On sump pump discharge use swing check valve with external spring or lever and weight.

C. Wafer Check Valves: Class 125, 200-psi CWP, ASTM A 126 cast-iron body, bronze disc/plates, stainless-steel pins and springs, Buna N seals, installed between flanges.

1. On grooved piping systems use grooved by grooved check valve in lieu of flanged or wafer with grooved flange adapters.

D. Lift Check Valves: Class 125, ASTM B 62 bronze body and cap (main components), horizontal or vertical pattern, lift-type, bronze disc or Buna N rubber disc with stainless-steel holder threaded or soldered end connections.

2.09 CHAINWHEELS

i) Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to [ball] [butterfly] [and] [plug] valve stems.
3. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve. Include zinc coating.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.01 EXAMINATION

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

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

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

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

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

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

3.02 INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

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

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

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

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

G. For chain-wheel operators, extend chains to 78 inches above finished floor elevation.

H. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.
2. Wafer Check Valves: Horizontal or vertical position, between flanges.
3. Lift Check Valve: With stem upright and plumb.

Note – Install all checks a minimum of 5 pipe diameters downstream of pump discharge or elbow to avoid flow turbulence. Flow straighteners may be needed in extreme cases.

3.03 SOLDERED CONNECTIONS

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Open gate and globe valves to fully open position.

E. Remove the cap and disc holder of swing check valves having composition discs.

F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.

G. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.04 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.05 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, all butterfly valves, except for the NIBCO LD2000 / 3000, require flanges both upstream and downstream for proper shutoff and retention. NIBCO LD2000 / 3000 series butterfly valves are suitable for bubble-tight dead-end service without the need for a downstream flange.

3.06 VALVE END SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2-1/2 Inches and Smaller: Solder ends, except provide threaded ends for HVAC and low-pressure steam service.
2. Steel Pipe Sizes, 2-1/2 Inches and Smaller: Threaded or grooved end.
3. Steel Pipe Sizes, 3 Inches and Larger: Grooved end or flanged.

3.07 APPLICATION

A. General Application: Use gate, ball, and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.

3.08 ADJUSTING

A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION

SECTION 23 0529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.

B. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
   3. Division 23 Section " Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
   4. Division 23 Section " Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
   5. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.03 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.

1.04 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 and obtain approval from authorities having jurisdiction.

1.05 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.

C. Welding certificates.

1.06 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code-Reinforcing Steel." ASME Boiler and Pressure Vessel Code: Section IX.

B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.2, "Structural Welding Code--Aluminum."
   3. AWS D1.3, "Structural Welding Code--Sheet Steel."
   4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   5. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

2.02 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. 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.
15. Simpson Strong-Tie Co.

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

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

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.03 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.04 METAL FRAMING SYSTEMS

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

B. Manufacturers:
1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Hilti, Inc.
5. Power-Strut Div.; Tyco International, Ltd.
6. Thomas & Betts Corporation.
7. Tolco Inc.
8. 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.

2.05 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.01 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 hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

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

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

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.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
   10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
   11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
   12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
   13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
   15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
   16. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
   17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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

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

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.

b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

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

M. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.02 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. 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 above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

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

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

E. 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.

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

G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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 B31.1 (for power piping) and 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 B31.1 for power piping and ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.

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

3.04 ADJUSTING

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

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

3.05 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.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

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

END OF SECTION

SECTION 23 0548

VIBRATION AND SEISMIC / WIND CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SCOPE

A. Provide engineered vibration isolation and restraint systems in accordance with the requirements of this section including design, engineering, materials, testing, inspections and reports.

B. All mechanical equipment, piping and ductwork shall be mounted on or suspended from vibration isolators to reduce the transmission of vibration and mechanically transmitted sound to the building structure.

C. All mechanical equipment, piping and ductwork shall be restrained as required by Federal, State and Local building codes to preserve the integrity of nonstructural building components during wind and/or seismic events to minimize hazards to occupants and reduce property damage.

1.03 SUMMARY

A. This Section includes the following:
1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraint channel bracings.
16. Restraint cables.
17. Seismic-restraint accessories.
18. Mechanical anchor bolts.
19. Adhesive anchor bolts.
20. Vibration isolation equipment bases.
21. Restrained isolation roof-curb rails.
22. Certification of seismic and wind restraint designs.

23. Installation supervision.
24. Design of attachment of housekeeping pads.
25. All components requiring IBC compliance and certification.
26. All inspection and test procedures for components requiring IBC compliance.
27. Restraint of all mechanical equipment, pipe and ductwork, within, on, or outdoors of the building and entry of services to the building, up to but not including, the utility connection, is part of this Specification.
28. Seismic certification of equipment

B. Related Requirements:

1. Section 21 0548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 22 0548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.04 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. ASCE: American Society of Civil Engineers

D. OSHPD: Office of Statewide Health Planning and Development for the State of California.

E. Ip: Importance Factor.

F. ESSENTIAL FACILITIES, (Occupancy Category IV, IBC-2009)

1. Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow or earthquakes.

G. LIFE SAFETY

1. All systems involved with fire protection, including sprinkler piping, jockey pumps, fire pumps, control panels, service water supply piping, water tanks, fire dampers, smoke exhaust systems and fire alarm panels.

2. All mechanical, electrical, plumbing or fire protection systems that support the operation of, or are connected to, emergency power equipment, including all lighting, generators, transfer switches and transformers.

3. All medical and life support systems.

4. Hospital heating systems and air conditioning systems for maintaining normal ambient temperature.

5. Automated supply, exhaust, fresh air and relief air systems on emergency control sequence, including air handlers, duct, dampers, etc., or manually-operated systems used for smoke evacuation, purge or fresh air relief by the fire department.

6. Heating systems in any facility with Occupancy Category IV, IBC-2009 where the ambient temperature can fall below 32 degrees Fahrenheit.

H. HIGH HAZARD

1. All gases or fluids that must be contained in a closed system which are flammable or combustible. Any gas that poses a health hazard if released into the environment and vented Fuel Cells.

1.05 REFERENCE CODES AND STANDARDS

A. Codes and Standards: The following shall apply and conform to good engineering practices unless otherwise directed by the Federal, State or Local authorities having jurisdiction.

1. IBC
2. ASCE 7
3. NFPA 13 (National Fire Protection Association)

B. The following guides may be used for supplemental information on typical seismic installation practices. Where a conflict exists between the guides and these construction documents, the construction documents will preside.

1. FEMA (Federal Emergency Management Agency) manuals 412, Installing Seismic Restraints for Mechanical Equipment and 414, Installing Seismic Restraints for Ductwork and Pipe.
2. SMACNA (Sheet Metal and Air-conditioning Contractors' National Association) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd ed.
3. ASHRAE (American Society for Heating, Refrigerating and Air-conditioning Engineers) A Practical Guide to Seismic Restraint
4. MSS (Manufacturers Standardization Society of the Valve and Fittings Industry) MSS SP-127, Bracing for Piping Systems, Seismic – Wind – Dynamic, Design, Selection, Application.

1.06 ISOLATOR AND RESTRAINT MANUFACTURER'S RESPONSIBILITIES:

A. Provide project specific vibration isolation and seismic restraint design prepared by a registered design professional in the state were the project is being constructed, and manufacturer certifications that the components are seismically qualified.

1. Provide calculations to determine restraint loads resulting from seismic forces as required by IBC, Chapter 16 and ASCE 7, latest editions. Seismic calculations shall be certified by an engineer licensed in the state where the project is being constructed.

B. Provide installation instructions and shop drawings for all materials supplied under this section of the specifications.

1. Provide seismic restraint details with specific information relating to the materials, type, size, and locations of anchorages; materials used for bracing; attachment requirements of bracing to structure and component; and locations of transverse and longitudinal sway bracing and rod stiffeners.
2. Provide seismic bracing layout drawings indicating the location of all seismic restraints.

    a. Each piece of rotating isolated equipment shall be tagged to clearly identify quantity and size of vibration isolators and seismic restraints.

C. Provide, in writing, the special inspection requirements for all Designated Seismic Systems as indicated in Chapter 17 of the IBC.

D. Provide training for installation, operation and maintenance of isolation and restraint systems.

1.07 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading: Per the structural drawings and specifications.

B. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC: Per the structural drawings and specifications.
   2. Assigned Occupancy Category as Defined in the IBC: Per the structural drawings and specifications.
      a. Component Importance Factor: 1.5.
         1) Life safety components required to function after an earthquake.
         2) Components containing hazardous or flammable materials in quantities that exceed the exempted amounts for an open system listed in Chapter 4.
         3) For structures in Seismic Use Group IV, components needed for continued operation of the facility or whose failure could impair the continued operation of the facility.
         4) Storage racks in occupancies open to the general public (e.g., warehouse retail stores).
      b. Component Importance Factor: 1.0.
         1) All other components
      c. Component Response Modification Factor: Per the structural drawings and specifications.
      d. Component Amplification Factor: Per the structural drawings and specifications.
   3. Design Spectral Response Acceleration at Short Periods: Per the structural drawings and specifications.
   4. Design Spectral Response Acceleration at 1-Second Period: Per the structural drawings and specifications.

1.08 ACTION SUBMITTALS

A. Product Data: For the following:

   1. Submittals shall include catalog cut sheets and installation instructions for each type of anchor and seismic restraint used on equipment or components being isolated and/or restrained.
   2. Submittals for mountings and hangers incorporating springs shall include spring diameter and free height, rated load, rated deflection, and overload capacity for each vibration isolation device.
   3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
      b. Annotate to indicate application of each product submitted and compliance with requirements.

4. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

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

1. "Basis for Design" report: Statement from the registered design professional that the design complies with the requirements of the ASCE 7-05 Chapter 13, IBC 2009 chapter 1912 and ACI 318. In addition, the basis for compliance must also be noted, as listed below:

   a. Project specific design documentation prepared and submitted by a registered design professional (ASCE 7, 13.2.1.1)
   b. Submittal of the manufacturer's certification that the isolation equipment is seismically qualified by:
   c. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
   d. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
   e. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

2. Seismic restraint load ratings must be certified and substantiated by testing or calculations under direct control of a registered professional engineer. Copies of testing and calculations must be submitted as part of submittal documents. OSHPD pre-approved restraint systems are exempt from this requirement if their pre-approval is current and based upon the IBC 2009 (i.e. OPA-07 pre-approval numbers).

3. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

4. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.

   a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.

5. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

6. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
7. Seismic and Wind -Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic-restraint and vibration isolation details and wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
    d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.09 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

1. Submittal drawings and calculations must be stamped by a registered professional engineer in the State where the project is being constructed who is responsible for the seismic restraint design.
2. Calculations and restraint device submittal drawings shall specify anchor bolt type, embedment, concrete compressive strength, minimum spacing between anchors, and minimum distances of anchors from concrete edges. Concrete anchor locations shall not be near edges, stress joints, or an existing fracture. All bolts shall be ASTM A307 or better.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control test reports.

1.10 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Project Architect or Engineer of Record is to provide a "Statement of Special Inspections" in conformance with 2009 IBC, Chapter 17.

F. Each contractor responsible for the installation of Designated Seismic Systems (systems with component Ip>1.0) must submit a written "Statement of Responsibility" as required by Section 17 06.1 of the IBC 2009, prior to prior to the commencement of work on any system or component. The contractor shall:

1. Identify the components that are part of the Quality Assurance Plan.
2. Identify all Special Inspection and Testing for components installed as part of this contract.
3. List control procedures within the contractor's organization for all special inspection and testing, including methods, frequency of reporting and their distribution of those reports.
4. List all personnel, including their qualifications, exercising control over the seismic aspects of the project.

1.11 SEISMIC CERTIFICATION OF EQUIPMENT

A. Component Importance Factor. All plumbing and mechanical components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

C. For equipment or components where I*p* = 1.0.

1. Submit manufacturer's certification that the equipment is seismically qualified by:

   a. An engineered analysis conforming to the requirements of Chapter 13 of ASCE 7.
   b. Testing by a nationally recognized testing standard procedure such as ICC-ES AC 156. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.
   c. Experience data conforming to a nationally recognized procedure. The substantiated seismic design capacities shall exceed the seismic demands determined by Section 13.3 of ASCE 7.

2. The equipment and components listed below are considered rugged and shall not require Special Seismic Certification:

   a. Valves (not in cast-iron housings, except for ductile cast iron).

b. Pneumatic operators.
c. Hydraulic operators.
d. Motors and motor operators.
e. Horizontal and vertical pumps (including vacuum pumps).
f. Air compressors
g. Refrigerators and freezers.
h. Elevator cabs.
i. Underground tanks.
j. Equipment and components weighing not more than 20 lbs. supported directly on structures (and not mounted on other equipment or components) with supports and attachments in accordance with Chapter 13, ASCE 7.

3. Rugged equipment and components in this section are for factory assembled discrete equipment and components only and do not apply to site assembled or field assembled equipment or equipment anchorage. The list is based in part on OSHPD Code Application Notice 2-1708A.5.

D. Special Certification requirements for Designated Seismic Systems (i.e. I*p* = 1.5): Seismic Certificates of Compliance supplied by manufacturers shall be submitted for all components that are part of Designated Seismic Systems. In accordance with the ASCE 7, certification shall be via one of the following methods:

1. For active mechanical and electrical equipment that must remain operable following the design earthquake:

a. Testing as detailed by part C.1.b above.
b. Experience data as detailed by part C.1.c above.
c. Equipment that is considered “rugged” per part C.2 above.

2. Components with hazardous contents shall be certified by the manufacturer as maintaining containment following the design earthquake by:

a. Testing as detailed by part C.1.b above.
b. Experience data as detailed by part C.1.c above.
c. Engineering analysis utilizing dynamic characteristics and forces. Tanks (without vibration isolators) designed by a registered design professional in accordance with ASME Boiler and Pressure Vessel Code, and satisfying the force and displacement requirements of Sections 13.3.1 and 13.3.2 of ASCE 7 having an importance factor, I*p* = 1.0 shall be considered to satisfy the Special Seismic Certification requirements on the basis of ASCE 7 Section 13 .6.9.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS

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

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
4. Kinetics Noise Control.
5. Mason Industries.

6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Elastomeric Isolation Pads **P1**:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Ribbed pattern.
5. Load-bearing metal plates adhered to pads.

C. Double-Deflection, Elastomeric Isolation Mounts **M1**:

1. Mounting Plates:

   a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded, or with threaded studs or bolts.
   b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

D. Restrained Elastomeric Isolation Mounts **M2**:

1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

   a. Housing: Cast-ductile iron or welded steel.
   b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

E. Spring Isolators **S1**: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators **S2**: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation. Baseplates shall limit floor load to 500 psig.

2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Restrained Spring Isolators **S3**: Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric pad: For high frequency absorption at the base of the spring.

H. Elastomeric Hangers **H1**:

1. Description: Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods

    a. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
    b. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

I. Spring Hangers **H2**: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and Insert in Compression.
    a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
    b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
    c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
    d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
g. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop **H3**: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Description: Combination Coil-Spring and Elastomeric-Insert Hanger with spring and insert in Compression and vertical limit stop.

a. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
f. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
g. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
h. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support **R1**:

1. Description: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene.

a. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
b. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

L. Resilient Pipe Guides **R2**:

1. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.

a. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

M. Horizontal Thrust Restraints **T1**: Modified specification S2 isolator.

1. Horizontal thrust restraints shall consist of a modified specification S2 spring mounting. Restraint springs shall have the same deflection as the isolator springs.
2. The assembly shall be preset at the factory and fine tuned in the field to allow for a maximum of 1/4" movement from stop to maximum thrust.

3. The assemblies shall be furnished with rod and angle brackets for attachment to both the equipment and duct work or the equipment and the structure.
4. Restraints shall be attached at the center line of thrust and symmetrically on both sides of the unit.

2.02 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

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

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Restrained Vibration Isolation Roof-Curb Rails: **RC1**:

C. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.

D. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.

E. Lower Support Assembly: The lower support assembly shall be a formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

F. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch-thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic and wind restraint.

a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch-thick.

H. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.03 VIBRATION ISOLATION EQUIPMENT BASES

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

1. Amber/Booth Company, Inc.
2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. Steel Bases and Rails **SB1**: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

    a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base **IB1**: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 2-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

    a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.04 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.

2. CalDyn (California Dynamics Corporation).
3. ISAT (International Seismic Application Technology).
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibro-Acoustics
7. VMC (Vibration Mountings & Controls, Inc.)

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES.

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. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

D. Channel Support System: MFMA-4, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cables: ASTM A 603 galvanized or ASTM A 492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement. Cables located in exterior or other wet locations such as wash-down areas shall be stainless steel.

F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.

G. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

H. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

I. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

J. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

K. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

L. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

M. All post installed anchors utilized in the seismic design must be qualified for use in cracked concrete and approved for use with seismic loads.

N. Expansion anchors shall not be used for anchorage of equipment with motors rated over 10 HP with the exception of undercut expansion anchors. Spring or internally isolated equipment are exempt from this requirement.

O. All beam clamps utilized for vertical support must also incorporate retention straps.

P. All seismic brace arm anchorages to include concrete anchors, beam clamps, truss connections, etc., must be approved for use with seismic loads.

2.05 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic and wind-control devices to indicate capacity range.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 COORDINATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Divison 03 Section "Cast-in-Place Concrete."

B. Coordinate size, shape, reinforcement and attachment of all housekeeping pads supporting vibration/seismically rated equipment. Concrete shall have a minimum compressive strength of 4,000 psi or as specified by the project engineer. Coordinate size, thickness, doweling, and

reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space, embedment and prevent edge breakout failures. Pads and piers must be adequately doweled in to structural slab.

C. Housekeeping pads shall have adequate space to mount equipment and seismic restraint devices.

D. Housekeeping Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors and shall also be large enough and thick enough to ensure adequate edge distance and embedment depth for restraint anchor bolts to avoid housekeeping pad breakout failure. Refer seismic restraint manufacturer's written instructions.

E. Coordinate with vibration/seismic restraint manufacturer and the structural engineer of record to locate and size structural supports underneath vibration/seismically restrained equipment (e.g. roof curbs, cooling towers and other similar equipment). Installation of all seismic restraint materials specified in this section shall be accomplished as per the manufacturer's written instructions. Adjust isolators and restraints after piping systems have been filled and equipment is at its operating weight, following the manufacturer's written instructions.

3.03 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES and per the seismic restraint manufacturer's design.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.04 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

C. Isolate all mechanical equipment 0.75 hp and over per the isolator and seismic restraint schedule and these specifications. Vibration isolators shall be selected in accordance with the equipment, pipe or duct weight distribution so as to produce reasonably uniform deflections

D. All isolation materials and seismic restraints shall be of the same vendor and shall be selected and certified using published or factory certified data

E. Installation of all vibration isolation materials, flexible connectors and supplemental equipment bases specified in this section shall be accomplished as per the manufacturer's written instructions with mountings adjusted to level equipment. Any variance or non-compliance with the manufacturer's instructions shall be reviewed and approved in writing by the manufacturer or corrected by the contractor in an approved manner.

F. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

G. Locate isolation hangers as near to the overhead support structure as possible.

H. No rigid connections between isolated components and the building structure shall be made that degrades the noise and vibration control system herein specified. “Building” includes, but is not limited to, slabs, beams, columns, studs and walls. “Components” includes, but is not limited to, mechanical equipment, piping and ducts.

I. Coordinate work with other trades to avoid rigid contact with the building.

J. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor’s expense.

K. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor’s expense.

L. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor’s expense.

M. Use horizontal thrust restraints **T1** to protect Air handling equipment and centrifugal fans against excessive displacement which results from high air thrust when thrust forces exceed 10% of the equipment weight.

N. Isolated equipment, duct and piping located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure will not be acceptable.

O. On completion of installation of all isolation materials and before startup of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment, leaving equipment free to move on the isolation supports.

P. All floor mounted isolated equipment shall be protected with specification M1, M2, S1, S2 or S3 isolator.

Q. Horizontal Pipe Isolation: All HVAC pumped water, pumped condensate, glycol, and refrigerant piping size 1-1/4” and larger within mechanical rooms shall be isolated. Outside equipment rooms this piping shall be isolated for the greater of 50’ or 100 pipe diameters from rotating equipment. For the first three (3) support locations from externally isolated equipment provide specification H2 or H3 hangers or specification S1, S2 or S3 mounts with the same deflection as equipment isolators (max 2”). All other piping within the equipment rooms shall be isolated with the same specification isolators with a 3/4” minimum deflection. Steam piping size 1-1/4” and larger which is within an equipment room and connected to rotating equipment shall be isolated for three (3) support locations from the equipment. Provide specification H2 or H3 hangers, or specification S1 or S2 mounts with the same deflection as equipment isolators but a minimum of ¾”.

R. Install full line size flexible pipe connectors at the inlet and outlet of each pump, cooling tower, condenser, chiller, coiling connections and where shown on the drawings. All connectors shall be suitable for use at the temperature, pressure, and service encountered at the point of installation and operation. End fitting connectors shall conform to the pipefitting schedule.

Control rods or protective braid must be used to limit elongation to 3/8". Flexible connectors shall not be required for suspended in-line pumps.

S. All plumbing pumped water, piping size 1-1/4" and larger within mechanical rooms shall be isolated the same as HVAC piping above. Isolators are not required for any plumbing pumped water, pumped condensate, and steam piping outside of mechanical rooms unless listed in the isolation schedule.

T. Pipe Riser Isolation: The operating weight of all variable temperature vertical pipe risers 1-1/4" and larger, requiring isolation where specifically shown and detailed on riser drawings shall be fully supported by specification M1, M2 or R1 supports. S1, S2, S3, H2 or H3 steel spring deflection isolators with minimum 3/4-inch minimum shall be in those locations where added deflection is required due to pipe expansion and contraction. Spring deflection shall be a minimum of 4 times the anticipated deflection change. Springs shall be selected to keep the riser in tension. Height saving brackets used with isolators having 2.5" deflection or greater shall be of the precompression type to limit exposed bolt length. Specification R1 riser supports shall be installed near the center point of the riser to anchor the riser when spring isolation is used. Specification R2 riser guides may be used in conjunction with spring isolators per design calculations. Pipe risers up through 16" shall be supported at intervals of every third floor of the building. Pipe risers 18" and over, every second floor. Wall sleeves for take-offs from riser shall be sized for insulation O.D. plus two times the anticipated movement to prevent binding. Horizontal take-offs and at upper and lower elbows shall be supported with spring isolators as required to accommodate anticipated movement. In addition to submittal data requirements previously outlined, riser diagrams and calculations shall be submitted for approval. Calculations must show anticipated expansion and contraction at each support point, initial and final loads on the building structure, and spring deflection changes. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist if installed per design proposed.

U. Where riser pipes pass through cored holes, core diameters shall be a maximum of 2" larger than pipe O.D. including insulation. Cored holes must be packed with resilient material or firestop as provided by other sections of this specification or local codes. Where seismic restraint is required specification isolator S3 shall support risers and provide longitudinal restraint at floors where thermal expansion is minimal and will not bind isolator restraints.

V. Duct Isolation: Isolate all duct work with a static pressure 2" W.C. and over in equipment rooms and to minimum of 50 feet from the fan or air handler. Use specification type H2 or H3 hangers or type S1 or S2 floor mounts.

3.05 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. On projects with Seismic Site Class A or B, seismic design or restraint is not required.

2. On projects with Seismic Design Category C: Components with an importance factor of 1.0 do not require seismic design or restraint.

3. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

4. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

5. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES. providing required submittals for component.

6. Suspended Equipment: All suspended equipment that meets any of the following conditions requires seismic restraints as specified by the supplier:

    a. Rigidly attached to pipe or duct that is 75 lbs. and greater,
    b. Items greater than 20 lbs and distribution systems weighing more than 5 lbs/lineal foot, with an importance factor of 1.0 hung independently or with flexible connections.
    c. Possibility of consequential damage.
    d. For importance factors greater than 1.0 all suspended equipment requires seismic restraint regardless of the above notes.
    e. Wall mounted equipment weighing more than 20 lbs.
    f. Exemptions:

        1) Equipment weighing less than 20 lbs and distribution systems weighing less than 5 lbs/lineal foot, with an Ip = 1.0 and where flexible connections exist between the component and associated ductwork, piping or conduit.

7. Base Mounted Equipment: All base mounted equipment that meets any of the following conditions requires attachments and seismic restraints as specified by the supplier:

    a. Connections to or containing hazardous material,
    b. With an overturning moment.
    c. Weight greater than 400 lbs.
    d. Mounted on a stand 4 ft. or more from the floor
    e. Possibility of consequential damage.
    f. For importance factors greater than 1.0 all base mounted items require seismic restraints regardless of the above notes.
    g. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.
    h. Exemptions:

        1) Floor or curb-mounted equipment weighing less than 400 lbs and not resiliently mounted, where the Importance Factor, Ip = 1.0, the components are mounted at 4 feet or less above a floor level, flexible connections between the components and associated duct work, piping and conduit are provided and there is no possibility of consequential damage.

8. Roof Mounted Equipment:
    a. To be installed on a structural frame, seismically rated roof curb, or structural curb frame mechanically connected to the structure. Items shall not be mounted onto sleepers or pads that are not mechanically and rigidly attached to the structure. Restraint must be adequate to resist both seismic and wind forces.
    b. Roof curbs shall be installed directly to building structural steel or concrete roof deck and not to top of steel deck or roofing material.
    c. Exemptions:
        1) Curb-mounted mushroom, exhaust and vent fans with curb area less than nine square feet are excluded.

9. Rigid Mounted Equipment:

a. Anchor floor and wall mounted equipment to the structure as per the stamped seismic certifications / drawings.
b. For equipment with high center of gravity additional cable restraints shall be furnished, as required by isolation manufacturer, to limit forces and motion caused by rocking.
c. Suspended equipment shall be restrained using seismic cable restraints, or struts, and hanger rods as per the stamped seismic certifications / drawings.

10. Vibration Isolated Equipment:

a. Seismic control shall not compromise the performance of noise control, vibration isolation or fire stopping systems.
b. Equipment supported by vibration-isolation hangers shall be detailed and installed with approximately a 1/8" gap between the isolation hangers and the structure. Isolators at restraint locations must be fitted with uplift limit stops.

B. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

C. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.

E. Installation and adjustment of all seismic restraints specified in this section shall be accomplished as per the manufacturer's written instructions. Any deviation from the manufacturer's instructions shall be reviewed and approved by the manufacturer.

F. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Seismically restrain piping, with an Ip = 1.0, located in boiler rooms, mechanical equipment rooms and refrigeration equipment rooms that is 1¼" I.D. and larger.
3. Seismically restrain all other Ip = 1.0 piping 2½" diameter and larger.
4. Seismically restrain all Ip = 1.5 piping larger than 1" diameter.
5. Branch lines may not be used to brace main lines.
6. Exemptions:

a. All high deformability pipe 3" or less in diameter suspended by individual hanger rods where Ip = 1.0.
b. High deformability pipe or conduit in Seismic Design Category C, 2" or less in diameter suspended by individual hanger rods where Ip = 1.5.
c. High deformability pipe in Seismic Design Category D, E or F, 1" or less in diameter suspended by individual hanger rods where Ip = 1.5.
d. All clevis supported pipe runs installed less than 12" from the top of the pipe to the underside of the support point and trapeze supported pipe suspended by hanger rods having a distance less than 12" in length from the underside of the pipe support to the support point of the structure.
e. Piping systems, including their supports, designed and constructed in accordance with ASME B31.
f. Piping systems, including their supports, designed and constructed in accordance with NFPA, provided they meet the force and displacement requirements of Section 13 .3.1 and 13.3.2 (ASCE 7).

G. Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.

H. Install flexible piping connectors where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

I. Where pipe sizes reduce below dimensions required for seismic, the final restraint shall be installed at the transition location.

J. Restraint Spacing For Piping: Sizes shown are maximum. Actual spacing determined by calculation.

1. For non-ductile piping (e.g., cast iron, PVC) space transverse supports a maximum of 20' o.c., and longitudinal supports a maximum of 40' o.c.
2. For piping with hazardous material inside (e.g., natural gas, medical gas) space Transverse supports a maximum of 20' o.c., and longitudinal supports a maximum of 40' o.c.
3. For pipe risers, restrain the piping at floor penetrations using the same spacing requirements as above.
4. For all other ductile piping see Table "A" below

K. Seismic Restraint of Ductwork: Seismically restrain per specific code requirements, all ductwork listed below (unless otherwise indicated on the drawings), using seismic cable restraints: (Ductwork not meeting criteria listed below is to be "Exempt")

1. Restrain rectangular ductwork with cross sectional area of 6 square feet or larger. Duct with and an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.
2. Restrain round ducts with diameters of 28" or larger. Duct with and an importance factor of 1.5 must be braced with no exceptions regardless of size or distance requirements.
3. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
4. Duct must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze. Additional reinforcing is not required if duct sections are mechanically fastened together with frame bolts and positively fastened to the duct support suspension system.
5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
6. Walls, including gypsum board non-bearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
7. If ducts are supported by angles, channels or struts, ducts shall be fastened to it at seismic brace locations in lieu of duct reinforcement.
8. All ductwork weighing more than 17 lb/ft.
9. Exemptions:

    a. Duct runs supported at locations by two rods less than 12 inches in length from the structural support to the structural connection to the ductwork. This exemption does not apply to ducts with an importance factor of 1.5.

10. See Table "A" below for restraint spacing.

L. Exemptions do not apply for:

1. Life Safety or High Hazard Components

   a. Including gas, fire protection, medical gas, fuel oil and compressed air needed for the continued operation of the facility or whose failure could impair the facility's continued operation, Occupancy Category IV, IBC-2009 as listed in Section 1.3 B regardless of governing code for HVAC, Plumbing, Electrical piping or equipment. (A partial list is illustrated.) High Hazard is additionally classified as any system handling flammable, combustible or toxic material. Typical systems not excluded are additionally listed below.

2. Piping

   a. Fuel oil, gasoline, natural gas, medical gas, steam, compressed air or any piping containing hazardous, flammable, combustible, toxic or corrosive materials. Fire protection standpipe, risers and mains. Fire Sprinkler Branch Lines must be end tied.

3. Duct

   a. Smoke evacuation duct or fresh air make up connected to emergency system, emergency generator exhaust, boiler breeching or as used by the fire department on manual override.

4. Equipment

   a. Previously excluded non life safety duct mounted systems such as fans, variable air volume boxes, heat exchangers and humidifiers having a weight greater than 75 lbs require independent seismic bracing.

M. Spacing Chart For Suspended Components:

Table "A" Seismic Bracing
(Maximum Allowable Spacing Shown- Actual Spacing to Be Determined by Calculation)

Equipment	**On Center Transverse**	**On Center Longitudinal**	**Change Of Direction**
Duct			
All Sizes	30 Feet	60 Feet	4 Feet
Pipe Threaded, Welded, Soldered Or Grooved			
To 16"	40 Feet	80 Feet	4 Feet
18" – 28"	30 Feet	60 Feet	4 Feet
30" – 40"	20 Feet	60 Feet	4 Feet
42" & Larger	10 Feet	30 Feet	4 Feet

N. Roof mounted duct is to be installed on sleepers or frames mechanically connected to the building structure. Roof anchors and seismic cables or frames shall be used to resist seismic and wind loading. Wind loading factors shall be determined by the registered design professional.

O. Where duct sizes reduce below dimensions required for seismic restraint the final restraint shall be installed at the transition location.

P. Install cables so they do not bend across edges of adjacent equipment or building structure.

Q. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

R. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

S. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

T. Seismically Rated Beam Clamps are required where welding to or penetrations to steel beams are not approved.

U. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.06 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.07 FIELD QUFALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

1. A representative of the vibration isolation system manufacturer shall review the project installation and provide documentation indicating conformance to vibration isolation design intent

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

1. The installing contractor shall submit a report upon request to the building architect and/or engineer, including the manufacturer's representative's final report, indicating that all seismic restraint material has been properly installed, or steps that are to be taken by the contractor to properly complete the seismic restraint work as per the specifications.

3.08 SPECIAL INSPECTIONS

A. Special Inspection Requirements: All Designated Seismic Systems are subject to Special Inspection per IBC Chapter 17. The seismic restraint manufacturer will provide a special inspection plan to the contractor for submittal to the owner and design team for use by the projects special inspectors. The plan will include the following:

1. A list of all components of the seismic system that require inspection of testing.
2. The required frequency of testing and inspection.
3. Type and nature of testing required.

3.09 IDENTIFICATION

A. Install identification tags at all seismic brace locations. Tags to include the following information:

1. Specific seismic forces (g-force) the location was designed to resist.
2. Maximum brace reaction at connection to structure.
3. For single hung items, the maximum pipe/conduit size the brace location was designed to accommodate.
4. For trapeze supported items, the maximum weight (lbs/lf) the brace location was designed to accommodate.
5. For suspended equipment, the maximum unit operating weight (lbs) the brace location was designed to accommodate.
6. Location identifier cross matched to that on plan set layout.
7. Company name of installing contractor.

3.010 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.

1. Adjust active height of spring isolators.

C. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

EQUIPMENT ISOLATION SCHEDULE

LOCATION	A' CRITICAL (35'-50' SPAN)			B' UPPER STORY (20'-35' SPAN)			C' GRADE		
EQUIPMENT (1)	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE	ISOLATOR TYPE	MINIMUM DEFLECTION (IN)	BASE TYPE
AIR HANDLING UNITS									
FLOOR MOUNTED									
UP TO 15 HP	S3	1.5		S3	0.75		S3	0.75	
20 HP & OVER	S3	2.5	SB1	S3	1.5		S3	0.75	
SUSPENDED									
UP TO 15 HP	H3	1.75		H3	1		H3	1	
20 HP & OVER	H3	2.5	SB1	H3	1.75		H3	1	
HIGH PRESSURE FAN SECTIONS									
UP TO 30 HP	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	IB1
40 HP & OVER	S1	3.5	IB1	S3	2.5	IB1	S3	1.5	IB1
CENTRIFUGAL FANS									
CL. I & II UP TO *54-112"* W.D.									
UPT015HP	S3	1.5	SB1	S3	0.75	SB1	S3	0.75	SB1
20-50 HP	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	SB1
60 HP & OVER	S1	3.5	IB1	S1	2.5	IB1	S3	1.5	SB1
CL. I & II 60" W.D. & OVERI ALL CL. III FANS									
UPT015HP	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	IB1
20-50 H P	S1	2.5	IB1	S1	2.5	IB1	S3	1.5	IB1
60 HP & OVER	S1	3.5	IB1	S1	2.5	IB1	S3	1.5	IB1
AXIAL FLOWFANS									
FLOOR MTD.									
UP TO 15 HP	S3	1.5	SB1	S3	0.75		S3	0.75	
20 HP & OVER	S1	3.5	IB1	S3	1.5		S3	0.75	
SUSPENDED									
UP TO 15 HP	H3	1.75	SB1	H3	1		H3	1	
20 HP & OVER	H3	2.5	SB1	H3	1.75	SB1	H3	1.5	
VENT (UTILITY SETS)									
FLOOR MTD	S3	1.5	SB1	S3	0.75		S3	0.75	
SUSPENDED	H3	1.75	SB1	H3	1		H3	0.75	
CABINET FANS, FANS SECTIONS									
FLOOR MTD.									
UP TO 15 HP	S3	1.5		S3	0.75		S3	0.75	
20 HP & OVER	S1	2.5	IB1	S3	1.5		S3	0.75	
SUSPENDED									
UP TO 15 HP	H3	1.75		H3	1		H3	0.75	
20 HP & OVER	H3	2.5	SB1	H3	1.75		H3	1.75	
PUMPS									
FLOOR MTD.									
UP TO 15 HP	S3	0.75	IB1	S3	0.75	IB1	SRVD	0.4	IB1
7-112 HP & OVER	S3	1.5	IB1	S3	1.5	IB1	S3	0.75	IB1
SUSPENDED INLINE	H3	1.75		H3	1.75		H3	1	
REFRIGERATION UNITS									
RECIPROCATING COMPRESSORS	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	IB1
RECIPROCATING CONDo UNITS & CHILLERS	S1	2.5	IB1	S3	1.5		S3	0.75	
HERMETIC CENTRIFUGALS	S3	2.5		S3	1.5		P1	0.15	
OPEN CENTRIFUGALS	S1	2.5	IB1	S3	1.5	IB1	P1	0.15	
ABSORPTION MACHINES	S3	1.5		S3	0.75		P1	0.15	
AIR COMPRESSORS									
TANK TYPE (HORIZONTAL TANK)	S1	2.5	IB1	S3	1.5		S3	0.75	
TANK TYPE (VERTICAL TANK)	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	
COOLING TOWERS & CLOSED CIRCUIT COOLERS									
UP TO 500 TONS	S3	2.5		S3	0.75		P1	0.15	
OVER 500 TONS	S3	4.5		S3	2.5		P1	0.15	
AIR COOLED CONDENSERS									

UP TO 50 TONS	S3	1.5		S3	0.75		P1	0.15	
OVER 50 TONS	S3	2.5		S3	1.5		P1	0.15	
ROOFTOP AIR CONDITIONING UNITS									
REQUIRING WEATHER SEAL									
UP TO 5000 CFM (12 TON)	S1	1.5	RC1	S1	0.75	RC1			
OVER 5000 CFM (12 TON)	S3	2.5	RC1	S3	1.5	RC1			
OTHER TYPES									
UP TO 25 TONS	S3	1.5		S3	1.5				
OVER 25 TONS	S3	2.5		S3	1.5				
BOILER (PACKAGE TYPE)									
ALL SIZES	S3	1.5		S3	0.75		P1	0.15	
ENGINE DRIVEN GENERATORS									
UP TO 60 HP	S1	2.5	IB1	S3	1.5	IB1	S3	0.75	
75 HP & OVER	S1	3.5	IB1	S3	2.5	IB1	S3	0.75	

NOTES:

1) Thrust restraints required on all high-pressure fan section, suspended axial-flow fans and on floor-mounted axial fans operating at 3.0" S.P. or greater.

END OF SECTION

SECTION 23 0550

OPERATIONS AND MAINTENANCE MANUALS

PART 1- GENERAL

1.01 RELATED DOCUMENTS

A. All pertinent sections of Division 22 & 23 Mechanical General Requirements are part of the work of this Section. Division 1 is part of this and all other sections of these specifications.

1. Testing and Balancing is specified in Section 23 0594.
2. Training and Instructions to Owner's Representative is specified in Section 23 0100.

1.02 SCOPE OF WORK

A. Submission of Operating and Maintenance Manuals complete with Balancing reports. (Coordinate with Division 1).

B. Coordination of work required for system commissioning.

1.03 SUBMITTALS

A. Submit product data in accordance with Division 1 and Section 23 0100. Submit the following:

B. Sample of O and M manual outline.

PART 2 - PRODUCTS

2.01 O & M MANUALS

A. The operating and maintenance manuals shall be as follows:

1. Binders shall be red buckram with easy-view metal for size 8-1/2 x 11-inch sheets, with capacity expandable from 2 inches to 3-1/2 inches as required for the project. Construction shall be rivet-through with library corners. No. 12 backbone and lining shall be the same material as the cover. The front cover and backbone shall be foil-stamped in white as follows:

OPERATING AND MAINTENANCE
MANUAL
FOR THE

HILLCREST JUNIOR HIGH SCHOOL
Murray City School District
Board of Education

VOLUME No. ( )

VAN BOERUM & FRANK ASSOCIATES, INC.
MECHANICAL ENGINEER

NWL ARCHITECTURE
ARCHITECT

Binders shall be a manufactured by Hiller Bookbinding.

PART 3- EXECUTION

3.01 OPERATING AND MAINTENANCE MANUALS:

A. Work under this section shall be performed in concert with the contractor performing the system testing and balancing. Six (6) copies of the manuals shall be furnished to the Architect for distribution to the owner.

B. The "Start-Up and Operation" section is one of the most important in the manual. Information in this section shall be complete and accurately written and shall be verified with the actual equipment on the job, such as switches, starters, relays, automatic controls, etc. A step-by-step start-up procedure shall be described.

C. The manuals shall include water-balancing reports, system commissioning procedures, start-up tests and reports, equipment and system performance test reports, warranties, and certificates of training given to the owner's representatives.

D. An index sheet typed on AICO Gold-Line indexes shall be provided in the front of the binder. The manual shall be include the following:

SYSTEM DESCRIPTIONS

START-UP PROCEDURE AND OPERATION OF SYSTEM

MAINTENANCE AND LUBRICATION TABLE

OPERATION AND MAINTENANCE BULLETINS

AUTOMATIC TEMPERATURE CONTROL DESCRIPTION OF OPERATION, INTERLOCK AND CONTROL DIAGRAMS, AND CONTROL PANELS.

AIR AND WATER SYSTEM BALANCING REPORTS

EQUIPMENT WARRANTIES AND TRAINING CERTIFICATES

SYSTEM COMMISSIONING REPORTS

EQUIPMENT START-UP CERTIFICATES

END OF SECTION

SECTION 23 0553

IDENTIFICATION FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes mechanical identification materials and devices.

B. Provide red lettering on the ceiling tiles of the locations of all fire dampers, smoke dampers and fire /smoke dampers. Size of lettering and verbiage is to conform to IBC and NFPA standards.

1.03 SUBMITTALS

A. Product Data: For identification materials and devices.

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

1.04 QUALITY ASSURANCE

A. Comply with ASME A13.1, "Scheme for the Identification of Piping Systems" for lettering size, length of color field, colors, and viewing angles of identification devices.

1.05 SEQUENCING AND SCHEDULING

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

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

PART 2 - PRODUCTS

2.01 IDENTIFYING DEVICES AND LABELS

A. General: Products specified are for applications referenced in other Division 22 & 23 Sections. If more than single type is specified for listed applications, selection is Installer's option.

B. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
2. Location: Accessible and visible.

C. Stencils: Standard stencils, prepared with letter sizes conforming to recommendations of ASME A13.1. Minimum letter height is 1-1/4 inches for ducts, and 3/4 inch for access door signs and similar operational instructions.

1. Stencil Paint: Exterior, oil-based, alkyd gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
2. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.

D. Snap-On Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.

E. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.

F. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least 3 times letter height and of length required for label.

G. Lettering: Manufacturer's standard preprinted captions as selected by Engineer.

H. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

1. Arrows: Either integrally with piping system service lettering, to accommodate both directions, or as separate unit, on each pipe marker to indicate direction of flow.

I. Plastic Duct Markers: Manufacturer's standard laminated plastic, in the following color codes:

1. Green: Cold-air supply.
2. Yellow: Hot-air supply.
3. Blue: Exhaust, outside, return, and mixed air.
4. Hazardous Material Exhausts: Use colors and designs recommended by ASME A13.1.
5. Terminology: Include direction of airflow; duct service such as supply, return, and exhaust; duct origin, duct destination, and design flow.

J. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive, vinyl tape, at least 3 mils thick.

1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
2. Color: Comply with ASME A13.1, unless otherwise indicated.

K. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick, polished brass..
2. Size: 1-1/2-inches diameter, unless otherwise required.

3. Indicate valve service and normal position on valve. Example Cold water, N.O.

L. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

M. Valve Tag Fasteners: Brass, wire-link chain; beaded chain; or S-hooks.

N. Access Panel Markers: 1/16-inch- thick, engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed valve. Provide 1/8-inch center hole for attachment.

O. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Brown: Energy reclamation equipment and components.
4. Blue: Equipment and components that do not meet criteria above.
5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
6. Terminology: Match schedules as closely as possible. Include the following:

   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

P. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.

1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

PART 3 - EXECUTION

3.01 LABELING AND IDENTIFYING PIPING SYSTEMS

A. Install pipe markers on each system. Include arrows showing normal direction of flow.

B. Marker Type: Stenciled markers with painted, color-coded bands complying with ASME A13.1.

C. Marker Type: Plastic markers, with application systems. Install on pipe insulation segment where required for hot, noninsulated pipes.

D. Fasten markers on pipes and insulated pipes by one of following methods:

1. Snap-on application of pretensioned, semirigid plastic pipe marker.
2. Adhesive lap joint in pipe marker overlap.

3. Laminated or bonded application of pipe marker to pipe or insulation.
4. Taped to pipe or insulation with color-coded plastic adhesive tape, not less than 3/4 inch wide, lapped a minimum of 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
5. Taped to pipe or insulation with color-coded plastic adhesive tape, not less than 1-1/2 inches wide, lapped a minimum of 3 inches at both ends of pipe marker, and covering full circumference of pipe.

E. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations according to the following:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.
3. Near penetrations through walls, floors, ceilings, or nonaccessible 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 a maximum of 50-foot intervals along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.02 VALVE TAGS

A. Install on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. Indicate service and normal position of all tagged valve and control devices. List tagged valves in valve schedule.

B. Tag Material: Brass.

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

1. Valve-tag schedule shall be included in operation and maintenance data.

3.03 EQUIPMENT SIGNS AND MARKERS

A. Install engraved plastic-laminate signs or equipment markers on or near each major item of mechanical equipment. Include signs for the following general categories of equipment:

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
2. Fire department hose valves and hose stations.
3. Meters, gages, thermometers, and similar units.
4. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
5. Pumps, compressors, chillers, condensers, and similar motor-driven units.

6. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
7. Fans, blowers, primary balancing dampers, and mixing boxes.
8. Packaged HVAC central-station and zone-type units.
9. Tanks and pressure vessels.
10. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

B. Optional Sign Types: Stenciled signs may be provided instead of engraved plastic, at Installer's option, where lettering larger than 1-inch high is needed for proper identification because of distance from normal location of required identification.

1. Lettering Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
2. Terms on Signs: Distinguish between multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

C. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers; or provide stenciled signs and arrows showing service and direction of flow.

1. Location: Locate signs near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.04 ADJUSTING AND CLEANING

A. Relocate mechanical identification materials and devices that have become visually blocked by work of this or other Divisions.

END OF SECTION

SECTION 23 0594

GENERAL TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Measuring electrical performance of HVAC equipment.
4. Setting quantitative performance of HVAC equipment.
5. Verifying that automatic control devices are functioning properly.
6. Measuring sound and vibration.
7. Reporting results of the activities and procedures specified in this Section.

1.03 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. Test: A procedure to determine quantitative performance of a system or equipment.

L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

M. AABC: Associated Air Balance Council.

N. AMCA: Air Movement and Control Association.

O. NEBB: National Environmental Balancing Bureau.

P. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.04 SUBMITTALS

A. Contract Documents Examination Report: Within 90 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.

B. Strategies and Procedures Plan: Within 120 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.

C. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

D. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.

E. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

1.05 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB. Balancing may only be performed by the following:

1. Bonneville Test & Balance.
2. Certified Test & Balance.
3. RS Analysis.

B. Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service

representatives, HVAC controls Installer, and other support personnel. Provide 14ays' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:

    a. Submittal distribution requirements.
    b. Contract Documents examination report.
    c. Testing, adjusting, and balancing plan.
    d. Work schedule and Project site access requirements.
    e. Coordination and cooperation of trades and subcontractors.
    f. Coordination of documentation and communication flow.

C. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

D. Testing, Adjusting, and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting, and Balancing" or frame NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.06 PROJECT CONDITIONS

A. Partial Owner Occupancy: The Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

1.07 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.08 WARRANTY

A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract

Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. National Project Performance Guarantee: Provide a guarantee on AABC or NEBB forms stating that AABC or NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

1. The certified Agent has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - **PRODUCTS** (Not Applicable)

PART 3 - **EXECUTION**

3.01 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine project record documents described in Division 1 Section "Project Record Documents."

D. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

F. Examine system and equipment test reports.

G. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and

fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

I. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.

K. Examine plenum ceilings, utilized for supply air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

L. Examine strainers for clean screens and proper perforations.

M. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

N. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

O. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.

P. Examine equipment for installation and for properly operating safety interlocks and controls.

Q. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices operate by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to design values.

R. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.02 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.

2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so design conditions for system operations can be met.

3.03 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC or NEBB national standards and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.04 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

3.05 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems. Additional procedures are required for variable-air-volume, multizone, dual-duct, induction-unit supply-air systems and process exhaust-air systems. These additional procedures are specified in other articles in this Section.

B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each air-handling unit component.

a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

5. Adjust fan speed higher or lower than design to achieve design conditions. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submains 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. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.
   1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
   2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.06 VARIABLE-AIR-VOLUME SYSTEMS' ADDITIONAL PROCEDURES

A. Compensating for Diversity: When the total airflow of all terminal units is more than the fan design airflow volume, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the design airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

   1. Set outside-air dampers at minimum and return- and exhaust-air dampers at a position that simulates full-cooling load.
   2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge duct losses.
   3. Measure total system airflow. Adjust to within 10 percent of design airflow.
   4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use the terminal unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
   5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

      a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

   6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
   7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure adequate static pressure is maintained at the most critical unit.
   8. Record the final fan performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

   1. Balance systems similar to constant-volume air systems.
   2. Set terminal units and supply fan at full-airflow condition.
   3. Adjust inlet dampers of each terminal unit to design airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
   4. Readjust fan airflow for final maximum readings.

5. Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum design airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
2. Adjust supply fan to maximum design airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units being tested at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to design airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.07 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at design flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.08 HYDRONIC SYSTEMS' BALANCING PROCEDURES

A. Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.

E. Adjust balancing stations to within specified tolerances of design flow rate as follows:

1. Determine the balancing station with the highest percentage over design flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.09 VARIABLE-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

A. Balance systems with automatic 2- and 3-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES

A. Balance the primary system crossover flow first, and then balance the secondary system.

3.11 HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

D. Measure inlet steam pressure. Check the setting and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves.

E. Record safety valve settings.

F. Verify operation of steam traps.

3.12 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating if high-efficiency motor.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.13 HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperatures.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperatures of entering and leaving air.
5. Wet-bulb temperatures of entering and leaving air for cooling coils designed for more than 5000 cfm.
6. Airflow.
7. Air pressure drop.

B. Reheat and Fan Coils: Measure the following data for each coil:

1. Entering water temperature.
2. Entering air temperature.
3. Leaving air temperature.
4. Air Flow

3.14 CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of design flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator water entering and leaving temperatures, pressure drop, and water flow.
2. Condenser water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by the chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kW.
5. The kW input if factory-installed instrumentation is furnished for measuring kW.
6. Capacity: Calculate in tons of cooling.
7. Air-Cooled Chillers: Verify condenser-fan rotation and record fan data, including number of fans and entering- and leaving-air temperatures.

3.15 COOLING TOWERS

A. Shut off makeup water for the duration of the test, and then make sure the makeup and blow-down systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser water flow to each cell of the cooling tower.
2. Measure entering- and leaving-water temperatures.
3. Measure wet- and dry-bulb temperatures of entering air.
4. Measure wet- and dry-bulb temperatures of leaving air.
5. Measure condenser water flow rate recirculating through the cooling tower.
6. Measure cooling tower pump discharge pressure.
7. Adjust water level and feed rate of makeup-water system.

3.16 BOILERS

A. Measure output performance of each boiler system.

3.17 TEMPERATURE TESTING

A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.18 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Verify free travel and proper operation of control devices such as damper and valve operators.

F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.

G. Confirm interaction of electrically operated switch transducers.

H. Confirm interaction of interlock and lockout systems.

I. Verify main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine if the system operates on a grounded or nongrounded power supply.

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

3.19 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.
3. Heating-Water Flow Rate: 0 to minus 10 percent.
4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.20 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.21 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of testing, adjusting, and balancing Agent.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of testing, adjusting, and balancing Agent who certifies the report.
10. Summary of contents, including the following:

    a. Design versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

11. Nomenclature sheets for each item of equipment.
12. Data for terminal units, including manufacturer, type size, and fittings.
13. Notes to explain why certain final data in the body of reports vary from design values.
14. Test conditions for fans and pump performance forms, including the following:

    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Fan drive settings, including settings and percentage of maximum pitch diameter.
    e. Inlet vane settings for variable-air-volume systems.
    f. Settings for supply-air, static-pressure controller.
    g. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present with single-line diagrams and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.

F. Equipment Test Reports: For all equipment tested:

1. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.

2. Motor Data: Include the following:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.

3. Test Data: Include design and actual values for the following: (all elements of the system that were tested, including air and water flows, static pressures, pump hoods, inlet and outlet static pressures, inlet, outlet pressure type of coils, raws, circuits face areas, inlet, outer wet bulb, dry bulb temperatures, duct sizes tested, inlet and outlet flows temperatures and pressures and all other pertinent data. The report to be organized per each item tested.)

a. Total rate in cfm, gpm and lbs/hr.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat coil static-pressure differential in inches wg.
g. Cooling coil static-pressure differential in inches wg.
h. Heating coil static-pressure differential in inches wg.
i. Outside airflow in cfm.
j. Return airflow in cfm.
k. Outside-air damper position.
l. Return-air damper position.
m. Vortex damper position.

G. Instrument Calibration Reports: For instrument calibration, include the following:

1. Report Data: Include the following:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.22 ADDITIONAL TESTS

A. Within 120 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

3.23 ADDITIONAL CHECKLISTS

(see next page)

System Readiness Checklist
Piping and Appurtenances

Installation:

- ☐ Piping installed with slope to drain.
- ☐ Hose end drain valves installed at all low points.
- ☐ Air vents with valves installed at all high points of the hot water systems.
- ☐ Automatic air vents piping installed for drainage to nearest drain.
- ☐ Unions installed on all equipment requiring disconnects for servicing.
- ☐ Dielectric unions installed on all dissimilar materials per specifications.
- ☐ Expansion joints and loops are installed as needed and per manufacturer's recommendations.
- ☐ Pressure and temperature gages installed at all specified points.
- ☐ Pressure and temperature gage ranges per specifications.
- ☐ P/T ports installed at locations specified.
- ☐ Relief valves installed on all pressure vessels as specified.
- ☐ Strainers installed at all specified locations including blow-off valve and cap.
- ☐ Air separators, expansion tanks and suction diffusers installed.
- ☐ Water treatment system installed per project documents.
- ☐ Glycol feeder system installed per project documents.
- ☐ Valves provided and installed per specification in regards to connection style and size.
- ☐ Valves installed for area and group isolation, maintenance isolation and service disconnects.
- ☐ Valves installed with stems oriented up.
- ☐ Control valves installed and wired to control system.
- ☐ All specified equipment, piping, valves, pump bodies, drains, unions are insulated per specification - removable insulation installed as specified.
- ☐ All valves tagged with number and function, valve index posted.
- ☐ Pipes across traffic areas provided with protection.
- ☐ Piping is shielded to prevent water leakage above electrical equipment/panels.
- ☐ Mechanical supporting devices installed at specified locations and spacing

Start-Up:

- ☐ Commissioning Authority has been notified for witness of start-up.
- ☐ Expansion tank pressures have been checked and set per engineer's guidance.
- ☐ Water pipe pressure tested and accepted. Attach reports.
- ☐ Water piping flushed and cleaned and chemically treated per specifications and accepted. Attach reports.
- ☐ Strainers cleaned per specification procedure prior to balancing.
- ☐ All air has been removed/bleed from the system prior to balancing.
- ☐ Water chemical treatment complete, treatment system operational, attach treatment report.
- ☐ Glycol feeder verified operational.
- ☐ Control valves verified operational.

System Readiness Checklist
Piping and Appurtenances (Continued)

Readiness:

- ☐ Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of all manufacturer's checklists.
- ☐ Damaged factory finishes have been replaced, repaired or touched up.
- ☐ Equipment and systems are labeled per project documents.
- ☐ Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ☐ All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

Note: This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the Contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

System Readiness Checklist
HVAC Pumps

Unit No: ____

Installation:

- ☐ Manufacturer's required maintenance clearance provided.
- ☐ Equipment labeled with equipment number.
- ☐ Pumps installed, leveled, grouted and plumbed.
- ☐ Pumps have been lubricated.
- ☐ Pumps have been aligned. Report attached.
- ☐ Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ☐ Associated piping, shutoff valves, control valves and insulation are complete.
- ☐ All balancing and check valves, gages and thermometers are installed per project documents.
- ☐ Unit disconnect within sight of unit, power available to unit and disconnect labeled.
- ☐ External controls installed.
- ☐ Internal controls and safeties installed.
- ☐ All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency

Start-Up:

- ☐ Commissioning Authority has been notified for witness of start-up.
- ☐ Motor operation and rotation verified.
- ☐ Controls verified operational.

Readiness:

- ☐ Manufacturer’s installation and start-up procedures were followed. Attach completed and signed copy of all manufacturer’s checklists.
- ☐ Damaged factory finishes have been replaced, repaired or touched up.
- ☐ Equipment and systems are labeled per project documents.
- ☐ Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ☐ All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

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System Readiness Checklist

Motors

Installation:

- ☐ Motors provided and installed per project documents.

Start-Up:

- ☐ Motor name plate data recorded.
- ☐ All motors meet minimum efficiency ratings.

Readiness:

- ☐ Manufacturer's installation procedures were followed.
- ☐ All required testing completed and test reports submitted.
- ☐ Damaged factory finishes have been replaced, repaired or touched up.
- ☐ Equipment and systems are labeled per project documents.
- ☐ All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

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System Readiness Checklist
Air Handling Equipment

Installation:

- ☐ Manufacturer's required maintenance clearance provided.
- ☐ Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ☐ Inspection and access doors are operable.
- ☐ Condensate drain with P-trap and cleanout is installed and unobstructed.
- ☐ Associated piping, shutoff valves, control valves and insulation are complete.
- ☐ Dampers and actuators installed and verified operational.
- ☐ Ductwork is complete including access to all serviceable components.
- ☐ Plenum and casings have been cleaned.
- ☐ Pipe and conduit penetrations have been caulked.
- ☐ Units are level and secured.
- ☐ Units have been lubricated prior to start-up.
- ☐ All filter access provided so filter can be replaced without the use of tools.
- ☐ Coil fins have been cleaned and combed out after construction in equipment area is completed.
- ☐ Unit disconnect within sight of unit, power available to unit.
- ☐ All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency
- ☐ Controls installed and verified operational.
- ☐ Unit heaters provided with provisions for cleaning via “water bath” method to include a water source and drain pan.
- ☐ Ceiling access doors have been provided as required for unit service access.
- ☐ Ductwork installed at unit inlets and outlets is greater than or equal to manufacturer’s required minimum values.

Start-Up:

- ☐ Motor rotation has been verified.
- ☐ Voltage and phase has been verified.
- ☐ Belts have been properly adjusted and aligned.

System Readiness Checklist (Preliminary Version)
Air Handling Equipment (continued)

Readiness:

- ☐ Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of all manufacturer's checklists.
- ☐ Temporary filters have been removed and new installed.
- ☐ All required testing completed and test reports submitted.
- ☐ Damaged factory finishes have been replaced, repaired or touched up.
- ☐ Equipment and systems are labeled per project documents.
- ☐ All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

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System Readiness Checklist
Terminal Units

Installation:

- ☐ Manufacturer's required maintenance clearance provided.
- ☐ Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ☐ Inspection and access doors are operable.
- ☐ Associated piping, shutoff valves, control valves and insulation are complete.
- ☐ Dampers and actuators installed and verified operational.
- ☐ Velocity probes installed, tubing connected to controller.
- ☐ Temporary filters have been removed, new installed, spares provided.
- ☐ Ductwork is complete including access to all serviceable components.
- ☐ Plenum and casings have been cleaned.
- ☐ Coil fins have been combed out if necessary.
- ☐ Units are level and secured.
- ☐ Coil fins have been cleaned and combed out after construction in equipment area is completed.
- ☐ Controls installed and verified operational.
- ☐ Terminal units provided with a sound attenuating insulated ductwork downstream of units.
- ☐ Terminal units provided with a minimum of 3 times duct diameter of straight run ductwork at inlet of units.

Start-Up:

- ☐ Manufacturer’s start-up procedures

Readiness:

- ☐ Manufacturer’s installation procedures were followed.
- ☐ All required testing completed and test reports submitted.
- ☐ Damaged factory finishes have been replaced, repaired or touched up.
- ☐ Equipment and systems are labeled per project documents.
- ☐ All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

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System Readiness Checklist
Variable Speed Drive Systems

Unit No: ____

Installation:

- ☐ Manufacturer's required maintenance clearance provided.
- ☐ Unit disconnect within sight of unit, power available to unit and disconnect labeled.
- ☐ External controls installed.
- ☐ Internal controls and safeties installed.
- ☐ Controlled parameter sensor (air or water) installed and configured through control system.
- ☐ Proper ventilation has been provided to over temperature nuisance trips.

Start-Up:

- ☐ Commissioning Authority has been notified for witness of start-up.
- ☐ Motor operation and rotation verified.
- ☐ Internal controls and safeties verified operational.
- ☐ External controls verified operational.
- ☐ Operating parameters measured and recorded.

Readiness:

- ☐ Manufacturer’s installation and start-up procedures were followed. Attach completed and signed copy of all manufacturer’s checklists.
- ☐ Damaged factory finishes have been replaced, repaired or touched up.
- ☐ Equipment and systems are labeled per project documents.
- ☐ Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ☐ All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

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System Readiness Checklist
Exhaust Fans

Unit No: ____

Installation:

- ☐ Manufacturer's required maintenance clearance provided.
- ☐ Equipment labeled with equipment number.
- ☐ Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ☐ Inspection and access doors are operable.
- ☐ Curb mounted fans are bolted to the curb and sealed per project documents.
- ☐ Speed controllers installed as needed for balancing.
- ☐ Ductwork is complete including access to all serviceable components.
- ☐ Plenum and casings have been cleaned.
- ☐ Unit has been lubricated.
- ☐ Belts and/or couplings have been properly adjusted.
- ☐ Unit disconnect within sight of unit, power available to unit and disconnect labeled.
- ☐ External controls installed.
- ☐ All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency

Start-Up:

- ☐ Commissioning Authority has been notified for witness of start-up.
- ☐ Motor operation and rotation verified.
- ☐ Internal controls and safeties verified operational.
- ☐ External controls verified operational.

Readiness:

- ☐ Manufacturer’s installation and start-up procedures were followed. Attach completed and signed copy of all manufacturer’s checklists.
- ☐ Damaged factory finishes have been replaced, repaired or touched up.
- ☐ Equipment and systems are labeled per project documents.
- ☐ Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ☐ All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

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System Readiness Checklist
Ductwork Systems

Installation:

- ☐ Manufacturer's required maintenance clearance provided.
- ☐ Inspection and access doors are operable.
- ☐ All ductwork installed per required SMACNA standards.
- ☐ Dampers and actuators installed and verified operational.
- ☐ Ductwork is complete including access to all serviceable components.
- ☐ Plenum and casings have been cleaned per the project requirements.
- ☐ Duct access doors provided before and after filters, coils, fans, automatic dampers, and fire/smoke dampers per the project requirements.
- ☐ Balancing dampers provided at all duct take-offs to diffusers, grilles, and registers.
- ☐ Fire/smoke damper shafts marked with blade position prior to installation.
- ☐ Fire/smoke damper operation (open/close) verified. Fire/smoke dampers powered open.
- ☐ Fire/smoke damper doors labeled and motors accessible for service (replacement).
- ☐ All ductwork has been thoroughly cleaned of debris, dust, marks, tags and labels removed.
- ☐ All ductwork is sealed as specified.
- ☐ All specified equipment and ductwork is insulated.

Start-Up:

- ☐ Medium velocity ductwork pressure tested to project requirements.
- ☐ Low velocity ductwork pressure tested to project requirements.

Readiness:

- ☐ Manufacturer’s installation procedures were followed.
- ☐ All required testing completed and test reports submitted.
- ☐ Damaged factory finishes have been replaced, repaired or touched up.
- ☐ Equipment and systems are labeled per project documents.
- ☐ All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

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System Readiness Checklist
Temperature Control

Installation:

- ☐ All control points have been provided per the Project Documents and are communicating with front end computer.
- ☐ System graphics are complete (showing all devices controlled, all adjustable points shown, all specified components), accurate (reflects actual field/unit installation, end-to-end verification of points done) and functional.
- ☐ Access Security levels have been set up per owner's needs.
- ☐ Network connection is complete, the central operator terminal has been updated and remote monitoring of the system has been tested.
- ☐ All specified associated equipment (such as PC, Monitor, printer, modem & laptop) has been provided, installed and is operational.
- ☐ Surge protection and battery back-up devices installed per Project Documents and tested.
- ☐ Control wiring, panels and all system components are permanently labeled, including point address designation, system reference and descriptions.
- ☐ Acceptance start-up test plan has been submitted and approved. Attach copy of test plan.
- ☐ Graphical interface plan has been submitted and approved by CA.
- ☐ All control points have been provided per the Project Documents and are communicating with front end computer.
- ☐ System graphics are complete (showing all devices controlled, all adjustable points shown, all specified components), accurate (reflects actual field/unit installation, end-to-end verification of points done) and functional.
- ☐ Room temperature and other setpoints installed per specification and owner's direction.
- ☐ Operating schedules have been set up per owner's direction
- ☐ Trend logs have been set up per Project Documents and/or as directed by the CA.
- ☐ Minimum OA %, from balancer, provided on graphics as permanent reference value.
- ☐ Alarms have been programmed per Project Documents and owner's direction.
- ☐ Stability of loop and VFD's has been verified.
- ☐ All sensors have been calibrated including temperature, pressure, flow and metering devices.

Start-Up:

- ☐ Point to point testing and sensor calibration is complete and checkout forms complete with copy submitted.
- ☐ Variable speed drive start-up per manufacturer's representative complete.

System Readiness Checklist
Temperature Control

Readiness:

- ☐ Manufacturer's installation procedures were followed.
- ☐ All required testing completed and test reports submitted.
- ☐ Damaged factory finishes have been replaced, repaired or touched up.
- ☐ Equipment and systems are labeled per project documents.
- ☐ All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

Note: This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the Contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

System Readiness Checklist
Testing, Adjusting, and Balancing

Installation:

- ☐ Balancing agenda provided to engineer. Provide copy to CA for review.
- ☐ Pre-balance conference complete.
- ☐ All equipment has been checked prior to balancing. Installation checklists attached.
- ☐ Fan belt tension and fan rotation verified prior to balancing.
- ☐ Air balanced prior to water balance.
- ☐ Construction filters removed, clean filters installed, damper position and operation checked prior to balancing. Air balance due with filters simulated as ½ dirty.
- ☐ Bathrooms are negative relative to other areas.
- ☐ Rooms pressures are positive while allowing for door closure in economizer mode.
- ☐ Relief damper operation has been checked to assure dampers open and close as needed.
- ☐ All systems balanced to design criteria except as approved by mechanical engineer and CA.
- ☐ Overall building pressure checked with outside air at 100% to assure adequate relief.
- ☐ All volume dampers, fire dampers, balancing and controls valves are set in a fully open position at the start of balancing.
- ☐ Hydronic system and strainers has been cleaned and treated prior to balancing.
- ☐ Expansion tanks are properly pressurized and not water logged.
- ☐ Air vents installed and operational, water system balanced with no air in system.
- ☐ Final damper and speed controller permanently marked for final balancing positions.
- ☐ List of control minimum OA damper positions in report and provided to controls contractor.
- ☐ Preliminary report has been provided on approved forms with data specified, attach copy.
- ☐ All defects/ deficiencies have been noted to CA/ engineer during testing, included in report.
- ☐ Noise and vibration has been checked and adjusted as necessary.
- ☐ All TAB procedures are complete and ready for the system balance demonstration. The TAB contractor will demonstrate proper balance by measuring and verifying 10% of the systems as selected and witnessed by the Commissioning Authority.

System Readiness Checklist
Testing, Adjusting, and Balancing

Start-Up: Not Applicable.

Readiness:

- ☐ All required testing completed and test reports submitted.
- ☐ All known issues have been corrected or reported to the CA and the systems are ready for the functional performance test phase of commissioning.

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END OF SECTION

SECTION 23 0710

EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes blanket, board, and block insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

B. Related Sections include the following:

1. Division 23 Section "Duct Insulation" for insulation materials and application for ducts and plenums.
2. Division 23 Section "Pipe Insulation" for insulation for piping systems.

1.03 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details for the following:

1. Field application for each equipment type.
2. Removable insulation sections at access panels.
3. Application of field-applied jackets.
4. Special shapes for cellular-glass insulation.

C. 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.

D. Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

1.04 QUALITY ASSURANCE

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

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

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

1.06 COORDINATION

A. Coordinate clearance requirements with equipment Installer for insulation application.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Mineral-Fiber Insulation:

a. CertainTeed Manson.
b. Knauf FiberGlass GmbH.
c. Owens-Corning Fiberglas Corp.
d. Schuller International, Inc.
e. John Manville.

2.02 INSULATION MATERIALS

A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft aluminum foil. Conductivity (k) shall not exceed 0.27 Btu per inch / h x ft^2 x °F at 75°F.

B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from aluminum foil. Conductivity (k) shall not exceed 0.27 Btu per inch / h x ft^2 x °F at 75°F.

2.03 FIELD-APPLIED JACKETS

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

B. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.

1. Adhesive: As recommended by insulation material manufacturer.
2. PVC Jacket Color: Color-code to match connected piping jackets based on materials

contained within the piping system.

C. Aluminum Jacket: Deep corrugated sheets manufactured from aluminum alloy complying with ASTM B 209, and having an integrally bonded moisture barrier over entire surface in contact with insulation. Metal thickness and corrugation dimensions are scheduled at the end of this Section.

1. Finish: Smooth or Stucco-embossed finish.
2. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and kraft paper.

2.04 VAPOR RETARDERS

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

PART 3 - EXECUTION

3.01 EXAMINATION

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

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

3.02 PREPARATION

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

3.03 GENERAL APPLICATION REQUIREMENTS

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

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

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

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

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

F. Keep insulation materials dry during application and finishing.

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

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

I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.

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

L. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges and fittings.

M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

N. Install vapor-retarder mastic on equipment scheduled to receive vapor retarders. Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.

O. Insulate the following indoor equipment:

1. Air Separators.
2. Chilled-water centrifugal pump housings.
3. Heating hot-water heat exchangers.
4. Plate & Frame heat exchangers, not factory insulated.
5. Hot water and chilled water storage tanks, not factory insulated.
6. Condensate receivers, not factory insulated.
7. Surge (Expansion) Tanks, not factory insulated.
8. Blowdown Separator.
9. Water Heaters.
10. All steam PRV’s, control valves, shut off valves, unions, etc.
11. Blow down heat recovery.
12. Steam Expansion Compensators.

P. Omit insulation from the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.04 INDOOR TANK AND VESSEL INSULATION APPLICATION

A. Blankets, Board, and Block Applications for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to the equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joint. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesive-attached or self-adhesive anchor pins and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. On tank and vessel, 3 inches maximum from insulation end joints, and 16 inches o.c. in both directions.
    c. Do not overcompress insulation during installation.
    d. Cut and miter insulation segments to fit curved sides and dome heads of tanks and vessels.

5. Impale insulation over anchor pins and attach speed washers.
6. 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
7. Secure each layer of insulation with stainless-steel bands.
8. Stagger joints between insulation layers at least 3 inches.
9. Apply insulation in removable segments on equipment access doors and other elements that require frequent removal for service.
10. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
11. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Flexible Elastomeric Thermal Insulation Applications for Tanks and Vessels: Apply insulation over entire surface of tanks and vessels according to the manufacturer's written instructions.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.05 FIELD-APPLIED JACKET APPLICATION

A. PVC Jackets: Apply jacket with longitudinal seams along top and bottom of tanks and vessels for horizontal applications. Secure and seal seams and end joints with manufacturer's welding adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along the seam and joint edge.

B. Aluminum Jackets: Secure jackets according to jacket manufacturer's written instructions.

3.06 EQUIPMENT APPLICATIONS

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

B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.

3.07 INTERIOR TANK AND VESSEL INSULATION APPLICATION SCHEDULE

A. Equipment: Air separators, expansion tanks and storage tanks.

1. Operating Temperature: 35°F to 75° F.
2. Insulation Material: Mineral-Fiber Board or Blanket Thermal Insulation
3. Insulation Thickness: 3-½ inches (k= 0.27 Btu per inch / h x ft^2 x °F at 75 °F).
4. Field-Applied Jacket: Aluminum to match piping.
5. Vapor Retarder Required: Yes.

B. Equipment: Heating hot-water heat exchangers, steam-to-water converters, air separators, and expansion tanks, blow down separator, water heaters, steam generators, blow down heat recovery.

1. Operating Temperature: 100°F to 450° F.
2. Insulation Material: Mineral-Fiber Board or Blanket Thermal Insulation
3. Insulation Thickness: 3-½ inches (k= 0.27 Btu per inch / h x ft^2 x °F at 75 °F).
4. Field-Applied Jacket: Aluminum.
    a. Aluminum Thickness: 0.032 inch.
    b. Corrugation Dimension: 1-1/4 by 1/4 inch or 2-1/2 by 5/8 inch.
5. Vapor Retarder Required: Yes.
6. Finish: None.

END OF SECTION

SECTION 23 0713

DUCT INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Outdoor supply and return.

B. Related Sections:

1. Division 23 Section "HVAC Equipment Insulation."
2. Division 23 Section "HVAC Piping Insulation."
3. Division 23 Section "Metal Ducts" for Duct Liner.

1.03 SUBMITTALS

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

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

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

C. Qualification Data: For qualified Installer.

D. 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.

E. Field quality-control reports.

1.04 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

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

1.05 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.

1.06 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.07 SCHEDULING

A. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

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

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

A. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials. Thermal conductivity (k) shall not exceed 0.27 Btu per inch / h x ft^2 x °F at 75 °F.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Aeroflex USA, Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS.

B. 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. Thermal conductivity (k) shall not exceed 0.27 Btu per inch / h x ft^2 x °F at 75 °F.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; SoftTouch Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Friendly Feel Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; SOFTR All-Service Duct Wrap.

A. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Thermal conductivity (k) shall not exceed 0.27 Btu per inch / h x ft^2 x °F at 75 °F.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; Commercial Board.
    b. Fibrex Insulations Inc.; FBX.
    c. Johns Manville; 800 Series Spin-Glas.
    d. Knauf Insulation; Insulation Board.
    e. Manson Insulation Inc.; AK Board.
    f. Owens Corning; Fiberglas 700 Series.

2.02 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700° F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; FlameChek.
b. Johns Manville; Firetemp Wrap.
c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
d. Thermal Ceramics; FireMaster Duct Wrap.
e. 3M; Fire Barrier Wrap Products.
f. Unifrax Corporation; FyreWrap.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2007 Addenda.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. 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).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2007 Addenda.

D. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2007 Addenda.

2.04 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    b. Eagle Bridges - Marathon Industries; 550.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    d. Mon-Eco Industries, Inc.; 55-50.
    e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.05 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
    c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.06 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
    d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2007 Addenda.

2.07 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.

2.08 FIELD-APPLIED JACKETS

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

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
   1. Color: Color as selected by Architect.

C. Metal Jacket:

   1. Products: Subject to compliance with requirements, provide one of the following:

      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
      b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
      c. RPR Products, Inc.; Insul-Mate.

   2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

      a. Sheet and roll stock ready for shop or field sizing.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

2.09 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, provide one of the following:

      a. ABI, Ideal Tape Division; 491 AWF FSK.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      c. Compac Corporation; 110 and 111.
      d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

   1. Products: Subject to compliance with requirements, provide one of the following:

      a. ABI, Ideal Tape Division; 488 AWF.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
      c. Compac Corporation; 120.
      d. Venture Tape; 3520 CW.

   2. Width: 2 inches.
   3. Thickness: 3.7 mils.
   4. Adhesion: 100 ounces force/inch in width.

5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements provide one of the following:

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209 Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding**,** 0.135-inch-diameter shank, length to suit depth of insulation indicated.

   a. Products: Subject to compliance with requirements, provide one of 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- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) AGM Industries, Inc.; CHP-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, provide one of the following:

      1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.

   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-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. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened 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, provide one of the following:

      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-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, provide one of the following:

      1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      2) GEMCO; Peel & Press.
      3) Midwest Fasteners, Inc.; Self Stick.

   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.

PART 3 - EXECUTION

3.01 EXAMINATION

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

   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

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

3.02 PREPARATION

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

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

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

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

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

F. Keep insulation materials dry during application and finishing.

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

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

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

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

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

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

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.05 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.06 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches on center.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches on center.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches on center.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches on center each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches on center.

3.07 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.08 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.09 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round, rectangular and flat-oval, supply, return and outdoor air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2-inches thick and 1.5-lb/cu. ft. Nominal density. Thermal conductivity (k) shall not exceed 0.27 Btu per inch / h x ft^2 x °F at 75 °F.

B. Concealed, supply, return outdoor air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2-inches thick and 1.5-lb/cu. ft. Nominal density. Thermal conductivity (k) shall not exceed 0.27 Btu per inch / h x ft^2 x °F at 75 °F.

C. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket thickness as required to achieve 2-hour fire rating.

   a. Ductwork is to be wrapped with 2 layers of approved fire wrap that meets ASTM E-2336.

D. Exposed, round, rectangular and flat-oval, supply, return outdoor air duct insulation shall be one of the following:

   1. Mineral-Fiber Blanket: Mineral-Fiber Blanket: 2-inches thick and 1.5-lb/cu. ft. Nominal density. Thermal conductivity (k) shall not exceed 0.27 Btu per inch / h x ft^2 x °F at 75 °F.
   2. Mineral-Fiber Board: 2-inches thick and 3-lb/cu. Ft. nominal density. Thermal conductivity (k) shall not exceed 0.27 Btu per inch / h x ft^2 x °F at 75 °F.

E. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket thickness as required to achieve 2-hour fire rating.

   a. Ductwork is to be wrapped with 2 layers of approved fire wrap that meets ASTM E-2336.

F. Exposed, supply, return-air plenum insulation shall be one of the following:

   1. Mineral-Fiber Blanket: 2-inches thick and 1.5-lb/cu. ft. nominal density. Thermal conductivity (k) shall not exceed 0.27 Btu per inch / h x ft^2 x °F at 75 °F.
   2. Mineral-Fiber Board: 2-inches and 2-lb/cu. ft. nominal density. Thermal conductivity (k) shall not exceed 0.27 Btu per inch / h x ft^2 x °F at 75 °F.

3.13 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Exposed, round and flat-oval, supply-air and return-air duct insulation shall be one of the following:

   1. Flexible Elastomeric: 1 inch thick.
   2. Polyolefin: 1 inch thick.

C. Exposed, rectangular, supply-air and return-air duct insulation shall be one of the following:

   1. Flexible Elastomeric: 1 inch thick.
   2. Polyolefin: 1 inch thick.

D. Exposed, supply-air and return-air plenum insulation shall be one of the following:

   1. Flexible Elastomeric: 1 inch thick.
   2. Polyolefin: 1 inch thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Ducts and Plenums:

1. Aluminum, corrugated 0.32-inch thick.

END OF SECTION

SECTION 23 0719

HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping.
2. Condenser-water piping
3. Heating hot-water piping.
4. Refrigerant suction and hot-gas piping.
5. Heat Pump piping.

B. Related Sections:

1. Section 23 0713 "Duct Insulation."
2. Section 23 0716 "HVAC Equipment Insulation."

1.03 ACTION SUBMITTALS

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

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

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

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

1.05 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.06 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.

1.07 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 0529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.08 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Insulation for below-ambient service requires a vapor-barrier.

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

D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Aeroflex USA, Inc.; Aerocel.
    b. Armacell LLC; AP Armaflex.
    c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

H. 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 I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; SoftTouch Duct Wrap.
    b. Johns Manville; Microlite.
    c. Knauf Insulation; Friendly Feel Duct Wrap.
    d. Manson Insulation Inc.; Alley Wrap.
    e. Owens Corning; SOFTR All-Service Duct Wrap.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Fibrex Insulations Inc.; Coreplus 1200.
    b. Johns Manville; Micro-Lok.
    c. Knauf Insulation; 1000-Degree Pipe Insulation.
    d. Manson Insulation Inc.; Alley-K.
    e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ with factory-applied ASJ-SSL. Thermal conductivity (k-value) at 75 deg F is 0.27 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 75 deg F is 0.27 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; CrimpWrap.
    b. Johns Manville; MicroFlex.
    c. Knauf Insulation; Pipe and Tank Insulation.
    d. Manson Insulation Inc.; AK Flex.
    e. Owens Corning; Fiberglas Pipe and Tank Insulation.

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

2.02 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide the following:

    a. Ramco Insulation, Inc.; Super-Stik.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements, provide the following:

    a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Aeroflex USA, Inc.; Aeroseal.
    b. Armacell LLC; Armaflex 520 Adhesive.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
    d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.04 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
b. Eagle Bridges - Marathon Industries; 570.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.05 SEALANTS

A. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: **Minus 40 to plus 250 deg F**.

5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 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.

2.07 FIELD-APPLIED JACKETS

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

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

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

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system. 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.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
    d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
    e. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.08 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, provide one of the following:

    a. ABI, Ideal Tape Division; 428 AWF ASJ.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    c. Compac Corporation; 104 and 105.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 491 AWF FSK.

b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.09 SECUREMENTS

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

B. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping and Seals.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.

3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

PART 3 - EXECUTION

3.01 EXAMINATION

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

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

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

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2-inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2-inches on center.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

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

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

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.

6. Cleanouts.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

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

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 07 8413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 8413 "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.07 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches on center.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.08 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with **1-inch** overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches on center and at end joints.

3.09 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 9113 "Exterior Painting" and Section 09 9123 "Interior Painting."

1. Flat Acrylic Finish: **Two** finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

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

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 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.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Condenser-Water Supply and Return:

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

a. Flexible Elastomeric: 1 inch thick.
b. Mineral-Fiber, Preformed Pipe, Type I: 1 inch (25 mm thick.

C. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 1 1/2 and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2” thick. Thermal conductivity (k-value) at 75 deg F is 0.27 Btu x in./h x sq. ft. x deg F or less.

2. NPS 2 and greater : Insulation shall be [one of] the following:

    a. Mineral-Fiber, Preformed Pipe, Type I or Pipe and Tank Insulation: 2 inches thick. Thermal conductivity (k-value) at 75 deg F is 0.27 Btu x in./h x sq. ft. x deg F or less.

3. Insulation runouts not exceeding 48 inches in length for connection between control valve and HVAC coil shall be the following:

    a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick. Thermal conductivity (k-value) at 75 deg F is 0.27 Btu x in./h x sq. ft. x deg F or less.

D. Refrigerant Suction and Hot-Gas Piping:

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

    a. Flexible Elastomeric: 1 inch thick.
    b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Refrigerant Suction and Hot-Gas Flexible Tubing:

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

    a. Flexible Elastomeric: 1 inch thick.

F. Heat Pump Water, 40 to 200 Deg F:

1. NPS 1-1/2 and Smaller: Insulation shall be the following:

    a. Mineral-Fiber, Preformed Pipe, Type I, 1-1/2 inches thick. Thermal conductivity (k-value) at 75 deg F is 0.27 Btu x in./h x sq. ft. x deg F or less.

2. NPS 2 and Larger: Insulation shall be the following:

    a. Mineral-Fiber, Preformed Pipe, Type I or Pipe and Tank Insulation: 2 thick. Thermal conductivity (k-value) at 75 deg F is 0.27 Btu x in./h x sq. ft. x deg F or less.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Condenser-Water Supply and Return:

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

    a. Flexible Elastomeric: 2 inches (50 mm) thick.
    b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:
    a. Flexible Elastomeric: 2 inches thick.

C. Refrigerant Suction and Hot-Gas Flexible Tubing:

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

a. Flexible Elastomeric: 2 inches thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Water Piping, Mechanical Rooms and Where Exposed:

1. PVC, Color-Coded by System: 30 mils thick.
2. Aluminum, Smooth: 0.020 inch thick.

3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. Aluminum, Stucco Embossed: **0.020 inch** thick.

END OF SECTION

SECTION 23 0800

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

1.5 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Section 012100 "Allowances."

1.6 UNIT PRICES

A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Section 012200 "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.7 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.8 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.9 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.

8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least **10** days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing **Subcontractor 10** days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing **Subcontractor** shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R **Subcontractor**, testing and balancing **Subcontractor**, and HVAC&R Instrumentation and Control **Subcontractor** shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R **Subcontractor** shall prepare a pipe system

cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of **gas** systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION

SECTION 23 0900

HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. The BMCS Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. The building automation system shall be an extension of the existing District wide Schneider DDC control system, I/NET with StruxureWare. The Schneider DDC control system shall be supplied and installed by Utah Yamas Controls, utilizing local programming and in house, full time employee resources. Outsourcing programming, engineering, start up and commissioning shall not be accepted and shall be provided by Utah Yamas Controls trained staff. The extension of the existing system shall include direct integration capabilities to the existing I/Net DDC controllers including all programming tools, graphics editors and reporting packages. All components of the system – workstations, servers, application controllers, unitary controllers, etc. shall communicate using StruxureWare and the existing DDC INET communication network, BACnet protocol, as defined by ASHRAE Standard 135-2007, or EIA standard 709.1, the LonTalk™ protocol, or Modbus protocol.

B. Includes all necessary software and materials for a complete and operating system without additional cost to the owner and as indicated elsewhere in the specification and shall include the following:

1. Furnishing and installing a complete temperature control and building management system (BMCS). System to include –

    a. Local Head End System Workstation including feature to functioning as a local Graphic Operator's Interface located at the school.
    b. All hardware, software and services necessary to seamlessly be connected through the Wide Area Network (WAN) to a fully implemented District Level Internet Web based Server Head End System located at the School District's Offices. All web based services must be compatible with any web browser from any computer, upgrade web server software as required.
    c. Program the DDC and create the graphic screens.
    d. All components and controllers shall be manufactured by Schneider Electric Control System (formerly TAC) StructureWare and installed by Utah-Yamas Controls Intermountain Inc.

2. Engineering, programming, district head end graphics and time schedules, checking out and commissioning a complete system in accordance with design documents and

sequences of operation.
3. Furnishing and installing all the required conduit, cable and wire for the entire system.
4. Mounting and wiring all temperature control and building management devices, controllers and equipment for a complete system.
5. Creating and installing a complete graphical interface which will include all points and systems for the entire BMCS.
6. District training, using job specific Operation and Maintenance Manuals.
7. Documentation - Four hard copies of the Project's Operation and Maintenance Manuals. Provide CD ROM containing all job documentation (i.e. PDF files of data sheets, CAD files, DDC Programming etc.) with each O&M Manual. Full operating and programming software.
8. Twenty-four (24) months warranty for all labor and equipment for the entire system.
9. All damper and valve operators are to be Electronic/Electric. All valve operators on valves 2" and smaller are to be direct coupled.
10. All low voltage wire shall be run in conduit where exposed in mechanical areas, areas not accessible, areas where it may be subject to damage, or areas with a single point of access requiring crawling in the concealed area. Low voltage wire may be installed in plenums and other concealed areas where easy and reasonable access is regularly available. Wire run in plenums and other concealed areas shall be plenum rated wire and shall meet all NEC and local code requirements.
11. Furnish and install air flow measurement stations (AFMS).
12. Furnish and install water flow meter.
13. Furnish and install CO2 sensors.
14. Provide emergency shutdown mushroom switches for all boilers with two poles, one for the shut down and one for an alarm switch to the graphics panel.
15. Provide a 120 volt power convenience outlet in all control panels for laptop power.

C. Related Sections

1. Division 23 - Installing of temperature control valves, thermal wells in pipes, DP Sensors and flow switches etc.
2. Division 26 - Power provisions as described in Contract Documents.

D. District To Provide –

1. Connection point for District's BMCS LAN Communication (Ethernet).

1.02 SUBMITTALS

A. Product Data - Manufacturer's original catalog data and descriptive information on each piece of equipment to be used.

B. Shop Drawings

1. Control diagram for each major and/or minor mechanical and electrical system to be

monitored and controlled. Diagrams will show locations of control and operational components, and duct static sensors, and devices. ATC diagrams will be generated using AutoCAD or similar software package drawn on 11" X l7" or larger sheets.

2. Ladder and wiring diagram for each controller.
3. Ladder and wiring diagram for overall control system.
4. Graphics penetration path in block diagram form.
5. Software control schematics which accomplishes each "Sequence of Operation".
6. Full and complete As-Built Drawings and online graphics demonstration must be submitted to the Owner and the Engineer and approved before final payment can be made.
7. Full copy of software on thumb drive left in main panel on site and a full CD copy give to the district.

C. Closeout

1. Operations And Maintenance Manual Data –

a. Requirements are as follows –

1) Provide operating and maintenance instructions for each item of equipment submitted under Product Data.
2) Include copy of approved shop drawings.
3) Provide all documentation hard copy and in digital format on CD format. Files to include standard format *.dwg, *doc *wpd *pdf etc.

1.03 QUALITY ASSURANCE

A. Pre-Installation Meeting - Schedule meeting with Division 23 and Division 26 installation contractors before installation of system begins.

1.04 SCHEDULING

A. Coordination

1. Coordinate planning and installation of equipment with parties specified to be involved in BMCS including but not limited to:

a. BMCS Contractor
b. Electrical Subcontractor
c. Mechanical Subcontractor
d. District
e. Architect and Consultants
f. Balancing Subcontractor

PART 2 - PRODUCTS

2.01 COMPONENTS

A. The following is a list of approved component manufacturer's:

1. Work Station - HP DC8100 Computer SFF (to be installed at the school)

   a. Operating System - Windows 7 Professional or XP Pro
   b. Intel® Core i5-650 SIPP Processor AY039AV
   c. 4GB DDR3 (PC3-1333) MHz non-ECC (2x2GBDIMM)
   d. 320GB Hard Drive
   e. NVIDIA Geforce 310 (512MBSH) PCIex 16 Graphics Card
   f. HP USB Standard Keyboard
   g. HP USB 2-Button Optical Scroll Mouse
   h. Sophos Anti Virus/DeepFreeze
   i. All required BMCS vendor and third party software and full software keys.
   j. 802.11 a/b/g/n Wi-Fi Adapter
   k. HP 20” wide screen LCD Monitor

      1) StructureWare with all connectors and cables;

2. Controllers –

   a. Schneider Electric StructureWare Control Systems shall be utilized as specifically indicated and specified elsewhere in this specification.

3. Sensors, actuators and other components - The following are approved manufacture's for the various field devices. Other manufacturers may be used if approved by engineer in writing at least I week prior to bid.

   a. Temperature Sensors – Schneider - TAC I-net
   b. Space Static Pressure Sensors - Dwyer, Mamac, Setra, Veris; (±0.25"wc).
   c. Duct Static Pressure Sensors - Dwyer, Mamac, Setra, Veris; (0-5"wc).
   d. Control Relays - IDEC model RH2B-UL with base, PAM style
   e. CT Relays - Veris - models H-800, H-908; Functional Devices Rib XGTA.
   f. Stainless Steel Ball Valve/Actuator Combination - Honeywell, Belimo, TAC.
   g. Damper and Valve Actuator - Belimo, TAC (electric and/or direct couple type as specified)
   h. UPS for DDC Panels - Omnipro Model 280 -APC
   i. Transformer/Power Supplies – Veris, Functional Devices.
   j. Others devices as pre-approved by engineer
   k. Mechanical Timer - (0 to 3Hr)
   l. Sensor Guards - Metal with key locking cover.

m. Temperature Low Limit Stats – Honeywell or approved equal.
n. Dampers - Ruskin CD5O or approved equal
o. Outside air flow measuring sensor (AFMS) – EBTRON Gold or Air Monitor Electraflo.
p. CO2 Sensor – Veris, Vulcain Infrared type or approved equal.
q. Butterfly Valves - capable of a minimum 75 psig close off pressure, Delta, TAC, Honeywell, Johnson, with electric actuators.

2.02 APPROVED CONTRACTORS AND EQUIPMENT SUPPLIERS

A. Manufacturers: All components and controllers shall be manufactured by Schneider Electric I-Net unless specified otherwise

1. Direct Digital Control Systems and Approved Installing Contractors:

a. Schneider Electric Control System (formerly TAC) StructureWare as installed by Utah-Yamas Controls Intermountain Inc.

2. Manufacturers and installers other than listed in Paragraph 2.2.A.1 must demostae to the owner the ability to communicate to the existing district wide DDC system and obtain written prior approval.

2.03 METERS

A. General: Meters shall be permanently installed, record at <1 hour intervals, and transmit data to the BMS. BMS shall store meter data for a minimum of 36 months and stored data shall be available through the BMS interface. BMS shall report stored data in hourly, daily, monthly and annual energy use formats.

B. Water Meter: Equal to Onicon F-4600 inline flow meter. Utilizes wetted ultrasonic transducers for flow measurement. Unit shall be BACnet MS/TP device compatible with BMS.

2.04 DISTRICT GRAPHICAL USER INTERFACE

A. All necessary software, hardware, setup and programming shall be provided and implemented in order to accomplish a properly integrated Graphic User Interface (GUI). All graphics shall be loaded on a server at the School District's server room.

B. The color graphic terminal (which shall be part of the local Head End System at the school) shall be driven by internet browser software which displays all information in a graphical format. The operator shall access any information via a command prompted, mouse driven interface. The operator shall be able to penetrate to any level of desired system information without being required to enter any commands from the keyboard. This same information should be available

from their home browser as well. An additional Icon on the desktop to access the GUI software with a district provided user name and password.

1. The color CRT shall continuously display the present operator, local site connected to, number of total alarms for the system and total unacknowledged alarms. A section of the screen shall be dedicated to displaying the reported alarm.
2. All system commands shall be graphically displayed using iconic, pull-down, popup or graphical data entry templates. Each command selection shall display an advisory description of the commands operation to inform the operator of the expected result.
3. Pop-up windows shall be used to display groups, points and other pertinent information where a variety of items are available to choose from. This feature shall be context sensitive when a user/operator requires help during a particular function request.

C. Graphics shall be provided to meet the Murray School District's graphics standard. Contractor is required to customize each school to meet the standard. No Canned programs are allowed and each graphic screen must meet the districts' standard for that area or application. Included in the graphics package must be all customized graphics that are for troubleshooting or energy management.

D. All system commands shall be graphically displayed using iconic, pull-down, pop-up or graphical.

E. All systems (including air handlers, rooftop units, makeup air units, pumps, boilers, chillers) shall be trended on the hard drive of the districts internet server. The trend shall include equipment start time and stop time; mixed air, discharge air, space temperatures; supply and return water temperatures of all water loops; status and speed of equipment. Information shall be trended on 15 minute intervals (continuous 24 hours per day and 365 days per year) with two years of data stored on a sliding window.

2.05 DISTRICT SUPERVISOR INTEGRATION

A. Global Controllers.

1. StruxureWare AS Automation Server, manufactured by Schneider Electric. No Substitutions are allowed. Each global controller shall communicate with LON, BACNET, MODBUS. No additional licensing costs shall be incurred by the owner for multiple protocols. Sufficient resource space and processor allocation shall be insured to account for the quantity of nodes connected to the AS global controller. If needed additional AS global controllers shall be added to insure that proper resource space and processor allocations exist.

2.08 DDC EQUIPMENT

A. Main Level DDC controllers

1. The contractor shall utilize and employ only the following controllers for any central plant systems and air handling units. A single controller shall be designated with all programming

and I/O for each system. This will allow stand alone equipment operation in the event of communications failure. Connection of multiple small controllers or combined operation of application specific devices (ASD) with other programmable controllers on air handlers and central plant equipment is not permitted.

a. Controllers by Schneider Electric

2. All main level controller inputs shall have at least 12 bit A/D converters for input accuracy. Less resolution is unacceptable for main level controllers. All main level controller outputs shall have board mounted hand-off-auto switches for output override capability.

B. Application Specific Devices (ASDs)

1. The contractor shall utilize and employ only the following controllers for any application specific devices (ASD) such as heat pump, unitary equipment, etc. No Substitutions are allowed:

a. Controllers by Schneider Electric

C. Software:

1. Controller and System HVAC Applications

a. Provide latest version of software. Include and implement the following capabilities from the control units if documented by the specified sequence of operations:

1) Complete integration with each school with existing Schneider DDC INET control systems. Software package shall include software for editing, operation, and programming.
2) Load Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, occupied/unoccupied setback/setup, DDC with PID, and trend logging.
3) HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy/economizer switchover.
4) Programming Application Features: Include trend point, alarm reporting, alarm lockout, weekly scheduling, staggered start, sequencing, anti-short cycling and calculated point.

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2.07 REMOTE WEB ACCESS HARDWARE

A. Remote access controller shall be provided with the following:

1. Graphics viewing
2. Trending capability

3. Schedule and calendar modification capability.

2.08 GENERAL

A. Sensor Guards

1. In classrooms, Gyms, media center, corridors, storage rooms, toilet rooms, exercise rooms and multipurpose rooms, room sensors shall be wall-mounted and furnished complete with a metal guard sized to fit the sensor. Guards shall have key locks or allen set screw.

B. Sensors

1. Provide insulating base where thermostat is mounted on exterior walls.
2. Room, duct mounted or immersion type temperature sensors shall be furnished as required for the application. Averaging element sensors shall be used whenever there is a possibility of air temperature stratification in the ductwork. Averaging sensors shall be of sufficient length to provide accurate temperature measurements.

C. Labeling

1. All controls except individual room controls shall be permanently labeled with an identification name and number keyed to the ATC diagrams. Labels shall be mounted on or adjacent to the device such that if the device is replaced the label remains intact. This applies to both field and panel mounted controls.

D. ATC and DDC Panels

1. All panels shall be listed by ETL or UL.
2. Each panel cabinet shall be made of steel (not less than 16 gage) with welded seams and finished corners. Provide a full back plate and full hinged door such that the assembly provides a completely enclosed panel. The panel shall be fully painted for a finished appearance. Supply panel with key locking latch.
3. Each panel shall contain all controllers, relays and all other devices related to the systems served by that panel. All devices shall be mounted inside the panel or on the face of the panel. Appropriately sized nameplates made of black plastic laminate with white engraved letters shall be used to identify all panel mounted devices.
4. Panel Wiring: Run all wiring within enclosed distribution gutters (similar to Panduit). all wiring entering or leaving the panel shall terminate on numbered terminal strips. All wiring entering or leaving the panel shall be tagged with a permanent, identifying tag. All wire and tube identification numbers shall be designated on the control drawings. All wiring shall be color coded and the color shall not be changed between the terminal strip and the end destination of that wire.
5. Duct static pressure sensor locations shall be labeled in the panel. Duct static pressure sensor locations shall be shown on the As-built Record drawings.

6. Hydronic system delta-pressure sensor locations shall be labeled in the panel. Hydronic system delta-pressure sensor locations shall be shown on the As-built Record drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Submittal review.
   1. A submittal review shall be held at the engineer's office or net meeting where the BAS contractor shall present the control system and how each piece of mechanical equipment shall run. The contractor shall define all equipment interfaces including communication interface, analog signals, resets and data gathering.
   2. The submittal review shall be attended by owners representatives, commissioning authority, mechanical and electrical contractors and suppliers. The expectation of this meeting is for all to ratify the control methods and to ensure that the design intent is met.

B. System commissioning

   1. At the completion of the Mechanical, Electrical and Plumbing systems (typically identified as "MEP Complete" milestone on the project schedule), a complete building automation system shall be in place to allow monitoring the system throughout commissioning activities. The following shall be in place at MEP Complete prior to Test and Balance (TAB):

      a. Control system shall be completely commissioned at the component or sub-system level.
      b. System software and logic shall be complete and installed on the site computer.
      c. All system graphics shall be complete and installed on the site computer. System graphics shall include; air handlers, hot and cold water systems, terminal units and floor plans. All controlled parameters shall include input and setpoint.
      d. Control loop trending on all controlled parameters including: AHU – MA temp, DA temp, DA static, HWS temp and pressure, and building static.
      e. Alarms shall be enabled on all systems as they are placed in automatic control. Alarms shall be sent via email or text to BAS project engineers and construction management personnel responsible for maintaining the site conditions through the transition to occupancy.
      f. Temporary remote internet access to the system shall be provided by the BAS contractor including hardware and service for a period of one year or until the owner's infrastructure is in place. Prior to the Test and Balance, the system shall be assessable via the internet by the commissioning authority, TAB contractor, owners representatives, and design engineers.

C. On-Site Assistance

   1. Occupancy Adjustments: Within one year of date of Substantial Completion, provide site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel

in making program changes and in adjusting sensors and controls to suit actual conditions. The contractor shall specifically budget for no less than 40 hours on-site graphics assistance and no less than 40 hours of on-site programming assistance. In the event that the contractor is unable to meet the districts energy management requirements in the above allocated time, the contractor is required to spend whatever time is necessary to provide the district with a complete and operating system that meets the districts' requirements and standards.

D. Training

1. Provide a minimum of 40 hours of on-site or classroom training throughout the contract period for personnel designated by the Owner. Each session shall be a minimum of four hours in length and must be coordinated with the building Owner. Train the designated staff of Owners Representative and Owner to enable them to:

    a. Proficiently operate the system.
    b. Understand control system architecture and configuration.
    c. Understand DDC system components.
    d. Understand system operation, including DDC system control and optimizing routines (algorithms).
    e. Operate the workstation and peripherals.
    f. Log on and off the system.
    g. Access graphics, point reports, and logs.
    h. Adjust and change system set points, time schedules, and holiday schedules.
    i. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
    j. Understand system drawings, and Operation and Maintenance manual.
    k. Understand the job layout and location of control components. Access data from DDC controllers.
    l. Operate portable Operator Terminals.
    m. Set up and trouble shooting Trending and Trend Logs.

END OF SECTION

SECTION 23 0993

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED SECTIONS

A. This Section includes the Building Management System (BMS) control equipment for HVAC systems and components, including open protocol control components for terminal heating and cooling units. Depending on the scope of the project, the complete specification may have numerous sections that interface to this section.

B. District To Provide connection point for District's BMCS LAN Communication (Ethernet).

PART 2 – SEQUENCE OF OPERATION

2.01 GENERAL OPERATION

A. Control Programs: The control programs to achieve the sequence of operation shall reside in the field controller. These controllers shall be capable of standalone operation, such that if communication with the network level controller is lost or disrupted, the sequence of operation will continue to operate. Global functions such as Scheduling, Optimal Start/Stop, and Outside Air Temperature Reset may reside on the Global Controller.

B. Optimal Start/Stop is to be incorporated into the District system-wide energy management program. Any time a school experiences a school wide change of state (i.e. unoccupied-occupied or power-up after loss of electrical power or fire alarm), the EMS shall initiate a school wide optimal start-up procedure so as to minimize the electrical demand based on a 15-minute sliding window, this shall include only starting one motor every 2 minutes with a ramp time on all VFD set to a minimum of at least 120 sec, this ramp speed is set long enough to allow the duct static or pressure sensor to give feedback without overdriving the VFD and wasting energy.

C. Human Machine Interface (HMI): The HMI shall be a PC WEB based graphical package. User's privileges determine whether setpoints and parameters can be modified, or outputs manually overridden.
   1. This graphical package shall contain graphical representations of the mechanical equipment.
   2. The graphics shall display all the digital and analog points as listed in the points list for each mechanical system.
   3. Digital output points shall have the capability to be manually overridden on and off from the HMI. These overrides may be timed, until or forever. Manual overrides cannot override any safety conditions.
   4. Analog output points shall have the capability to be manually overridden on and off from the HMI. These overrides may be timed, until or forever. Manual overrides cannot override any safety conditions.

5. All setpoints, parameters and calculated values shall be displayed and adjustable from the HMI.
6. All setpoints and parameters defined as (adjustable) shall be adjustable from the HMI.

2.02 NET ENERGY LOOP (NEL) SYSTEM CONTROL

A. The net energy loop system consists of the ground heat exchanger, ground heat exchanger basket strainer, heat rejection loop, heat injection loop and two variable speed water circulating pumps each driven by their own VFD in a series configuration and a reduced size ”jockey pump” for night, weekend and summer operations.

B. The DDC system shall monitor the net energy loop supply and return water temperature at the ground heat exchanger header.

C. A Basket Strainer status differential pressure switch shall be provided and connected to the DDC controller to indicate basket filter status. A dirty basket filter alarm shall be sent to the host computer and a “Basket Strainer Fault” shall be indicated on a graphic screen.

D. Provide NEL supply and return temperature sensors located upstream and downstream of the ground heat exchanger header connected to the DDC system.

E. BUILDING PUMPS:
1. One building loop pump is sized to operate the building with a pump as standby pump. Loop differential pressure sensors and a flowmeter shall be provided by the BMCS contractor for control of the pumps.
2. The control and monitoring of the pumps shall be through a main LAN controller. No sub-LAN or micro controllers shall be used in this application.
3. Each pump shall be started from a local DDC controller through a "HAND-OFF-AUTO" switch, located on the face of the VFD bypass panel. In "HAND" position, the pump shall operate continuously; in "OFF" position, the pump shall be stopped; and in "AUTO" position, the pump shall be started and stopped by the DDC system. The DDC system shall monitor the VFD status via a Hawkeye 904 VFD style motor current monitoring switch for each pump. If a heat pump loop pump is not running when commanded to do so by the DDC system, the other pumps shall automatically start & an alarm shall be sent to the DDC system. When the heat pump loop pump system is enabled, the lead loop pump shall start. The lead pump shall rotate on a monthly basis.
4. A global interlock shall be provided to prevent heat pump operation throughout the building when building pumps fail to start and there is no water flow in the net energy loop, or if the net energy loop temperature is above 110°F or below 25°F (adjustable).
5. In Occupied Mode and not Summer Mode, the lead pump shall run when commanded to do so by the DDC system to circulate the net energy loop system water throughout the building. A building pump shall run whenever the outside air temperature is below 35°F to provide freeze protection for the building.
6. Two water differential pressure transmitters located at the most remote heat pumps (see mechanical piping plans), shall be provided and connected to the DDC system. The pressure sensors measure the changes in loop pressure as the two-position heat pump valves in the building are opened and closed. The DDC system shall modulate the speed of the VFD’s on the building pump(s) to maintain desired NEL system pressure. (Initial differential pressure setting shall be 8 psig, this setting must be optimized in conjunction with the Test and Balance contractor during building commissioning).
7. The heat pump water flow meter, located in the net energy supply piping in the boiler room, shall be monitored by the BMCS. When the lead pump reaches 90% capacity, as measure by heat pump water flow maintained for 15 minutes (adjustable), the second

pump shall be started and the two pumps modulated in parallel to maintain heat pump water differential pressure. When heat pump water flow drops to 30% and maintained for 15 minutes, the BMCS shall shutdown the second pump and modulate the lead pump to maintain heat pump water differential pressure.

8. In Summer Mode, the jockey pump shall run continuously to maintain flow to the Administration area heat pumps.

F. HEAT REJECTION MODE:
1. The heat rejection loop consists of a cooling tower, condenser pumps, heat exchanger, filter and a mixing valve.
2. Enable the cooling tower and cooling tower mixing valve when the net energy return loop temperature is above 90 degrees F. Once enabled, cooling tower shall operate for the remainder of the day until building is unoccupied.
3. The cooling tower pumps shall run as follows: The lead tower pump shall run continuously when the building is occupied and the cooling tower is enabled. The local DDC controllers shall alternate the lead pump on a monthly basis. If a pump does not run when it is commanded to do so, the second pump shall start and an alarm shall be sent to the DDC system. Status of operation shall be by an analog current monitoring CT. Amperage will determine pump status of operation. The cooling tower fan speed will modulate via VFD to maintain the heat rejection supply water temperature.
4. Provide supply and return temperature sensors in the heat rejection loop connected to the DDC system.

G. HEAT INJECTION MODE:
1. The heat injection loop consists of two boilers, two boiler pumps and a glycol feed system.
2. Interconnecting control and interlock wiring shall be provided and installed by the ATC Contractor. The boiler shall be furnished with all hardware and software required for communication with the DDC system. The ATC Contractor shall furnish and install all interconnecting wiring for the boiler interface panels. The ATC Contractor shall furnish and install all hardware and software required for interface with the boiler system.
3. Enable the boiler when the net energy return building loop temperature is at or below 40 degrees F. When the net energy loop water temperature maintains 40 degrees F or above for a minimum of 30 minutes (adj) the heat injection loop will be disabled.
4. The boiler pumps shall run when the associated boiler is running. A manual bypass installed between the boiler pumps will allow the owner to operate the boiler and pumps independently in the event of an equipment failure.
5. Provide supply and return temperature sensors in the heat injection loop connected to the DDC system.

2.03 FLUID TO AIR HEAT PUMPS, 4 TON AND SMALLER

A. The heat pumps shall have factory-installed controls for connection to the application specific DDC controller furnished by the BMCS contractor. Each heat pump unit will consist of a compressor, reversing valve, supply fan, water side isolation valve (unless otherwise noted on the mechanical piping plans), automatic outside air damper, manual return air dampers and filters.

B. One Schneider Electric DDC controller shall be provided to control heat pumps. The DDC controls shall be located in the mechanical room with the heat pumps.

C. All low voltage transformers for the DDC system shall be centrally located in an equipment room to facilitate easy maintenance.

D. WARM-UP: Each heat pump shall perform an optimal start program that shall include a building warm-up feature. In this mode, each heat pump shall start individually before scheduled occupancy in sufficient time to allow each space to warm-up to its occupied setpoint. In warm-up mode, the associated automatic outside air damper shall remain closed until the occupied period begins. Warm-up mode shall only activate during the winter months between October 15 and April 15.

E. During the occupied mode as determined by the DDC system and through the factory-furnished controls, the heat pump unit shall operate to satisfy the room temperature setpoint. The room setpoint shall be adjustable by the room occupant at the thermostat. The heat pump supply fan shall operate continuously during the occupied mode. In the unoccupied mode the heat pump shall be off unless the unoccupied set point is not satisfied. In that case the heat pump shall cycle on long enough to satisfy the unoccupied set point. Whenever a heat pump is cycled on during unoccupied mode, the building pumps shall operate. During the occupied mode as determined by the DDC system, the DDC controller shall stage the heat pump unit and the reversing valve in sequence to maintain the desired space temperature.

F. OCCUPIED: BMS shall enable supply fan and open outside air damper to minimum position. Via room CO2 sensor, BMS shall adjust outside air damper to maintain space at setpoint listed in the CO2 concentration set points table below. Low mixed air temperature sensor shall override outside air damper back to minimum at mixed air temperature of 45°F or below. Refer to plans for CO2 sensors.

G. An interlock shall be provided to prevent heat pump compressor operation when a building loop pump fails to start and there is no water flow in the building heat pump loop, or if the building loop temperature is above 110°F or below 25°F (adj).

H. All outside air dampers with damper motors shall be provided by the ATC contractor. Division 26 shall provide 120 volt power to the control dampers.

I. The automatic outside air damper, providing the minimum outside air, shall be open whenever a heat pump which it serves is in the occupied mode. During the unoccupied mode, the automatic outside air damper shall be closed.

J. If a heat pump supply air temperature less than 45°F is detected, the DDC system shall close the outside air damper, stage the heat pump to full heat and send an alarm to the host computer.

K. A discharge air temperature sensor shall be provided in the supply air for each heat pump unit and connected to the DDC system.

L. A current sensing switch shall be provided and connected to the DDC controller to indicate fan(s) status of each heat pump. If the fan(s) fails to start when commanded, an alarm shall be sent to the host computer and a “heat pump fan fault” shall be indicated on a graphic screen which displays the status of all heat pumps.

M. A filter status differential pressure switch shall be provided for each heat pump and connected to the DDC controller to indicate filter status of each heat pump. A dirty filter alarm shall be sent to the host computer and a “heat pump filter fault” shall be indicated on a graphic screen which displays the status of all heat pump filters.

N. Isolation valves on the water side of the heat pumps shall be provided by the equipment manufacturer where indicated. The ATC contractor shall provide the appropriate low voltage controls and wiring for two-position operation of this valve. The valve shall be slow to open to

prevent water hammer effects. Whenever the heat pump compressor is off, the control valve shall be closed. Whenever the heat pump compressor cycles on, the control valve shall be open. Appropriate time delays shall be provided for valve operation to prevent the heat pump units from tripping. Where time delay controls are not provided by the manufacturer, the ATC contractor shall be responsible to provide the appropriate time delay. The time delay provided shall be in the form of an external, hardware, time delay relay module. The external relay module shall be wired such that each Application Specific DDC controller will operate in stand-alone mode reliably regardless of the sub-lan communication status. Some selected heat pumps shall not have a water side isolation valve. These units shall be designated as 'end of the loop' units and shall be designed to allow minimum water flow for the building loop pumps.

O. The morning startup and startup after a power outage of all heat pumps shall be staged to prevent large building demand loads for the loop pumps and the building electrical system. The heat pumps shall be staged to start at 30-second (adjustable) intervals.

P. The heat pump units shall be subject to building fire alarm (by Division 26), duct supply ionization detectors (by Division 26), building start-stop programs, and other conditions or logic pre-programmed into the local DDC controller.

2.04 FLUID TO AIR HEAT PUMPS, 5 TON AND LARGER

A. The heat pumps shall have factory-installed controls for connection to the application specific DDC controller furnished by the BMCS contractor. Each heat pump unit will consist of a compressor(s), reversing valve(s), supply fan(s), water side isolation valve (unless otherwise noted on the mechanical piping plans), automatic outside air damper, automatic return air dampers and filters. The BMCS contractor shall provide modulating, spring-return actuators for each damper.

B. One Schneider Electric DDC controller shall be provided to control heat pumps. The DDC controls shall be located in the mechanical room with the heat pumps.

C. All low voltage transformers for the DDC system shall be centrally located in an equipment room to facilitate easy maintenance.

D. There are heat pumps with associated relief fans and outside air units as indicated in the following table. It is intended that paired heat pumps serving these spaces be operated in unison to control the space temperature, economizer functions, CO2 control and building pressure control systems.

Heat Pumps w/Economizer	**Relief**	**Outside Air**	**Space Served**
HP-5, 6 & 7	RH-1A & RH-1B	VF-3, VF-5 & VF-6	Auditorium and Stage
HP-55, 56	RH-5A & RH-5B	DOA-2	Gymnasium
HP-57	RH-4	DOA-3	Auxiliary Gym
HP-68	RH-9	VF-11	Media Center
HP-34	RH-8	VF-27	Band
HP-32	RH-7	VF-25	Choral
HP-37	RH-6	VF-26	Little Theater
HP-8 & HP-9	L-2 & L-3	DOA-1	Cafeteria

E. WARM-UP: Each heat pump shall perform an optimal start program that shall include a building warm-up feature. In this mode, each heat pump shall start individually before scheduled occupancy in sufficient time to allow each space to warm-up to its occupied setpoint. In warm-up mode, the associated automatic outside air damper shall remain closed until the occupied period begins. Warm-up mode shall only activate during the winter months between October 15 and April 15.

F. PURGE: In purge mode, each heat pump(s) shall start individually before scheduled occupancy in an attempt to allow each space to cool-down to its occupied setpoint. In purge mode, the heat pump supply fan(s) shall run, the outside air damper shall open to 100% and the return damper close and the associated relief hood damper shall open. The heat pump compressor(s) shall remain off. Purge mode shall only activate during the summer months between April 15, and October 15 when the outside air temperature is greater than 50°F but less than 70°F.

G. During the occupied mode as determined by the DDC system, and through the factory-furnished controls each heat pump system shall operate to satisfy the room temperature setpoint, CO2 concentration set points table below, and building pressurization. A wall mount LCD temperature sensor shall be connected to the DDC controller shall provide space temperature indication. The heat pump supply fan(s) shall operate continuously during the occupied mode. During the occupied mode as determined by the DDC system, the DDC controller shall stage the economizer dampers, the heat pump unit compressor(s) and reversing valve, in sequence to maintain the desired space temperature.

H. An interlock shall be provided to prevent heat pump compressor operation when a building loop pump fails to start and there is no water flow in the building heat pump loop, or if the building loop temperature is above 110 degrees F or below 25 degrees F (adjustable).

I. All return, relief and outside air dampers with damper motors shall be provided by the ATC contractor. Division 26 shall provide 120 volt power to the control dampers.

J. If a heat pump supply air temperature less than 45°F is detected, the DDC system shall close the outside air and relief dampers, stage the heat pump to full heat and send an alarm to the host computer.

K. In occupied mode, positive building pressure of 0.05 inches w.c. (adj) shall be maintained by modulating the relief damper(s) open. In unoccupied mode, the outside air and relief dampers shall be closed.

L. In the unoccupied mode, heat pump(s) shall remain off unless the unoccupied set point is not satisfied. In that case the heat pump(s) shall cycle on long enough to satisfy the unoccupied set point. In the unoccupied mode, outside air and relief dampers shall remain closed. Whenever a heat pump is cycled on during unoccupied mode, the building loop pumps shall operate.

M. EVENT MODE: An event mode schedule shall be provided through the DDC system to allow all heat pump(s) units in areas such as the gym, auditorium and cafeteria area to operate in a pre-determined time schedule.

N. A discharge air temperature sensor shall be provided in the supply air for each heat pump unit and connected to the DDC system. Sensors shall also be provided to monitor the mixed air, return air and relief air temperatures.

O. A current sensing switch shall be provided and connected to the DDC controller to indicate fan(s) status of each heat pump. If the fan(s) fails to start when commanded, an alarm shall be

sent to the host computer and a “heat pump fan fault” shall be indicated on a graphic screen which displays the status of all heat pumps.

P. A filter status differential pressure switch shall be provided for each heat pump and connected to the DDC controller to indicate filter status of each heat pump. A dirty filter alarm shall be sent to the host computer and a “heat pump filter fault” shall be indicated on a graphic screen which displays the status of all heat pump filters.

Q. Isolation valves on the water side of the heat pumps shall be provided by the equipment manufacturer where indicated. The ATC contractor shall provide the appropriate low voltage controls and wiring for two-position operation of this valve. The valve shall be slow to open to prevent water hammer effects. Whenever the heat pump compressor is off, the control valve shall be closed. Whenever the heat pump compressor cycles on, the control valve shall be open. Appropriate time delays shall be provided for valve operation to prevent the heat pump units from tripping. Where time delay controls are not provided by the manufacturer, the ATC contractor shall be responsible to provide the appropriate time delay. The time delay provided shall be in the form of an external, hardware, time delay relay module. The external relay module shall be wired such that each Application Specific DDC controller will operate in stand-alone mode reliably regardless of the sub-lan communication status. Some selected heat pumps shall not have a water side isolation valve. These units shall be designated as ‘end of the loop’ units and shall be designed to allow minimum water flow for the building loop pumps.

R. The morning startup and startup after a power outage of all heat pumps shall be staged to prevent large building demand loads for the loop pumps and the building electrical system. The heat pumps shall be staged to start at 30-second (adjustable) intervals.

S. The heat pump units shall be subject to building fire alarm (by Division 26), duct supply ionization detectors (by Division 26), building start-stop programs, and other conditions or logic pre-programmed into the local DDC controller.

2.05 CO2 CONCENTRATION SET POINTS TABLE

SPACE	CO2 CONCENTRATION SETPOINT (PPM)
CAFETERIA	1900
AUDITORIUM	2200
RECEPTION	1600
CLASSROOM	900
ART CLASSROOM	1100
CAFETERIA	1400
SCIENCE CLASSROOM	1100
MEDIA CENTER	950
MULTIUSE ASSEMBLY/GYM	2100
SHOP	1400
MUSIC/THEATER/DANCE	1900
OFFICE SPACE	900
CONFERENCE	1600

2.06 VENTILATION FANS AND ELECTRIC COILS

A. Ventilation fans and associated electric coils shall operate during occupied hours and shall remain off during unoccupied hours. Fan VFD shall modulate the fan based on the heat pump

demands.

B. The control system shall monitor fan status and discharge air temperature and display this data on the graphical user interface. Should temperature drop 5°F below setpoint while heating is enabled, the system will generate an alarm in the system and display the alarm on the space graphic and reduce outside air damper to minimum value.

C. Provide discharge air temperature sensor in ductwork downstream of electric coil. Discharge air temperature sensor shall report to the ATC system and be graphically displayed. Unit operation shall be displayed at the ATC system graphics. Temperature heating control initial set point 25°F.

D. BMS shall modulate fan speed via VFD based on maintaining duct static set point and the heat pump demands. Coordinate with the balancing contractor.

2.07 DEDICATED OUTSIDE AIR UNITS

A. Dedicated outside air units shall operate during occupied hours and shall remain off during unoccupied hours.

B. The control system shall monitor fan status and discharge air temperature and display this data on the graphical user interface. Should temperature drop 5°F below setpoint while heating is enabled, the system will generate an alarm in the system and display the alarm on the space graphic and reduce outside air damper to minimum value.

C. Provide discharge air temperature sensor in ductwork downstream of unit. Discharge air temperature sensor shall report to the ATC system and be graphically displayed. Unit operation shall be displayed at the ATC system graphics. Temperature heating control initial set point 25°F.

D. BMS shall modulate fan speed based on maintaining duct static set point and the heat pump demands. Coordinate with the balancing contractor.

2.08 RELIEF

A. Relief hoods or louvers, refer to the mechanical plans for locations, have ATC dampers installed in the throat or at the wall. The test and balance contractor and ATC contractors shall coordinate and calibrate the damper control to open and relieve building pressure whenever building pressures rise above 0.05 inches w.c.

2.09 ELECTRIC HEATER CONTROL (CUH OR EUH OR EWH)

A. The electric heater shall cycle from a thermostat to control the space temperature. The ATC contractor shall provide the thermostat and transformers, relays, switches conduit and wiring for a complete and functional system.

2.10 KITCHEN DISHWASHER EXHAUST FAN

A. The dishwasher exhaust fan shall be interlocked with the dishwasher to be on whenever the dishwasher is on. A time delay relay shall be installed to keep the dishwasher exhaust fan running five minutes after the dishwasher is turned off.

B. (Gas-fired dishwasher only, coordinate with Food Service equipment) The gas valve serving the dishwasher shall not open unless the exhaust fan is operating as determined by electrical

interlock and differential pressure type air flow switch.

2.11 KITCHEN GREASE HOOD EXHAUST FANS

A. The kitchen exhaust fans shall operate from temperature sensors located in the hoods. The ATC contractor shall interlock the kitchen exhaust fans with the associated makeup air unit. Wire from the hood control panel to the auto gas shut-off valves.

2.12 KITCHEN MAKE-UP AIR UNITS

A. The makeup air units supply air damper shall open when the fan starts and close on fan shutdown. Install electrical interlock wiring so that the makeup air unit operates when exhaust fan is operating. Install and wire factory-furnished makeup unit remote control panel in an approved location on exhaust hood in kitchen.

2.13 EXHAUST FANS

A. Each general area exhaust fan shall be controlled by an individual 'DO' point in the building energy management system. They shall operate on schedules to be determined by the School District. Provide fan status.

B. Restroom, lockers, art room and shop exhaust fans shall run continuously when the spaces are occupied. Refer to the print shop sequence for the fan serving the print shop.

C. Press box exhaust fans shall operate by occupancy sensors.

D. The kiln room exhaust fan shall be controlled by a wall-mounted switch and shall not be connected to the DDC system. When the switch is in the on position the associated ventilation fan shall operate and outside air ATC damper shall open and the exhaust fan turn on. When the switch is in the off position the ventilation fan shall turn off and the outside air ATC damper shall close and the exhaust fan turn off. Interface BMS with room thermostat for high or low limits, adjustable.

E. Interlock the paint spray booth exhaust fan with the paint booth makeup air unit. When the Paint Spray Booth exhaust fan is running, the makeup air unit will be 100% outside air and on high speed. While operating the Paint Booth MAU will modulate the gas burner and cooling to maintain space temperature. Multiple gas burners will be staged on.

F. The science prep and chemical cabinet exhaust fans shall operate continuously.

G. The science and foods exhaust fans shall operate with a wall mounted timer switch provided and installed by Division 26.

H. The electrical room and elevator exhaust fans shall be started and stopped by a line-voltage thermostat located in the space served. Start the fan when the temperature reaches 90 deg F (adjustable) and turn off the fan when the temperature decreases to 85 deg F (adjustable).

I. The scenery exhaust fan shall operate with a wall mounted timer switch provided and installed by Division 26. The associated heat pumps shall operate and ATC dampers providing make-up air to the space shall open when scenery exhaust is operating and close when not operating.

J. The boiler room exhaust fan shall operate by a thermostat, set to 90°F (adjustable). When the fan is operating the outside air ATC damper shall open and close when the fan is not operating.

K. The laser engraver exhaust fan shall operate with a wall mounted timer switch provided and installed by Division 26.

L. Exhaust fans shall have motorized dampers with damper motors the same voltage as the fan motor provide by Division 23. Division 26 shall connect the damper motors to open whenever the exhaust fan is operating.

2.14 PRINT SHOP

A. The print shop exhaust fans shall run continuously when the space is occupied.
B. The associated make-up air unit supply air damper shall open when the fan starts and close on fan shutdown. Install electrical interlock wiring so that the make-up air unit operates print shop exhaust fan is operating. Install and wire factory-furnished makeup unit remote control panel to the auto gas shut-off valves.

2.15 DUST COLLECTOR

A. Refer to Division 26 for the wiring requirements of the dust collector components.
B. The controls contractor shall provide a relay to disable the dust collector in the shop from operating when the building is unoccupied.
C. Install and wire the safety controls that are furnished with the dust collectors.

2.16 AIR FILTER UNITS

A. Division 26 shall install a wall mount switch to control the operation of the Air Filter Units located in the Wood Shop.

2.17 VAV SUPPLY DIFFUSERS

A. The ATC Contractor shall install the thermostat, control voltage transformer and accessory equipment provide with the diffuser to provide a complete and operation system. Division 26 shall provide 120 volt power for the VAV diffusers.

2.18 DUCTLESS SPLIT SYSTEMS

A. Provide all necessary miscellaneous wiring for a completely operation system per manufacturers instructions including wiring the wall mounted hard wired thermostat.
B. Provide a separate DDC space sensor for monitoring of space temperature only.

2.19 FUEL FIRED UNIT HEATER

A. DDC room thermostat shall cycle the unit heater to maintain minimum desired room temperature. Initial thermostat setpoint shall be 60 F.

2.20 WATER CHEMICAL TREATMENT SYSTEM

A. The water treatment system shall be furnished complete by the vendor. The ATC contractor shall provide 120-volt power, interconnecting wiring between components as necessary to make a complete operational system.

2.21 GLYCOL FEED SYSTEMS

A. The ATC contractor shall wire all misc. power and pressure sensors provided with the equipment to make the systems completely operational.

2.22 CULINARY HOT WATER SYSTEMS

A. When the starter or MCC mounted (H-O-A) switches are in the AUTO position, and any of the fan systems is running in the OCCUPIED mode, a strap-on thermostat mounted on the culinary hot water return line shall cycle domestic hot water pump to maintain 120°F (initial setting) culinary return water temperature.

B. An immersion sensor with well in the hot water storage tank, acting through a DDC controller, shall cycle hot water heater and hot water heater pump to maintain 130°F storage tank temperature.

C. Strap-on aquastats mounted on the recirculating lines to the storage tanks shall cycle their associated pumps to maintain 120°F and 140°F. respectively. Pumps and water heaters shall be interlocked with the building energy management system such that they will not operate unless enabled by the building energy management system. Coordinate wiring and control of pumps with water heater manufacturers.

2.23 EMERGENCY SHUTDOWN SWITCHES (Boilers & Water Heaters)

A. A remote mushroom type, single acting, manually reset, shutdown switch shall be located just inside each mechanical room door or opening and marked for easy identification. A pilot light shall illuminate whenever the push button is pressed. If there is more than one door to the mechanical room, there should be a switch located at each door.

B. The emergency shutdown switch(es) when activated must disconnect all power to the boiler burner and all hot water heater controls. A visual alarm indicator of a different color than the building fire alarm indicators shall be activated when the boilers are shutdown.

2.24 FOODS LAB GAS VALVES

A. Gas valves in the Foods room shall be controlled by a schedule in the DDC system to open the gas valve ½ hour before and close ½ hour after normal school hours.

B. An emergency shut-off button located at the teacher's station, shall allow the teacher to override the DDC schedule and close the gas valve for safety shut-down.

2.25 UTILITIES MONITORING

A. Division 23 shall provide a building water meter and a building gas meter with calibrated pulsed output. Landscape Contractor shall provide a landscape water meter with calibrated pulsed output. Division 26 shall provide the main electric power meter with a interface card (Modbus, Bacnet or Lonworks).

B. The ATC Contractor shall provide control wire to the meters, connect and display measured data at the DDC system.

2.26 LIGHTING CONTROL SYSTEM – Hallways and Parking

A. Division 26 shall furnish and install lighting control relays as indicated on the electrical drawings and shall provide conduit and wire between each relay and the nearest DDC controller. The ATC contractor shall provide pilot duty 'DO' contacts to control each relay and a momentary contact switch for each relay to provide a manual override of each relay for a unique, preprogrammed length of time.

B. Schedules for each individual lighting relay shall be determined by the Engineer and/or the District.

2.27 FIRE RISER TEMPERATURE MONITORING

A. A temperature sensor shall be provided and connected to the control system to monitor the temperature near the fire risers. If the temperature falls below 45° an alarm shall be generated and an email shall be sent to district personnel.
B. When the temperature falls below 45°, the control system shall enable the hvac equipment serving the area to warm-up the space.

2.28 DEMONSTRATION

A. Completely check, calibrate and test connected hardware and software to insure system performs in accordance with Contract documents and sequences of operation submitted.

B. Demonstrate complete system operations for District Engineer or Project Manager prior to system acceptance.

C. Training

1. Perform training at the same time as commissioning is done. Utilize specific manuals and record documentation.
2. Provide eight (8) hour training session for BMCS covering following topics:
    a. Sequence of operation review

b. Use of operator's terminal
c. Operating time schedules
d. Alarm messages
e. Network communications, both local and within the district's LAN.
f. Review modifying setpoints and schedules
g. Questions and answers.

D. Final Acceptance

1. Written acceptance sign-off of system operation will then occur after commissioning and training are complete. Acceptance will be signed by District's designated Commissioning Agent.
2. Checklist, provided by District, shall be initialed and signed by District's Project Manager at completion.
3. Punch list items completed and BMCS accepted.
4. Checklist shall verify required training has been provided.
5. Checklist shall also be signed by BMCS trainer and forwarded to District Engineer for final review and approval.
6. Final payment will not be made until checklist has been received, reviewed and approved by District's Engineer.

END OF SECTION

SECTION 23 1123

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Mechanical sleeve seals.
7. Grout.
8. Concrete bases.
9. This division is to pay all costs associated with the gas meter that are required by the local gas company/authority. Gas Meter is to come with Pulsating meter reader to be compatible to the Building Management System

1.03 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.

1.04 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2 psig but not more than 5 psig, and is reduced to secondary pressure of more than 0.5 psig but not more than 2 psig.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.05 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.
4. Dielectric fittings.
5. Mechanical sleeve seals.
6. Escutcheons.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.

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

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

D. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

E. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

F. Qualification Data: For qualified professional engineer.

G. Welding certificates.

H. Field quality-control reports.

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

1.06 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.

1.07 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.

D. Protect stored PE pipes and valves from direct sunlight.

1.08 COORDINATION

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

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

2.02 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: [**40**] mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.03 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

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

2.04 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
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 and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.
9. Listing: Valves NPS 1 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.

D. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of 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.
7. Listing: Valves NPS 1 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.

E. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

    a. McDonald, A. Y. Mfg. Co.
    b. Mueller Co.; Gas Products Div.
    c. Xomox Corporation; a Crane company.

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.

6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 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.

F. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

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

    a. Flowserve.
    b. Homestead Valve; a division of Olson Technologies, Inc.
    c. McDonald, A. Y. Mfg. Co.
    d. Milliken Valve Company.
    e. Mueller Co.; Gas Products Div.
    f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 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.

2.05 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

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

    a. Vanguard Valves, Inc.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: 5 psig.
4. Cast-aluminum body with nickel-plated chrome steel internal parts.
5. Nitrile-rubber valve washer.
6. Sight windows for visual indication of valve position.
7. Threaded end connections complying with ASME B1.20.1.
8. Wall mounting bracket with bubble level indicator.

B. Earthquake Valves: Comply with ASCE 25.

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

a. Pacific Seismic Products, Inc.

2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
3. Maximum Operating Pressure: [0.5 psig] [7 psig] [60 psig].
4. Cast-aluminum body with stainless-steel internal parts.
5. Nitrile-rubber, reset-stem o-ring seal.
6. Valve position, open or closed, indicator.
7. Composition valve seat with clapper held by spring or magnet locking mechanism.
8. Level indicator.
9. End Connections: Threaded for valves NPS 2 and smaller; flanged for valves NPS 2-1/2 and larger.

2.06 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 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

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

a. 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: 5 psig.

2.07 DIELECTRIC FITTINGS

A. Dielectric Unions:

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

    a. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Hart Industries International, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
    f. Wilkins; Zurn Plumbing Products Group.

2. Minimum Operating-Pressure Rating: 150 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric-Flange Kits:

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

    a. Advance Products & Systems, Inc.
    b. Calpico Inc.
    c. Central Plastics Company.
    d. Pipeline Seal and Insulator, Inc.

2. Minimum Operating-Pressure Rating: 150 psig.
3. Companion-flange assembly for field assembly.
4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
5. Insulating materials suitable for natural gas.
6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.08 SLEEVES

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

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

2.09 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

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

a. Advance Products & Systems, Inc.
b. Calpico Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.10 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, Cast-Brass Escutcheons: With set screw.

1. Finish: Polished chrome-plated or rough brass.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.

1. Finish: Polished chrome-plated or rough brass.

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

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

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

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

2.11 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, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.12 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective

jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.01 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.

3.02 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.

3.03 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, cast-brass type with polished chrome-plated finish.
    c. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    d. Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
    e. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
    f. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
    g. Piping in Unfinished Service Spaces: One-piece, stamped-steel type with set screw or spring clips.
    h. Piping in Equipment Rooms: One-piece, cast-brass type.
    i. Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
    j. Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

L. 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 Section "Penetration Firestopping."

M. Verify final equipment locations for roughing-in.

N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

O. 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 long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

Q. 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.

R. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

    1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
    2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

    a. Exception: Tubing passing through partitions or walls does not require striker barriers.

5. Prohibited Locations:

    a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
    b. Do not install natural-gas piping in solid walls or partitions.

S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

T. Connect branch piping from top or side of horizontal piping.

U. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

V. Do not use natural-gas piping as grounding electrode.

W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.04 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.

C. Install earthquake valves aboveground outside buildings according to listing.

D. Install anode for metallic valves in underground PE piping.

3.05 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. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

D. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.06 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.07 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 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.

3.08 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.09 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, 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 (semigloss).
    d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.

    a. Prime Coat: Quick-drying alkyd metal primer.
    b. Intermediate Coat: Interior latex matching topcoat.
    c. Topcoat: Interior latex (flat).
    d. Color: Gray.

2. Alkyd System: MPI INT 5.1E.

    a. Prime Coat: Quick-drying alkyd metal primer.
    b. Intermediate Coat: Interior alkyd matching topcoat.
    c. Topcoat: Interior alkyd (flat).
    d. Color: Gray.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psig 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.11 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.

3.12 DEMONSTRATION

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

3.13 INDOOR PIPING SCHEDULE

A. Aboveground, piping NPS 2 and smaller shall be the following:

1. Steel pipe with wrought-steel fittings and welded or threaded joints.

B. Aboveground, piping NPS 2-1/2” and larger shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints in a vented conduit.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:

1. Two-piece, bronze ball valve with bronze trim.
2. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:

1. Bronze plug valve.
2. Cast-iron, nonlubricated plug valve.

END OF SECTION

SECTION 23 2113

HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Cooling-water piping.
3. Condenser-water piping.
4. Makeup-water piping.
5. Condensate-drain piping.
6. Air-vent piping.
7. Dielectric fittings.
8. Heat Pump Water piping.
9. Safety-valve-inlet and -outlet piping.

B. Related Sections include the following:
1. Division 23 Section “Hydronic Piping Specialties”.
2. Division 23 Section “Ground Heat Exchanger”.
3. Division 23 Section “Vibration Isolation and Seismic Restraint”.
4. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment"

1.03 SEISMIC REQUIREMENTS

A. Component Importance Factor. All mechanical components shall be assigned a component importance factor. The component importance factor, I*p*, shall be taken as 1.5 if any of the following conditions apply:

1. The component is required to function for life-safety purposes after an earthquake.
2. The component contains hazardous materials.
3. The component is in or attached to an Occupancy Category IV structure and it is needed for continued operation of the facility or its failure could impair the continued operation of the facility.

B. All other components shall be assigned a component importance factor, I*p*, equal to 1.0.

C. Seismic Performance: Pipe hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 <Insert requirement> and with the requirements specified in Section 23 0548 "Vibration and Seismic Controls for HVAC."

1. For piping with a seismic importance factor of 1.0 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."

2. For piping with a seismic importance factor of 1.5 the term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."

1.04 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Steel pipe and fittings.
2. Copper pipe, tubing and fittings.
3. Dielectric fittings.

B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

1.05 INFORMATIONAL SUBMITTALS

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

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports: Written reports as specified in Part 3 of this section including:

1. Test procedures used.
2. Test results showing compliance with specified requirements.
3. Failed test results with corrective action taken to achieve compliance with specified requirements.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Grooved-Joint couplings, fittings, valves and specialties: Installers shall be certified by Grooved-Joint manufacturer as having been trained and qualified to join piping with Grooved-Joint pipe couplings and fittings.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. All grooved joint couplings, fittings, valves and specialties shall be the products of a single manufacturer.

1. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.

1.07 COORDINATION

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe sleeve installations for foundation wall penetrations.

C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

D. Coordinate pipe fitting pressure classes with products specified in related sections.

E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

PART 2 - PRODUCTS

2.01 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.

1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
2. Grooved-End-Tube Couplings: Coupling housings shall be cast with offsetting, angle-pattern bolt pads to provide joint rigidity and support and hanging in accordance with

ANSI B31.1 and B31.9. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230 deg F without use of special lubricants. For use with housing, and ASTM A449 electroplated steel nuts and bolts.

D. Wrought-Copper Unions: ASME B16.22.

2.02 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Forged Steel “Olet” Type Fittings, Welding, Socket-Welding and Threaded: ASME B16.11 and ASTM A105.

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

I. Grooved Mechanical-Joint Fittings and Couplings:

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

   a. Victaulic Company.
   b. Anvil International, Inc.
   c. Tyco-Grinnel

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 53, Type F, E, or S, Grade B factory-fabricated steel; or ASTM A 234, Grade WPB steel fittings with grooves or shoulders designed and constructed to accept grooved-end couplings.
3. Couplings: Two Ductile- housing and synthetic rubber gasket of central cavity pressure-responsive design; with ASTM A449 electroplated steel nuts and bolts to secure grooved pipe and fittings. Couplings shall comply with ASTM F1476 Standard Specification for the Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

a. Rigid Type: Coupling housings shall be cast with offsetting, angle-pattern bolt pads to provide joint rigidity and support and hanging in accordance with ANSI B31.1 and B31.9.
b. Gasket: High temperature EPDM gasket, suitable for water service to +250 deg F, without use of special lubricants.
c. Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for the elimination of flexible connectors.
d. 14" and Larger: Two –segment coupling, with lead-in chamfer on housing key and a wide-width gasket having a center-leg.

4. Combinations of grooved mechanical-joint couplings and short nipples may also be used.

J. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.03 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F 441, with wall thickness as indicated in "Piping Applications" Article.

1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.

2.04 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

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

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. 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.

G. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.

a. CPVC solvent cement shall have a VOC content of 490 g/L or less.

b. Adhesive primer shall have a VOC content of 550 g/L or less.
c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.05 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

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

a. Charlotte Pipe and Foundry Company.
b. IPEX Inc.
c. KBI Company.

2. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:

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

a. Charlotte Pipe and Foundry Company.
b. IPEX Inc.
c. KBI Company.
d. NIBCO INC.

2. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.06 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.Capitol Manufacturing Co.
c. Capitol Manufacturing Company.
d. Central Plastics Company.
e. Elster Perfection.
f. Grinnell Mechanical Products.
g. Matco-Norca.
h. Pipeline Seal and Insulator, Inc.
i. Precision Plumbing Products, Inc.

j. Victaulic Company.
k. Watts Regulator Co.
l. Zurn Industries, LLC.

B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

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

D. End Connections: Grooved, Threaded, or flanged.

E. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for **150- or 300-psig** minimum working pressure as required to suit system.

F. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.

G. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

H. Dielectric Nipples or Waterways: Electroplated steel with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller shall be **[any of]** the following:

1. **Type L** drawn-temper copper tubing, wrought-copper fittings, and **soldered brazed** joints.
2. **Schedule 40**, Grade B, Type 96 steel pipe; **Class 125, cast-iron** fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be **[any of]** the following:

1. **Type L** , drawn-temper copper tubing, wrought-copper fittings, and **brazed** joints.
2. **Schedule 40** steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Heat Pump piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40, Grade B, Type 96 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

D. Heat Pump piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

E. Heat Pump piping installed belowground and within concrete slabs shall be the following:

1. See Division 23 Section Ground Loop Heat Exchanger.

F. Makeup-water piping installed aboveground shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

G. Condenser-water piping, aboveground, NPS 2 and smaller, shall be **[any of]** the following:

1. **Type L,** drawn-temper copper tubing, wrought-copper fittings, and **brazed** joints.
2. **Schedule 40**, Grade B, Type 96 steel pipe**; Class 125, cast-iron** fittings; cast-iron flanges and flange fittings; and threaded joints.

H. Condenser-water piping, aboveground, NPS 2-1/2 and larger, shall be **any of** the following:

1. **Type L**, drawn-temper copper tubing, wrought-copper fittings, and **brazed** joints.
2. **Schedule 40** steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

I. Condensate-drain piping shall be the following:

1. Type K, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

J. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

K. Air-Vent Piping:

1. Inlet: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

L. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.02 EARTHWORK

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

3.03 PIPING INSTALLATIONS

A. PRE-WORK / PRE-REQUISITES

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
2. The Contractor shall study the architectural, structural, mechanical, electrical and other drawings to eliminate conflict of piping with other structure lighting or other services.

B. CONDITION

1. All installed pipe lines shall be free from dents, scars, and burrs, with ends reamed smooth.
2. All piping shall be clean and free from acids and loose dirt when installed and shall be kept clean during the completion of the installation.
3. Install piping free of sags and bends.
4. All installed pipe lines shall remain straight against strains tending to cause distortion during system operation. The contractor shall make proper allowance for pipe line expansion and contraction so that no unsightly distortion, noise, damage or improper operation results therefrom.

C. SELECTION

1. Select system components with pressure rating equal to or greater than system operating pressure.
2. No street type fittings shall be used.
3. No short nipples shall be used except at drain valves.
4. Plugs of rags, wools, cottons, waste, or similar materials may not be used for plugging.

D. ROUTING/ARRANGEMENT

1. Piping installations shall be neatly organized.

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

3. Install groups of pipes parallel to each other.

4. Install piping spaced to permit application of insulation.

5. Install piping parallel and spaced to permit the servicing of valves.

6. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls or axis of the building.

7. Diagonal runs are prohibited unless specifically indicated otherwise.

8. Install fittings for all changes in direction.

9. No piping shall be run above any electrical panels, electrical equipment or access clearances for electrical for electrical panels or equipment. No piping shall be allowed to run through any electrical rooms.

10. Piping shall be arranged, placed and installed to facilitate equipment maintenance and shall be so arranged to not interfere with the installation of the air-conditioning equipment, ducts, or the removal of other equipment or devices. All specialties shall be so placed to permit easy operation and access.

11. All piping shall be so installed to insure noiseless circulation.

12. Install fittings for all branch connections.

13. Unless otherwise indicated, install branch connections to mains using [mechanically formed] tee fittings or forged steel branch fittings in main pipe, with the branch connected to the bottom of the main pipe.

14. For up-feed risers, connect the branch to the top of the main pipe.

15. Forged branch fittings shall be installed per the manufacturer's recommendations.

E. ACCESS / ARRANGEMENT

1. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal. All piping shall be so arranged to not block access to manholes, access openings, etc.

2. Install piping at indicated slopes. If not indicated, install piping at a uniform grade of 0.2 percent upward in direction of flow. Traps are to be avoided where-ever possible.

3. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

4. When insulated pipes are supported by a roller hanger they shall be protected from damage by suitable pipe covering protection saddles. Saddles shall support pipe on roller and shall be packed with insulation.

5. Install valves according to Section 23 0523 "General-Duty Valves for HVAC Piping."

6. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, at each coil on all sides of automatic valves where valves do not have union connections, elsewhere as indicated, and wherever necessary to prevent undue difficulty in making repairs or replacement. Unions are not required at flanged connections.

7. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated. Install flanges on valves, apparatus, and equipment having 2 ½ inch NPS and larger connections. Flanges or unions as applicable for the type of piping specified shall be provided in the piping at connections to all items of equipment.

8. Install shutoff valve immediately upstream of each dielectric fitting. Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

9. Comply with requirements in Section 23 0516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides. Anchor piping for proper direction of expansion and contraction.

10. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 0517 "Sleeves and Sleeve Seals for HVAC Piping."

11. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 23 0517 "Sleeves and Sleeve Seals for HVAC Piping."

12. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 23 0518 "Escutcheons for HVAC Piping."

13. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS ¾) nipple and ball valve in blow-down connection of strainers NPS 2) and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2).

14. Install flexible connectors at inlet and discharge connections to pumps (except inline pumps) and other vibration-producing equipment.

15. Polypropylene pipe in or passing through plenums must be fire wrapped or installed in a metal conduit.

F. DRAINAGE

1. Drain valves shall be installed at all low points in all piping systems to allow for complete drainage of piping systems.
2. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
3. All piping systems shall be installed so that they can be easily drained by means of drainage of low points of all piping without disconnecting pipe.
4. If not specifically indicated on the drawings, the frequency of draining shall determine whether drain caps, plugs, cocks, or valves are to be used.

G. IDENTIFICATION

1. Comply with requirements in Section 23 0553 "Identification for HVAC Piping and Equipment" for identifying piping.

3.04 DIELECTRIC FITTING INSTALLATION

A. Make connections according to the following, unless otherwise indicated:

1. Install dielectric nipples or waterways in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install waterways, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Install Dielectric Fittings into Hydronic Piping Systems: Install dielectric nipples, waterways or couplings to connect piping materials of dissimilar metals.
4. End Connections: Grooved, threaded, or flanged.

3.05 HANGERS AND SUPPORTS

A. Comply with requirements in Section 23 0529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Comply with requirements in Section 23 0548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Steel roof deck shall not be used to support loads from piping, ductwork or equipment, unless noted otherwise. Hanger loads less than 50 lbs. may be hung from the steel roof deck in cases when hanging from the steel roof deck cannot be avoided; the attachment method must distribute the load across the deck as approved by the Structural Engineer.

D. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

E. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet.

F. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

G. PVC and CPVC Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

H. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

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

3.06 PIPE JOINT CONSTRUCTION

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

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

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

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 D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

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

H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846 Appendix.

I. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts.

1. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
2. Installed in accordance with the manufacturer’s written recommendations.
3. Ends shall be clean and free from indentations, projections or roll marks.
4. The gasket shall be molded and produced by the coupling manufacturer of an elastomer suitable for the intended service.
5. Unions and flanges for servicing and disconnect are not required in installations using grooved joint couplings.
6. Training: The coupling manufacturer’s factory-direct trained representative shall provide on-site training for the contractor’s field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed. The distributor’s representative will not be acceptable.

3.07 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 23 0519 "Meters and Gages for HVAC Piping."

3.08 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 23 2116

HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes special-duty valves and specialties for the following:
   1. Hot-water heating piping.
   2. Condenser-water piping.
   3. Heat Pump piping.
   4. Makeup-water piping.
   5. Condensate-drain piping.
   6. Air-vent piping.

B. Related Sections include the following:
   1. Division 23 Section Valves for HVAC Piping.
   2. Division 23 Section Hydronic Piping.
   3. Division 23 Section Ground Heat Exchanger.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air-control devices.
   3. Hydronic specialties.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.06 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 VALVES

A. Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 23 0523 "General-Duty Valves for HVAC Piping.

B. Gate valves are not used on this project.

C. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 23 0900 "Instrumentation and Control for HVAC.

D. Refer to Part 3 “Valve Applications” Article for applications of each valve.

E. Bronze, Calibrated-Orifice or Venturi, Balancing Valves, NPS 2 and smaller:

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

      a. Armstrong Pumps, Inc.
      b. Flow Design Inc.
      c. Gerand Engineering Co.
      d. Griswold Controls.
      e. ITT Bell & Gossett; ITT Fluid Technology Corp.
      f. Taco.

   2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
   3. Ball: Brass or stainless steel.
   4. Plug: Resin.
   5. Seat: PTFE.
   6. End Connections: Threaded or socket.
   7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
   8. Handle Style: Lever, with memory stop to retain set position.
   9. CWP Rating: Minimum 125 psig.
   10. Maximum Operating Temperature: 250 deg F.

F. Cast-Iron or Steel, Calibrated-Orifice or Venturi, Balancing Valves, NPS 2 ½ and larger:

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

      a. Armstrong Pumps, Inc.
      b. Flow Design Inc.

c. Gerand Engineering Co.
d. Griswold Controls.
e. ITT Bell & Gossett; ITT Fluid Technology Corp.
f. Taco.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

G. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

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

b. Amtrol, Inc.
c. Armstrong Pumps, Inc.
d. Conbraco Industries, Inc.
e. ITT Bell & Gossett; ITT Fluid Technology Corp.
f. Spence Engineering Company, Inc.
g. Watts Regulator Co.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Brass, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

H. Diaphragm-Operated Safety Valves: ASME labeled.

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

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.
d. Conbraco Industries, Inc.
e. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
f. Kunkle.
g. Spence Engineering Company, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.

4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: **Brass,** removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected pressure and heat capacity to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

I. Automatic Flow-Control Valves:

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

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump.
    c. Flow Design Inc.
    d. Griswold Controls.
    e. Taco

2. Body: Brass or ferrous metal.
3. Piston and Spring Assembly: Tamper proof, self-cleaning, and removable, for inspections and replacement.

    a. Corrosion resistant, Stainless steel.

4. Combination Assemblies: Include bronze or brass-alloy ball valve.
5. Identification Tag: Attached by chain and marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations:

    a. Minimum CWP Rating: 175 psig.

8. Maximum Operating Temperature: 200 deg F.
9. Each valve shall have an identification tag attached by chain, and be factory marked with the zone identification, valve number, and flow rate.
10. Fitted with pressure and temperature test valves.
11. Equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case.

2.02 AIR-CONTROL DEVICES

A. Manual Air Vents:

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

    a. Amtrol, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett Domestic Pump.
    d. Taco, Inc.

2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Manually operated with ball valve in the down position.
6. Inlet Connection: NPS 1/2.
7. Discharge Connection: NPS 1/8.
8. CWP Rating: 150 psig.
9. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

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

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Hoffman Specialty ITT Fluid Handling Div.
   d. Spirax-Sarco.
   e. Taco, Inc.
   f. Honeywell-Baukman.

2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

C. Bladder-Type Expansion Tanks:

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

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett ITT Fluid Handling Division.
   d. Taco, Inc.

2. Tank: Welded steel, rated for 125-psig working pressure and 240 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Replaceable butyl rubber bladder securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Access: Drain fitting and taps for pressure gage. Port for bladder replacement.
6. Support:
   a. Vertical tanks with floor mounting skirt.

D. Tangential-Type Air Separators:

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

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump.
d. Taco, Inc.

2. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank. Provide automatic air vent.
4. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
5. Blowdown Connection: Threaded.
6. Size: Match system flow capacity.

2.03 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

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

a. Armstrong Machine Works.
b. Hoffman Specialty ITT; Fluid Handling Div.
c. Metraflex Co.
d. Spirax Sarco.
e. Trane Co.
f. Tyco-Grinnell.
g. Tour & Andersson; (available through Victaulic Company).
h. Watts Regulator Co.

2. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: Stainless-steel, or perforated stainless-steel basket:

a. 20-mesh strainer.

5. CWP Rating: 125 psig.

B. Duplex Basket Strainers:

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

a. Crane Co.
b. Metraflex Co.
c. Spirax Sarco.
d. Stayflow, Div. Flexicraft, Inc.
e. Tyco-Grinnell.
f. Tour & Andersson; available through Victaulic Company.

2. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover, nitrile seals and bottom drain connection.

3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger. Clamped cover restraint.
4. Duplex chamber strainer with internal bronze diverting valve to maintain full flow in one chamber while second chamber is open for cleaning the strainer.
5. Strainer Screen: Perforated stainless-steel basket with 50 percent free area:
    a. 20-mesh 304 stainless steel strainer.
    b. 1/8” diameter basket perforations.
6. CWP Rating: 200 psig at 150 deg F.
7. 1-inch drains fittings on both chambers, ¼-inch NPT chamber vent fittings and ¼-inch NPT gauge taps on inlet and outlet.
8. Provide spare basket.

C. Stainless-Steel Braided-Corrugated, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Amber-Booth.
    b. Mason Industries.
    c. Metraflex Co.
    d. Twin City Hose.
2. Body: 321 Stainless-steel close pitch corrugated hose with woven, flexible, 304 Stainless-steel, protective jacket.
3. End Connections: Flanged, ANSI Class 150 carbon steel
4. Performance: Permanent Offset; 3/8 inch, Intermittent Offset; 1/8 inch.
5. Safe Working Pressure: 150 psig. (up to 8-inch diameter)
6. Maximum Operating Temperature: 200 deg F. (up to 8-inch diameter)

D. Spherical, Rubber, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Amber-Booth.
    b. Mason Industries.
    c. Metraflex Co.
    d. Twin City Hose.
2. Body: Double-sphere fiber-reinforced EPDM rubber body.
3. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
4. Performance: Capable of misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.
7. Limits: Cables permanently affixed to flanges to prevent joint from extending past its limits.

E. Expansion Fittings: Comply with requirements in Section 23 0516 "Expansion Fittings and Loops for HVAC Piping.

F. Diverting Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Taco, Inc.
2. Body: Cast Iron or Wrought Copper
3. Ends: Threaded or Soldered
4. Flow Direction: Indicated on fitting.
5. CWP Rating: 125 psig.
6. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.01 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff Duty: Ball, and butterfly valves.
2. Throttling Duty: Globe, ball, and butterfly valves.

B. Install shutoff-duty valves at each branch connection to supply mains and at supply connections to each piece of equipment.

C. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment and elsewhere as indicated on plans.

D. Install calibrated-orifice, balancing valves at each branch connection to return main.

E. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal unit.

F. Install check valves at each pump discharge and elsewhere as required to control flow direction.

G. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

H. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.02 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Automatic air vents may cause damage to ceilings and other finished surfaces. Air vents aid in system filling. Air removal after initial startup is accomplished by air separator or boiler diptube. Manual air vents may be a better solution.

C. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION

SECTION 23 2123

HYDRONIC PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Close-coupled, end-suction centrifugal pumps.
3. Wet rotor, inline pump

1.03 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, shipping weights, installed weights, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.
    a. Detail all wiring systems and differentiate clearly between manufacturer-installed and field-installed wiring.

1.05 CLOSEOUT SUBMITTALS

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

1.06 QUALITY ASSURANCE

A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

B. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

C. Regulatory Requirements: Fabricate and test steam condensate pumps to comply with HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.08 COORDINATION

A. Coordinate size and location of concrete bases.

PART 2 - PRODUCTS

2.01 FACTORY STOCK CIRCULATORS

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

1. Armstrong Pumps Inc.
2. ITT Corporation; Bell & Gossett.
3. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
4. TACO Incorporated.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, in-line or motor mounted pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rated for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded or threaded companion-flange or union-end connections or unions at connections for casings that are not available with threaded companion flanges.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
3. Pump Shaft: Steel, with oil lubricated copper-alloy shaft sleeve.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings:
   a. Oil lubricated, bronze-journal.

D. Motor: Single speed and rigidly or resiliently mounted to pump casing.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   a. Enclosure: Open, dripproof.
   b. Enclosure Materials:
      1) Cast iron.
   c. Motor Bearings: Permanently lubricated ball bearings.
   d. Efficiency:
      1) Premium efficient.
   e. Service Factor: 1.15

2.02 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

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

1. Armstrong Pumps Inc.
2. ITT Corporation; Bell & Gossett.
3. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
4. TACO Incorporated.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded or threaded companion-flange or union-end connections or unions at connections for casings that are not available with threaded companion flanges.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft: Steel, with oil lubricated copper-alloy shaft sleeve.

4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings:
    1. Oil lubricated, bronze-journal.

D. Motor: Single speed and rigidly or resiliently mounted to pump casing.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
    a. Enclosure: Open, dripproof.
    b. Enclosure Materials:
        1) Cast iron.
    c. Motor Bearings:
        1) Grease-lubricated ball bearings.
    d. Efficiency:
        1) Premium efficient.
    e. Service Factor: 1.15

2.03 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

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

1. Armstrong Pumps Inc.
2. ITT Corporation; Bell & Gossett.
3. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
4. TACO Incorporated.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rated for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, bronze fitted, with drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and threaded flanged or companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. ~~For constant-speed pumps,~~ Trim impeller to match specified performance.
3. Pump Shaft:
    a. Steel, with oil lubricated copper-alloy shaft sleeve.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

5. Pump Bearings:
   a. Oil lubricated, bronze-journal.

D. Motor: Single speed and rigidly mounted to pump casing with integral pump support.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

   a. Enclosure: Open, dripproof.

   b. Enclosure Materials: Cast iron.

   c. Motor Bearings: Grease-lubricated ball bearings.
   d. Efficiency:
      1) Premium efficient.
   e. NEMA Design: <Insert designation>.
   f. Service Factor: 1.15

2.04 WET ROTOR, INLINE PUMPS

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

1. Armstrong Pumps Inc.
2. ITT Corporation; Bell & Gossett.
3. Patterson Pump Co.; a subsidiary of the Gorman-Rupp Co.
4. TACO Incorporated.

B. Components

1. The pumps shall be a wet rotor inline pump, in cast iron or lead free stainless steel body construction specifically designed for quiet operation. Suitable standard operations at 230° F and 175 PSIG working pressure. The pump internals shall be capable of being serviced without disturbing piping connections.
2. The pump internals shall be capable of being serviced without disturbing piping connections.
3. Pump shall be equipped with a water-tight seal to prevent leakage.
4. Pump volute shall be of a cast iron design for heating systems or lead free stainless steel for domestic water systems. The connection style on the cast iron and stainless steel pumps shall be flanged.
5. Flange to Flange dimension shall be standard Bell & Gossett booster sizes such as 6-3/8”, 8-1/2”, 11-1/2”, and 12”. Flange dimensions shall be HVAC industry standard 2 or 4 bolts sizes.
6. Motor shall be a synchronous, permanent-magnet (PM) motor and tested with the pump as one unit. Conventional induction motors will not be acceptable.
7. Each motor shall have an Integrated Variable Frequency Drive tested as one unit by the manufacturer.
8. Integrated motor protection shall be verified by UL to protect the pump against over/under voltage, over temperature of motor and/or electronics, over current, locked rotor and dry run (no load condition).

9. Pump shall have BACnet connections built into the VFD as standard options.
10. Analog inputs, such as 0-10V and 4-20mA, are standard inputs built into the VFD.
11. Pumps shall be UL 778 listed and bear the UL Listed Mark for USA and Canada with on-board thermal overload protection.
12. Pumps shall be UL 778 listed and bear the UL Listing Mark for USA and Canada with on-board thermal overload protection.
13. Each pump shall be factory performance tested before shipment.
14. Operating Modes

    a. Constant Pressure – The pump maintains a constant differential pressure set by the user at any flow demand until the maximum speed is reached.
    b. Delta-P-Delta-T – This control mode is paired with proportional or constant pressure mode. The nominal differential pressure setpoint will vary according to the differential temperature between the built-in temperature sensor and external temperature sensor.

2.05 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

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

3.02 PUMP INSTALLATION

A. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

B. Comply with HI 1.4.

C. Install pumps in accordance with manufacturer’s instructions.Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

E. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

F. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03 “Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

G. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers elastomeric hangers of size required to support weight of in-line pumps.

1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.03 ALIGNMENT

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

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.04 CONNECTIONS

A. Comply with requirements for piping specified in Division 23 Section "Steam and Condensate Heating Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install check, shutoff, and throttling on discharge side of pumps.

E. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

F. Install suction diffuser and shutoff valve on suction side of vertical-inline and base-mounted pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

I. Install thermometers at pump suction and discharge.

J. Install check valve and gate or ball valve on each condensate pump unit discharge.

K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

L. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.05 STARTUP SERVICE

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

   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Perform the following startup checks for each pump before starting:

      a. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.
      b. Verify bearing lubrication.
      c. 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.
      d. Verify that pump is rotating in the correct direction.

   5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
   6. Open cooling water-supply valves in cooling water supply to bearings, where applicable.
   7. Open cooling water-supply valves if stuffing boxes are water cooled.
   8. Open sealing liquid-supply valves if pumps are so fitted.
   9. Open warm-up valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
   10. Open circulating line valves if pumps should not be operated against dead shutoff.
   11. Start motor.
   12. Open discharge valve slowly.
   13. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
   14. Check general mechanical operation of pumps and motors.
   15. Close circulating line valves once there is sufficient flow through pumps to prevent

overheating.

B. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
3. Review data in maintenance manuals. Refer to Division 1 Section Contract Closeout.
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 23 2123

SECTION 23 2300

REFRIGERANT 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 refrigerant piping used for Variable Refrigerant Flow (VRF) Heat Recovery Systems applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
   2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
   3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot-gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

C. Shop Drawing Scale: 1/4 inch equals 1 foot.

D. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Brazing certificates.

B. Welding certificates.

C. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

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

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

B. Any piping delivered to job site that is not sealed on both ends will be rejected.

1.9 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Wrought-Copper Fittings: ASME B16.22.
B. Wrought-Copper Unions: ASME B16.22.
C. Brazing Filler Metals: AWS A5.8.
D. Flexible Connectors:
   1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
   2. End Connections: Socket ends.
   3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
   4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
   5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.2 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT SYSTEMS

A. Refrigerant Piping from Outdoor Units to Indoor Units
   1. Copper Tube: ASTM B 280, Type ACR.
B. Refrigerant piping shall be hard-drawn type L degreased and deoxidized copper tubing with "sil-fos" silver brazed wrought-copper fittings.
C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed.

3.2 REFRIGERANT PIPING INSTALLATION

A. All refrigerant piping shall be brazed without using flux. Only use manufacturer approved flare nuts.
B. Dry nitrogen must be flowing through copper tube during all brazing operations to prevent the formation of copper oxides. Failure to do so will require all piping installed to that point be removed and replaced.
C. 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, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
D. Refrigeration tubing shall be cut (with a pipe cutter) so ends are perfectly square and will "bottom" in fittings. There must be no gaps left through which solder can run into the line. If a hack saw must be used, it shall always be guided with a mitre box to insure a square, even cut. Tubing shall be reamed to remove burrs, being careful not to expand tubing while reaming.
E. Joint shall be heated to proper brazing temperature being sure that it is uniformly hot so brazing material will flow to all parts of the joint. The brazing material shall be fed to the joint until a uniform line of brazing material appears around the pipe at the end of the fittings.
   1. NOTE: Should the Contractor be observed by the job superintendent of any authorized inspected brazing of any part of a refrigeration piping system without proper circulation of inert gas through the lines being worked on, it shall be assumed that the entire system was fabricated in such a manner, and all of the piping installed on that system shall be condemned and promptly removed from the job site at the expense of the Contractor.
   2. All of the foregoing piping shall be examined and, if found to leak, shall be made tight and test repeated until the system is proved tight. All tests shall be verified by the Owner's representative.
   3. Evacuate all piping prior to final charging to 2.5 MM Hg and hold for 24 hours minimum.
   4. Charge the system with clean, dry refrigerant until a proper operation charge has been added.
   5. Pipe covering shall not be installed, nor the piping anchored until testing is completed and all leaks have been properly eliminated.
   6. Install refrigerant piping according to ASHRAE 15.
   7. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

8. 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.
9. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
10. Mark all joint locations on insulation for future locating.
11. Install piping adjacent to machines to allow service and maintenance.
12. Install piping free of sags and bends.
13. Install fittings for changes in direction and branch connections.
14. Select system components with pressure rating equal to or greater than system operating pressure.
15. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
16. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels if valves or equipment requiring maintenance is concealed behind finished surfaces.
17. Install refrigerant piping in protective conduit where installed belowground.
18. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
19. Slope refrigerant piping as follows:
20. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
21. Install horizontal suction lines with a uniform slope downward to compressor.
22. Install traps and double risers to entrain oil in vertical runs.
23. Liquid lines may be installed level.

F. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

G. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

H. Identify refrigerant piping and valves according to Section 230150 "Balancing, Maintenance Manuals, and Identification"

I. Install sleeves for piping penetrations of walls, ceilings, and floors.

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

3.3 PIPE JOINT CONSTRUCTION

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

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

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.

C. Spring hangers to support vertical runs.

D. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

E. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).
10. Support multifloor vertical runs at least at each floor.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

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

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

E. Open shutoff valves in condenser water circuit.

F. Verify that compressor oil level is correct.

G. Open compressor suction and discharge valves.

H. Open refrigerant valves except bypass valves that are used for other purposes.

I. Check open compressor-motor alignment and verify lubrication for motors and bearings.

J. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 2500

CHEMICAL WATER TREATMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes water-treatment systems for the following:

1. Hot-water heating systems.
2. Condenser water systems.
3. Glycol GHEx

B. Samples shall be taken and turned into a testing agency for verification.

C. Related Sections include the following:

1. Division 23 Section “Ground Heat Exchanger”.

1.03 SYSTEM DESCRIPTION

A. Closed System: One bypass feeder on each system, with isolating and drain valves installed around balancing valve downstream of circulating pumps, unless otherwise indicated.

1. Introduce closed system treatment through bypass feeder when required or indicated by test.
2. Hot-water heating and GLHE System Performance: See specification section 238146 Water to Water Heat Pumps section 2.8A for water quality requirements for both the evaporator and condenser side of the heat pump
3. Glycol System Performance: Water treatment sized and equipped to treat raw water available at Project site to sustain the following water characteristics:

a.	Hardness:	less than 200ppm as CaCO3
b.	Sodium Nitrite:	800 —1000 ppm as NaNO2
c.	Conductivity (µmhos):	3000 to 4000 µmhos/cm
d.	Silica:	60 ppm or less.
e.	pH:	9.5 or above.

Water characteristics will change with location and type of treatment - usually the treatment parameters will be left to the water treatment supplier based on the type of treatment specified.

4. Closed Circulating Water Systems:

a. Chemicals:

1) Liquid Alkaline Cleaner
2) Non-Chromate, Borate-Nitrite corrosion inhibitor

b. Equipment: (To be mounted as per drawings)

1) One (1) Neptune VTF5-HP bypass feeder for each system.
2) One (1) Carlon water meter model 705JL or Seametrics Series MDT-075 to be installed in the make-up water line of each closed system.

c. Cleaning: Cleaning shall be performed by the contractor under the supervision of the chemical supplier at the time of start up. The system shall be filled with water and checked for leakage and debris. Add the proper dosage of liquid alkaline cleaner and circulate for 24 hours at required temperature. Drain and flush piping, clean the strainers. Flush until system pH is no more than eight.
d. Control: The contractor shall provide a Sodium Nitrite drop test kit for checking the concentration of sodium nitrite in the system.
e. Service: The contractor shall provide initial and continuing field service to fulfill the requirements and objectives of the General Water Treatment Specifications.

B. Condenser Water Treatment: Automatic systems for inhibitor, bleed and biocide activated by water meter on system makeup and conductivity controller in condenser water line.

1. Sequestering agent and corrosion inhibitor pumped from solution tank into condenser water supply to tower. Agitator as required.
2. Timer fed biocide with condenser bleed locked out to ensure biocide retention time.
3. Conductivity controller samples condenser water and operates bleed valve when condenser water pump is operating.
4. Biocide introduced to tower by solution pump according to timed feed. Biocide timer is integral to the conductivity controller.
5. Performance: Water treatment sized and equipped to treat raw water available at Project site.
6. Non-Acid Treatment System: (basic conductivity control)
7. Chemicals:
8. PECO 4961 Polymeric and Anti-foulant Condenser Water Treatment;
9. PECO 7445 Biocide – THPS;
10. PECO 7420 Biocide – Gluteraldehyde
11. Equipment: (to be mounted as per drawings)
12. One (1) LMI DC400 Conductivity Controller
13. One (1) contacting water meter to be sized for makeup line to cooling tower. Meter to produce one contact per 10 gallons of water makeup to the cooling tower.
14. One (1) Belimo Motorized ball valve for bleed. Valve to be sized appropriately for operating conditions of the cooling tower. Valve shall be fail-safe closed.
15. One (1) Apollo 70 ball valve sied to match motorized ball valve.
16. Two (2) Walchem EK-B16 series Chemical Metering Pump.
17. One (1) Power Engineering pump and control stand.
18. One (1) Power Engineering Injection Assembly.

Note: The pump and control stand shall be free standing and shall accommodate the chemical feed pumps and controller. The controller shall be mounted at the height appropriate for convenient visual inspection. The pumps shall be mounted at a height to easily accommodate pumping the chemical treatment from a 30 gallon shipping container.

Control: Contractor shall provide a Water Analysis drop test kit for Alkalinity, Hardness, and Chlorides analysis and adequate supply of reagents to test for chemical dosages and bleed off requirements.

C. Closed Loop Glycol Feed Systems:

1. Glycol Building : The glycol provided shall be inhibited ethylene glycol as manufactured by Dow Chemical or Huntsman. Trade name shall be Dowtherm SR-1 or Huntsman equal. The water quality in the preheat glycol water system shall meet the recommendations of the glycol manufacturer so as to reduce sludging. Glycol percentage shall be 30%, by volume, unless noted otherwise on the drawings.

2. Glycol GHEx: The glycol provided shall be DowFrost HD propylene as manufactured by Dow Chemical or Huntsman equivalent. The water quality shall meet the recommendations of the glycol manufacturer as well as 238146 Water to Water Heat Pump manufacturers' recommendations. Glycol percentage shall be 25%, by volume, unless noted otherwise on the drawings.

D. Equipment per each system:

1. 50 gallon polyethylene feed tank. Tank shall be mounted on a steel frame with accommodations for mounting a pump underneath. Tank shall be supplied with a hinged lid and all interconnecting piping to pump including strainer.

2. Level switch to deactivate pump and activate alarm on low level.

3. Control panel to house switching device for pump, audible alarm, HOA switch for pump, lights to indicate power and low level, pushbutton for alarm silence. Enclosure shall be NEMA 12. Control panel shall be mounted on the tank stand.

4. 1/3 HP rotary gear pump to be mounted under the feed tank. Materials of construction shall be bronze. Pump shall provide 3 GPM at 60 PSIG.

5. ASCO Solenoid valve 1/2" to be mounted in the feed line to the hot/chilled system. The valve shall be activated at the same time as the pump.

6. Honeywell pressure switch set at 50 (adjustable) PSIG to activate the glycol feed pump. Differential setting for the pressure switch shall be 10 (adjustable) PSI.

F. The water treatment contractor shall provide the cleaning chemicals and glycol for the entire GLHE system including loop field outside and system inside of the building. Refer to specification section 238146 Water to Water Heat Pumps section 2.8A for water quality requirements for both the evaporator and condenser side of the heat pump.

1.04 QUALITY ASSURANCE

A. Supplier Qualifications: A recognized chemical water treatment supplier with warehousing facilities in the Project's vicinity and that is or employs an experienced consultant, available at reasonable times during the course of the Work to consult with Contractor, Architect, and Owner about water treatment.

B. Chemical Standards: Meet state and local pollution-control regulations.

C. Comply with NFPA 70 for components and installation.

D. 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.
2. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.

1.05 MAINTENANCE

A. Service Period: Provide chemicals and service program for period of one year from startup date of equipment, including the following:

1. Initial water analysis and recommendations.
2. Startup assistance.
3. Training of operating personnel.
4. Periodic field service and consultation.
5. Customer report charts and log sheets.
6. Laboratory technical assistance.

1.06 EXTRA MATERIALS

A. Furnish the following extra materials, matching products installed, packaged with protective covering for storage and with identification labels clearly describing contents.

B. Chemicals: Furnish quantity equal to 50 percent of amount initially installed (or treatment for one year.)

1.07 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each type of product specified. Include manufacturer's technical product data, rated capacities of selected equipment clearly indicated, water-pressure drops, weights (shipping, installed, and operating), furnished specialties, accessories, and installation and startup instructions.

C. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Chemical Water Treatment Products:

a. West
b. Power Engineering

2.02 CHEMICAL WATER TREATMENT SYSTEM

A. Bypass (Pot) Feeders: Cast iron or steel, for introducing chemicals into system; with funnel, shutoff valve on top, air release valve on top, drain valve on bottom, and re-circulating shutoff valves on sides.

1. Capacity: 5 gal.
2. Working Pressure: 125 psi.
3. Working Pressure: 175 psi.

B. Positive Displacement Diaphragm Pump: Adjustable flow rate; thermoplastic construction; continuous-duty, fully enclosed electric motor and drive; and built-in relief valve.

C. Positive Displacement Piston Pump: Metal and thermoplastic construction; continuous-duty, fully enclosed electric motor and drive; and built-in relief valve.

D. Cold-Water Meter: Positive displacement type with sealed, tamperproof magnetic drive; impulse contact register; single-pole, double-throw, dry-contact switch.

E. Solenoid Valves: Forged-brass body, globe pattern, normally open or closed as required, general-purpose solenoid enclosure, and continuous-duty coil.

F. Electronic Timers: Infinitely adjustable over full range, 150-second and 5-minute range, mounted together in cabinet with HAND-OFF-AUTOMATIC switches and status lights.

G. Condenser Water Treatment Control Panel: Incorporate solid-state integrated circuits and digital LCD Control dissolved solids on conductivity and include the following:

1. 2 line x 20 character backlit LCD display with IR remote keypad,
2. Temperature compensate sensor probe adaptable to sample stream manifold.
3. Integrate the Cooling Tower Filtration backwash function with the Tower blowdown solids control.
4. Selectable control of inhibitor feed including the following:

    a. Metered make up or blowdown,
    b. Percent time,
    c. Bleed and feed, or bleed then feed.

5. Biocide programmer to include the following:

    a. 24-hour timer with14-day skip feature to permit activation any hour of the day.
    b. Precision, solid-state, bleed-lockout timer (0 to 9 hours) and biocide pump timer (0 to 2.5 hours), clock controlled.
    c. Digital display of time of day (24 hours).
    d. LCD display of day of week (14 days).
    e. Battery back-up so clock is not disturbed by power outages; quartz timekeeping accuracy.
    f. HAND-OFF-AUTOMATIC switches for biocide pumps.

2.03 CHEMICALS

A. Furnish chemicals recommended by water treatment system manufacturer for treating water to seals, and accessories.

B. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.

C. Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install treatment equipment level and plumb, according to manufacturer's written instructions, rough-in drawings, the original design, and referenced standards.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping adjacent to equipment to allow servicing and maintenance.
2. Heat Pump Water Piping: Conform to applicable requirements of Division 23 Section "Hydronic Piping".
3. Hot Water Piping: Conform to applicable requirements of Division 23 Section "Hydronic Piping."
4. GLHP System Piping: Conform to applicable requirements of Division 23 Section "Ground Heat Exchanger".

B. Electrical: Conform to applicable requirements of Division 26 Sections for connecting electrical equipment.

3.03 FIELD QUALITY CONTROL

A. Testing Agency: Provide the services of a qualified independent testing agency to perform field quality-control testing.

3.04 ADJUSTING

A. Sample boiler water at 1-week intervals after boiler startup for a period of 5 weeks and prepare certified test report for each required water performance characteristic. Where applicable, comply with ASTM D 3370 and the following standards:

1. Silica: ASTM D 859.
2. Steam System: ASTM D 1066.
3. Acidity and Alkalinity: ASTM D 1067
4. Iron: ASTM D 1068.
5. Water Hardness: ASTM D 1126.
6. Particulate and Dissolved Matter: ASTM D 1888.

3.05 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris; repair damaged finishes, including chips, scratches, and abrasions.

B. Ensure that system is operational, filled, started, and vented prior to cleaning. Place terminal control valves in OPEN position during cleaning. Use water meter to record capacity in each system.

C. Add cleaning chemicals as recommended by manufacturer.

1. Hot-Water Heating System: Apply heat while circulating, slowly raising system to design temperature; maintain for a minimum of 12 hours. Remove heat and allow to cool; drain and refill with clean water. Circulate for 6 hours at design temperature, then drain. Refill with clean water and repeat until system cleaner is removed.
2. Heat Pump Water System (steel piping in the building): Fill system with clean water and cleaning chemicals as recommended by manufacturer. Circulate system at design temperature for a minimum of 12 hours. Drain and refill with clean water. Circulate for 6 hours at design temperature, then drain. Refill with clean water and repeat until system cleaner is removed. Drain and refill with glycol-water solution.
3. GLHP System Piping: Flush and purge all system piping in accordance with The National Ground Water Association “Guidelines for the Construction of Vertical Boreholes for Closed Loop Heat Pump Systems” and the IGSHPA “Design and Installation Standards” (2000 Edition). Conform to applicable requirements of Division 23 Section “Ground Heat Exchanger”. Drain and refill with glycol-water solution.

3.06 COMMISSIONING

A. Startup Services: Provide the services of a factory-authorized service representative to provide startup service and to demonstrate and train Owner’s maintenance personnel as specified below.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.07 DEMONSTRATION

A. Provide services of supplier’s technical representative for half a day to instruct Owner’s personnel in operation, maintenance, and testing procedures of boiler water treatment system.

B. Train Owner’s maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

C. Review data in the operation and maintenance manuals. Refer to Division I Section “Contract Closeout.”

D. Schedule training with Owner, through the Architect, with at least 7 days’ advance notice.

END OF SECTION

SECTION 232700

GROUND HEAT-EXCHANGER

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.

B. Refer to specification section 230100 “Mechanical Requirements” for applicable Codes and Standards and other general conditions.

1.2 SUMMARY

A. This Section includes the following:

1. Ground Heat Exchanger (GHEx) including:
    a. Borehole system, including borehole, U-Bend assembly and grout.
    b. Header system, including trench, pipe and backfill.
    c. System start-up, including filling, flushing and purging the closed-loop ground heat exchanger.
    d. All other miscellaneous materials and labor.

1.3 GENERAL SCOPE OF WORK

A. An in-situ Thermal Conductivity test was conducted prior to installation of the GHEx. This test and the subsequent report are not a part of the GHEx scope.

1. The test bore holes are not to be incorporated into the GHEx:
    a. Contractor to determine its exact location and condition.
    b. Any discrepancies to be immediately to the engineer’s attention.

B. Provide a complete Ground Heat Exchanger system:

1. The Contractor shall provide a complete closed loop system as shown in the contract documents in accordance with International Ground Source Heat Pump Association (IGSHPA) *Design and Installation Standards,* 2011 ed.

C. The Contractor shall provide:

1. All geo-technical engineering.
2. Permits.
3. Surveys.
4. Underground drilling equipment.

5. Grouting.
6. Piping.
7. Vaults.
8. Valves.
9. Dewatering pumps.
10. Supports,
11. Surface excavation equipment,
12. Test equipment.
13. Other related equipment necessary to provide a complete working system as designed.

D. The drilling contractor shall be responsible for:

1. Purchasing and providing water for all work pertaining to this section.
2. A water meter, if required, must be obtained and leased from the water department.

E. Drilling methods used (rotary, air, mist, mud, etc.) are at the discretion of the Contractor. Core drilling of existing building walls to bring piping into the building to be the responsibility of the Contractor.

F. Timely completion of the Contractors Scope of Work is imperative. The contractor must coordinate with other trades and coordinate with overall completion schedule.

G. The Contractor is required to contact the owner minimum of 48 hours prior to backfilling any bore holes, trenches, etc.

H. All necessary excavations, backfilling and backfilling materials for this phase of the project shall be provided as work of this Division. Work shall conform to Division 2.

I. Contractor shall return borehole site to rough grade upon completion of GHEx installation.

J. The Contractor will be responsible for flush and purge, and testing of all GHEx system piping. Refer to Part 3.

K. Subfields:

1. Subfields must be drilled and headered in a sequence determined by the General Contractor.
2. Unless otherwise instructed by the owner's representative or Architect's Engineer, all subfields will be fully completed prior to moving to the next subfield.
3. It is the contractor's responsibility to inspect and verify site conditions.
4. All bids must reflect the full price to supply the necessary products and install the GHEx.
5. The plans require drilling new borehole and the emplacement of heat exchanger piping in the boreholes:
    a. The completed depth shall be determined by the placement of the U-Bend.
    b. The distance from the bottom of the U-Bend to the surface shall constitute the completed bore depth.
6. All vertical boreholes shall be of the minimum specified depth:
    a. There shall be no variations less than the specified depth.

b. Any variations of more than **10 vertical feet**, greater than the specified depth, shall be approved by the Engineer.

7. Supply and install HDPE-to-Victaulic (or equivalent) transition fittings on each subfield supply and return line in the manifold and pump room.

8. Terminate each return line from the GHEx with a calibrated balance valve.

9. The contractors are responsible for:

a. The core drilling and sealing of piping penetrations thru the foundation walls as necessary to accommodate their work;

1) Modular sealing units, designed for field assembly to fill the annular space between the pipe and opening shall be provided to create a waterproof seal.

2) Sealing units shall be constructed of EPDM and stainless steel materials. Pipes shall be sealed using Link Seal or other approved method.

L. Description of Site:

1. The contractor is responsible:

a. To visit the site and evaluate the conditions therein.

1) The drilling log(s) are attached to this section.

2) The contractor shall be responsible for ways and means of trenching and drilling.

2. Site conditions:

a. There are trees, power poles, overhead utility lines, etc. all within the GHEx site that need to be considered and coordinated with the GHEx installation.

1.4 SUBMITTALS

A. Product Data:

1. Material Specifications of all:

a. Piping and related equipment.

b. Drilling fluids.

c. Grouting materials to be used including:

1) Thermal conductivity, permeability, percent solids, grout weight, linear shrinkage potential, maximum particle size and unit yield along with verification of the required listing(s).

2. MSDS information on all products used in heat exchanger liquid or that have been used in conjunction with drilling and/or grouting of the boreholes.

a. All submittals must be provided and approved by the architects engineer prior to commencement of work.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Firms regularly engaged in installation of closed-loop GHEx, and/or projects of similar scope; whose installations have been in satisfactory use in similar service for not less than **5 years**.

B. Installer Qualifications: Fabricator of products.

1. Fabricators:

a. Must have completed a certification training program offered by the IGSHPA or approved manufacturer's certification program and shall have at least **2 years** of successful installation experience.

2. Coupling of piping:

a. The only acceptable method of joining buried HDPE pipe systems is by heat fusion process.

b. Each ground heat exchanger fabricator must have performed a fusion procedure under direct supervision of one of the following;

1) An IGSHPA Certified Heat Fusion Technician.

2) An IGSHPA approved manufacturer's certification program.

3) A DOT certified heat fusion technician.

c. Each certified technician must attend a retraining school annually.

C. Manufacturer Qualifications:

1. Firms regularly engaged in the manufacture of closed-loop GHEx products and tools of the types, materials and sizes required;

a. Whose products have been in satisfactory use in similar service for not less than **3 years**.

b. Whose products have been approved by the IGSHPA for GHEx use.

2. Manufacturer(s) supplying HDPE must be:

a. Regularly engaged in the manufacture of GHEx products and tools of the types, materials, and sizes required and the product supplied must be approved by IGSHPA for GHEx use.

D. Testing and Inspection:

1. Work shall be tested by the contractor at each stage of installation prior to backfilling. The Owner's representative shall examine installed work and review testing results. Final acceptance testing must be performed in the presence of the Owner's representative.

a. Sections of work backfilled without examination by Owner's representative will be re-excavated at the contractor's expense.

b. Contractor shall coordinate with Owner's representative to schedule required examinations. Contractor will provide a minimum of 48-hour notice prior to examination.

2. In accordance with International Mechanical Code (v2015), 1210.10 Tests:

a. Contractor shall, at the contractor's expense, facilitate investigation and corrective action should test results for flow and pressure loss deviate from calculated design values by more than 10 percent.

1.6 DELIVERY, STORAGE, AND HANDLING

A. All pipe and fittings are to be sealed to prevent debris, small animals and other foreign materials from entering the piping system.

B. Palletized bentonite grouting materials are to be protected from the weather with a protective covering.

1.7 WARRANTY

A. The pipe manufacturer shall provide a minimum warranty of **20 years**. The warranty shall be transferable.

1. Piping shall be guaranteed from material defects for a minimum of **5 years**. This shall include all material and labor to replace the faulty piping.

B. The total operation and integrity of the GHEx shall be guaranteed for **5 years** from placement of the system in service to allow for annual temperature cycling and settlement to occur.

1. Contractor shall be responsible to replace/repair all defects in the system and any directly related conditions caused by his work such as, but not limited to:

a. Sink holes.

b. Piping leaks caused by improper back-filling or fusing.

c. Freezing of the fluid due to improper burial or insulation.

d. Inadequate heat transfer due to uneven flow through circuits or bore holes caused by poor installation.

1.8 ENVIRONMENTAL IMPACT

A. Aquifers:

1. Aquifers shall be protected and reported as per state and local requirements. Provide oils, grease, and lubricants that are environmentally safe and of a quality used when encountering groundwater.

B. Protective shielding:

1. Pads, bras, or plastic sheeting shall be used under the drill rig and other equipment.

C. Make Up:

1. Use potable water for make-up of drilling fluids and grouts.

D. Drilling fluids:

1. Drilling fluids and drilling fluid additives shall be environmentally safe.

E. Dispose of drilling fluids:

1. Disposal of the drilling fluids, cuttings, and spoils shall be in accordance with local codes. Onsite disposal is acceptable if:

a. Permitted by state and local codes.

b. All products used in the drilling operation shall be environmentally safe.

c. The surface fluids are controlled in such a manner as not to interfere or hinder with other contractors or the timely progression of the project.

1.9 RECORD DRAWINGS

A. Submit scaled As-Built drawings indicating GPS coordinate locations of:

1. Bore holes.
2. Bore hole depth.
3. Amount of installed U-Bend.

B. Drawings shall include:

1. Diameter and number of bore holes and details of:
   a. Installed bores.
   b. Trenches.
   c. Building penetrations.
2. Grouting procedures prior to final inspection.

C. Additionally, Contractaor will:

1. Provide copies of all required site logs and records.
2. Annotate critical GPS locations.

D. The contractor shall maintain current records on the site at all times that show: Time, date, location, total depth and diameter of all bore holes.

1. Time, depth and results any mud tests.
2. All drilling fluid materials added to the system.
3. Any noticeable variations in lithology.
4. Density and volume of grout used on each borehole.

PART 2 - PRODUCTS

2.1 MATERIALS

A. High Density Polyethylene (HDPE) Piping: The only acceptable pipe and fittings material for the underground portion of the ground heat exchanger is high-density polyethylene. Specifications for the polyethylene heat exchanger are as follows:

1. General: All pipe and heat-fused material shall be manufactured from virgin polyethylene extrusion compound material in accordance with ASTM D-2513, Sections 4.1 and 4.2. Pipe shall be manufactured to outside diameters, wall thickness and respective tolerances as specified in ASTM D-3035 or D-2447.
2. Material: The material shall maintain a **1600 psi** Hydrostatic Design Basis at **73.4 deg. F** per ASTM D-2837, and shall be listed in PPI TR4 as either a PE3608 or PE4710 piping formulation.

3. Dimensions:
    a. Pipe with a diameter of less than **1-1/4 inches** (nominal) shall only be manufactured in accordance with ASTM D-3035 with a dimension ratio of **11**.
    b. Pipe with a diameter of **1-1/4 inches** (nominal) through **2 inches** (nominal) shall be manufactured in accordance with ASTM D-3035 with a minimum dimension ratio of 11 or maximum dimension ratio of 15.
    c. Pipe with a diameter or 3 **inches** (nominal) and larger shall be manufactured in accordance with ASTM D-3035 with a dimension ratio of 15.
4. Table of Water Pressure Rating at **73.4 deg. F** for DRPR PE3408 Plastic Pipe.

Dimension Ratio	Pressure Rating, psi
11	**160**
15	**110**

5. Marking/Locating:
    a. Sufficient information, including numerical markings every **2 feet**, shall be permanently marked on the length of the pipe. This information is defined by the appropriate ASTM pipe standard.
6. Certification Materials: The pipe manufacturer shall supply a notarized document confirming compliance with the above specifications.

B. U-Bend Assembly:
1. Shall be DR-11, High Density Polyethylene pipe (HDPE).
2. The U-Bend assembly for the vertical bore hole shall be factory manufactured or shop fabricated in a controlled environment and randomly tested at **100 psi** under quality control conditions prior to delivery to the job site, and
3. Assembly shall be constructed of the same material designation as the heat exchanger piping.
4. Each U-Bend assembly shall be factory or shop assembled using twice the required length of pipe and a fusion joined **180°** bend attached in the mid-point of the pipe, so as to create a continuous flow path for the full length of the assembly.
5. After completion:
    a. Both open ends shall be sealed with a cap, plug or tape.
    b. Reasonable care shall be taken so as not to crush, cut or kink the pipe during transportation to the job site.
6. If damaged, the area of damage shall be removed and replaced, at no additional cost to the owner.

C. Header and circuiting piping:
1. Shall be DR-15 HDPE piping of size indicated on the drawings.
2. All buried HDPE pipe shall conform to IGSHPA designated ASTM cell classifications, see closed Ground Heat Exchanger Materials section below.

D. Tracers/Locators:
1. Tracer/Locater Wire: AWG 2#18.
2. Tracer Wire Fittings: Connectors shall be waterproof.

E. Manufacturers: Subject to compliance with requirements, provide HDPE piping, materials and equipment certified for use in GHEx systems by one of the following manufacturers:

1. HDPE Piping:
    a. Arnco.
    b. Centennial Pipe, Inc.
    c. Chevron-Phillips Performance Pipe.
    d. Lamson Vylon Pipe.
    e. ISCO.
    f. WL Plastics.
2. U-bend Assembly:
    a. Centennial Plastics, Inc., Earth Loop
    b. Chevron Phillips Chemical Company, Performance Pipe Division
3. HDPE Pipe Fittings:
    a. Centenial Pipe, Inc.
    b. Central Fittings.
    c. Chevron-Phillips Performance Pipe Fittings.
    d. Lamson Vylon Pipe.
4. Transition Fittings:
    a. Central Plastics.
    b. Poly Cam.
5. Tracer Wire Fittings:
    a. Northstar Industries – SureSplice SK 14-12G.
    b. 3M Brand- DBY Direct Bury Splice Kit.
6. Grout/Thermal enhancement material:
    a. GeoPro, Inc.
    b. Baroid Industrial Drilling Products
    c. CETCO Minerals Technologies

F. Grouting Materials:

1. General:
    a. Bentonite.
    b. Thermally-enhanced.
    c. Complianance with IGSHPA standards specified in their publication “Grouting Procedures for Ground-source Heat Pump Systems” and local and state requirements.
    d. Shall be used to fill the annulus between the U-Bend assembly and the borehole wall.
    e. Grout shall be pumped from the bottom of the bore to surface grade with a tremie pipe insuring:

1) Proper thermal contact between the closed-loop heat exchanger and the earth.

2) Environmental integrity of each vertical bore column.

2. Permeability:

a. The grout mixture shall have a maximum permeability rate of less than **1x10-7 cm/s** as determined by using ASTMD-5084, “Measurement of Hydraulic Conductivity of Saturated, Porous Materials using a Flexible Wall Permeameter, Method C - test with increasing tailwater level".

b. The reported permeability shall be verified by an independent lab with a copy of the report being supplied upon request from the design engineer.

c. The laboratory verifying hydraulic conductivity shall be certified by AMRL (American Association of State Highway & Transportation Officials, Materials Reference Laboratory) and validated by the US Army Corps of Engineers to perform ASTM D-5084 at the time of verification.

3. Grouting compound shall be certified and listed by NSF (National Sanitation Foundation International) to ANSI/NSF Standard 60, "Drinking Water Treatment Chemicals - Health Effects".

4. Thermal Conductivity:

a. The thermal conductivity of the grouting compound must be **1.07 Btu/hr-ft-deg. F** or greater as determined when tested in accordance to ASTMD-5334, “Standard Test Method for Determination of Thermal Conductivity of Soils and Soft Rock by Thermal Needle Probe Procedure”.

b. The Reported value shall be verified by an independent company which has a minimum of **5 years** experience in measuring thermal conductivity using this method. A copy of the verification report shall be supplied upon request of the engineer.

c. Accurate grout records, inclusive of grout tremie depth and units used, must be kept.

1) These records must be available on the jobsite from day-to-day.

2) A summary report of the grouting operation must be provided to the architects engineer or engineer’s representative for the cumulative drilled boreholes by the 25th day of each month.

3) From time-to-time, the contractor may be requested to provide samples of the mixed grout for independent testing to determine field-mixed density, thermal conductivity, and permeability.

5. Pumping Equipment:

a. Contractor is responsible for supplying the correct pumping equipment for the grout specified.

6. Approved Grouting:

a. Portland or cement based grouts are not acceptable.

b. All grouting clays must be NSF approved.

G. Bedding Material:

1. The Contractor shall purchase, import, provide and install moisture conditioned sand bedding for all trenches.Horizontal Backfill Material:

1. Material shall be stockpiled on the site:
    a. In a location directed by the architect.
    b. If surplus or unsatisfactory material may be used for other material needs if deemed appropriate for the use per the contract specifications.
    c. Any native material used for backfill of trenches shall be 4" diameter or smaller and free of vegetation and debris.
2. Topsoil:
    a. Shall be of uniform composition, free of stones, lumps, live plants and their roots, sticks and other extraneous matter.
    b. Shall have a **pH** of **5.0 to 7.0** and contain not less than 3 percent organic matter.
    c. Topsoil that is suitable for use on site may be stockpiled at the site.
    d. Contractor shall provide new topsoil that is similar in characteristic to that found at the project site where required.
3. Earth Fill:
    a. Approved type of soil classified, in accordance with ASTM D-2487, as GW, GP, GM, SW, SP, SM, SC, ML or CL.
    b. Shall be free of foreign substances.
    c. Shall be obtained from excavation on this project or other approved source.
    d. Shall have a plasticity index between **7.5** and **17**.
4. Granular Fill:
    a. Shall include clean, natural or prepared gravel, gravel-sand mixtures, sands or gravely sands with little or no fines.
    b. A minimum of **95%** shall be retained on a **No. 200** sieve.

I. Drilling Fluids:
1. All drilling fluids shall comply with state and local codes and shall be utilized as directed by the manufacturer.
    a. Commercially processed clays added shall meet or surpass the viscosity specification per the American Petroleum Institute standard “Std. 13-A For Drilling Fluid Materials”.
2. Toxic or Dangerous materials shall not be used as additives in the drilling fluid.
3. All drilling fluid additives shall comply with recognized industry guidelines, practices, and local codes. Revise pressure ratings in "Ground-Loop, Heat-Pump Piping Minimum Working Pressure" Paragraph below to suit Project. Coordinate with Section 238146.13 "Water-to-Air Heat Pumps."
4. The drilling contractor is responsible for all water requirements.

J. GHEx Antifreeze:
1. The loop field antifreeze will be supplied by Division 23.
2. Antifreeze shall be provided by the same manufacturer for both the GHEx and building side piping.
3. Water used for the GHEx shall be:

a. De-ionized water or shall be a suitable water source that does not contain more than the **25 parts per million (ppm)** of chloride, sulfate, calcium or magnesium.

4. **25%** propylene glycol/potable water solution will be final loop circulating fluid.

PART 3 - EXECUTION

3.1 GROUND HEAT EXCHANGER DESCRIPTION

A. The GHEx shall consist of a number of vertical bores in an array as depicted in the project drawings and details.

3.2 EXAMINATION

A. Examine areas and conditions under which ground heat exchanger systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to manufacturer's recommendations.

B. Coordinate locations of GHEx piping runs with other utilities:

1. Contractor is responsible for locating all site utilities and other obstructions which would interfere with the GHEx installation, and making provision to avoid, relocate or repair said utilities and/or obstructions.

2. Cease work and inform the owner's representative immediately if any utilities or obstructions as described above are encountered that were previously unidentified.

C. Borehole locations and header pipes shall be adjusted, as necessary, to maintain a minimum distance from Owner's property line of **5 feet**.

3.3 CLEANLINESS

A. During installation, trash, soil, small animals and other foreign debris shall be kept out of the pipe. Ends of HDPE pipe shall be taped or fusion capped until the pipe is joined to the circuit.

B. Vertical boreholes shall be clean (no permanent casing) and of sufficient diameter to facilitate the installation of the U-Bend assembly.

3.4 INSTALLATION OF COMPONENTS

A. Bore Hole, Installation: Drill bore hole in accordance with local, State or Federal requirements:

1. Borehole alignment shall be as close as reasonably possible to the grid supplied in the drawings.

2. Borehole locations and header pipes shall be adjusted, as necessary, to maintain a minimum distance from Owner's property line of **5 feet**.

The maximum bit OD shall not exceed **5 ⅛ inches**.

3. If drilling conditions require larger bores, the Contractor shall contact the Engineer before proceeding.

B. Bore Hole, Testing:

1. Immediately prior to the U-Bend assembly being placed in the borehole, it shall be flow tested to ensure that there are no kinks, bends or pinches.
2. The test shall consist of forcing clean water into one end of the assembly, and visually inspecting the discharge.
3. If it is visible that an obstruction exists, the obstructed section of pipe shall be removed and replaced with an equal length section that is free of obstructions and re-attached by heat fusion.

C. HDPE Pipe Joining Methods:

1. The only acceptable method for joining the buried pipe system is by a heat fusion process.
2. Joining shall be the socket, butt, saddle fusion or electrofusion method in accordance with the pipe manufacturer's procedures.
3. The fusion technician shall be properly trained as specified under the Installer Qualifications article, and shall have executed quality fusion joints.
4. All cutout material must be removed from piping.
5. Bell reducer fittings or reducing tees shall be used at all pipe reductions to facilitate the removal of trapped air.

D. U-Bend, Installation:

1. Testing:
    a. Vertical loops shall be pressure tested in accordance with Phillips "Method I Hydrostatic Pressure Test" to **160 psi** with fluid for 45 minutes before and after insertion in the ground.
    b. If pressure cannot be verified at the opposite end of the circuit from the intake end, this is an indication of a collapsed, pinched, or otherwise damaged circuit pipe, and must be replaced.
    c. Special care should be taken with all vertical loops installed utilizing wire-line methods.
    d. Lack of lubrication and/or retrieving the running weights at high speed may cut or otherwise damage the vertical U-Bend assembly.
    e. Any vertical loop that is to be temporarily removed from service, or which is completed for a period of time prior to being placed in service, or is left uncompleted due to a recess or delay in construction shall be equipped with a water-tight cap.
2. Immediately after completion of the bore hole and full removal of all drilling equipment;
    a. The pre-tested, water filled U-Bend assembly shall be inserted into the borehole, U-Bend first.
    b. A stiffener that does not present potential damage to the assembly may be used to straighten the leading section of the assembly and to add counter weight for easier insertion.
3. Care shall be taken so that the sealed pipe ends do not "drop" into the open borehole below graded surface.
4. When bore holes are drilled with a mud, the U-Bend shall be staked and tied to prevent the assembly from "floating" out of the bore prior to the "setting" of the bentonite grout.

E. Grout, Installation:

1. Mixing:

a. All grout shall be mixed in accordance with manufacturer's instructions.

b. Grout density shall be measured and recorded for each batch and for each borehole.

c. Accurate grout records, inclusive of grout tremie depth and units used must be kept.

d. These records must be available on the jobsite from day-to-day.

e. A summary report of the grouting operation must be provided to the architect's engineer or engineer's representative for the drilled boreholes.

f. Grouting records shall be included with "as built" information.

2. Installation:

a. Grout material shall be:

1) Pressure pumped through a one **1 inch**, **1¼ inches** or a **1½ inch** inside diameter tremie pipe.

2) Placed in the bore column from the bottom to the top.

b. Grouting process shall:

1) Conform to the manufacturer's instructions and " Grouting for Vertical Geothermal Heat Pump Systems -- Engineering Design and Field Procedures Manual ", as published by the International Ground Source Heat Pump Association (IGSHPA), 2000 (ISBN: 0-929974-06-9).

c. Grout shall be continued to be pumped while the tremie is being extracted at a rate equal to the rate of material placement, until entire bore column is full and grouting material appears at the surface.

d. All boreholes must be topped off with grout from within **10 feet** of the surface to final grade.

e. All boreholes must be completely filled with grout.

f. Grout levels must be maintained to prevent surface borehole collapse and/or surface contamination from entering the borehole.

g. Reasonable and prudent care shall be taken during installation and grouting in order not to crush, cut, or kink the pipe.

3. Inspection/Testing:

a. Since some settling may occur after initial placement of the grout material, the contractor shall monitor each borehole and continue adding grout as required for a period of no less than **30 minutes** and no longer than **2 hours**.

b. Grouting manufacturer shall:

1) Provide testing of site mixed grouting material to verify thermal conductivity.

2) Provide an analysis of a minimum of three samples for this project.

3) At a minimum, sampling shall be taken at the beginning of the project, at approximately one-third of completion, and at approximately two-thirds of completion.

4) In the event that the analysis indicates a thermal conductivity value below the minimum specified value:

a) Corrective action shall be taken to increase thermal conductivity value back to minimum specified requirement.

b) Contractor shall submit a written report defining corrective action taken.

F. Global Positioning System survey:

1. Locate and record all boreholes and significant points of the well field with GPS instrumentation. This shall include but not be limited to any vaults, circuit reverse returns, and HDPE line corners. This data shall be included in the Record Drawings. Refer to Part 1.

G. Header Systems, Installation:

1. General:

   a. All horizontal piping shall be laid out in accordance with the engineering drawings. Install piping in accordance with manufacturers written instructions.

2. The horizontal ditches for the closed-loop ground heat exchanger header may be dug with a chain type trenching machine or a backhoe.

3. Unless otherwise indicated, excavation shall be by open cut.

4. Perform excavation of every description and of whatever substance encountered to the depths indicated on drawings.

5. During excavation, deposit material suitable for backfill in an orderly manner, a sufficient distance from the excavation banks to avoid overloading and to prevent slides or cave-ins.

6. All large and/or sharp rocks and foreign objects shall be removed from contact with the pipe.

7. Grade as necessary to prevent surface water from flowing into trenches or other excavations, and remove water accumulating therein by pumping or other acceptable method.

8. Keep banks of trenches and excavation for structures as nearly vertical as practicable and where required, properly sheet and brace.

9. Fill unauthorized excavation below levels indicated for pipe with sand.

10. Trench Excavation:

    a. The dirt removed from the trenches shall be stockpiled on the site in a location designated by the Architect.

    b. All piping shall be buried a minimum depth from final grade as shown on drawings.

    c. Grade bottom of trenches accurately to provide uniform bearing and support for each section of pipe on **6 inches** of sand along its entire length.

11. No trenches shall be cut near or under any footings without consultation first with the Architect's office.

12. Any trenches or excavations more than **30 inches** deep shall be tapered, shored, covered, or otherwise made absolutely safe so that no vehicle or persons can be injured by falling into such excavations, or in any way be harmed by cave-ins, shifting earth, rolling rocks, or by drowning.

13. The above protection shall be extended to all persons approaching excavation related to this work whether or not such persons are authorized to be in the vicinity of the construction.

14. De-watering:
    a. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding project site and surrounding area.
    b. Do not allow water to accumulate in excavations.
    c. Remove water to prevent softening of foundation bottoms, undercutting footings and soil changes detrimental to stability of sub-grades and foundations.
    d. Provide and maintain pumps, well points, sumps, suction and discharge lines and other de-watering system components necessary to convey water away from excavations.
    e. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas.
    f. Do not use trench excavations as temporary ditches.
15. Connections:
    a. Header pipes shall be installed and fusion connected to the vertical U-Bend assembly.
    b. The pipe and fittings must be joined using the socket, butt fusion or electrofusion process.
    c. The quantity of fusion joints in the system shall be kept to an absolute minimum.
    d. Turns should be made by bending the pipe according to manufacturer's specifications.
    e. The use of directional fittings should be kept to an absolute minimum.
    f. Reduction fittings shall be used at all pipe reductions to eliminate trapped air.
    g. Step-down, reverse-return headers are to be used. Consult pipe and/or fitting manufacturer for available fittings.
    h. Minimum Radius:
        1) Avoid sharp bends in piping runs. The minimum bend radius shall be determined by the following:

            Minimum Radius = Pipe O.D. (actual) x 25

        2) Saddle fusion fittings shall not be placed on radius bends less than 120 times the pipe diameter.
    i. Use only continuous lengths of pipe in bends. Install elbows fittings for required bends that are tighter radii than calculated above.
    j. Lateral piping supply and return lines or bundles shall be separated in the header trench by **6 inches** of sand to minimize thermal interference between the two bundles.

H. Header Systems, Testing:
1. An additional pressure test shall be performed after lateral piping is connected and before backfilling.
    a. Vertical loops and laterals shall be pressure tested in accordance with Phillips "Method II Hydrostatic Pressure Test" with fluid for **45 minutes to 1.2 times the 50 year** water rated working pressure (WRWP), calculated at the pipe's ambient temperature.

b. Results of the test shall be recorded and supplied to the engineer upon completion of the project.

c. This test shall be performed in the presence of the Architect's Engineer or Owner's Representative. Provide a minimum of **48 hours** notice.

d. NOTE: Phillips "Method II Hydrostatic Pressure Test", Technical Note #35, p. 10-11.

1) This is a two-stage test that tests first the pressure integrity of the piping and then the integrity of the joints.

2) Maximum pressure may exceed the pressure rating of the pipe at the static (ambient) temperature by no more than **20%**. (Ex. **196 psi @ 72 deg. F** for SD-11)

2. Every weld shall be visually and physically inspected, using industry standards, for cold joints.

3. Any joints failing the test shall be completely removed from the system and a new joint or fitting installed with the test being repeated.

4. Under these testing specifications:

a. A minimum of four pressure tests must be conducted.

b. Although high-pressure fluid is preferred, tests 3 and 4 may be performed with high-pressure air to obtain final pressure after all lines have been flushed and are full of fluid.

c. If air is used for tests 3, and 4, the circuit or subfield must then be re-flushed, per section 3.6, to remove any trapped air.

1) Test:

a) Each U-Bend prior to insertion into the borehole. (Air or fluid)

b) Each U-Bend subsequent to installation and grouting. (Air or fluid)

c) Each circuit after headering to the boreholes and prior to connecting to the subfield. (Circuit completely filled with fluid.)

d) Entire completed system from the mechanical room prior to headering to the mechanical room manifold. (System completely filled with fluid.)

I. Header Systems, Backfill:

1. Prepare dimensioned drawings of the complete ground heat exchanger piping system before backfilling.

2. Pipes shall be bedded by hand with a minimum of **6 inches** of moisture-conditioned sand below the pipes, and an additional **6 inches** of moisture-conditined sand above the pipes.

3. Backfilling:

a. Backfill with **4 inches** minus native material a minimum of **8 inches** over sand layer, then compact the trench to **90%** compaction.

b. Finish backfilling the trench with **4 inches** minus native material with **90%** compaction in 8-inches lifts.

4. Tracers/Locators:

a. Provide identification for the underground piping by use of locator wire and metallic tracer tape.

b. All header trenches shall be traced with locator wire and tracer tape.

c. Contractor shall test the tracer wire circuit prior to backfilling the trenches.

5. Care shall be taken to avoid driving construction equipment over newly filled trenches unless bridging is provided to support load over trenches.

J. Building Penetration:

1. The supply and return bundles from the loop fields will penetrate the building as shown on the drawings.

a. Wall or floor penetrations require a sleeve and seal that will prevent water infiltration.

1) Refer to Division 23 Section “Basic Mechanical Materials and Methods” for mechanical sleeve seals.

K. Header Termination: Supply and return headers from each Subfield shall be terminated in the mechanical room as shown on the drawings.

1. Each supply and return header shall have pressure/temperature taps for balancing flow and verifying loop performance.

2. Each supply and return header shall also have flanged, butterfly valves to isolate the Subfield when purging air from the system.

3. Provide flange connections at header ends to couple with the flanged connections on the manifold.

4. All header manifolds shall be constructed to IGSHPA standards and design criteria for 'Long Headers' to facilitate equivalent fluid flow, minimum pressure drop and air removal during purging.

5. All stub lengths between tees shall be the same lengths to maintain fluid flow balance.

6. All lines in the mechanical room must be labeled with proper annotations signifying Subfield, SUPPLY or RETURN, and Direction of Flow.

3.5 FLUSHING AND PURGING

A. General:

1. Before backfilling the trenches, all systems shall be flushed and purged of air and flow tested to ensure all portions of the GHEx are properly flowing.

2. A portable temporary purging unit shall be utilized and shall consist of the following:

a. Purge pump - high volume and high head.

b. Open reservoir.

c. Filter assembly with by-pass.

d. Flow meter.

e. Pressure gauge.

f. Connecting piping.

g. Connecting hoses.

B. Flushing and Purging:

1. Before the system is placed in operation, velocity flushing of all ground heat exchanger piping shall be performed to remove debris and air.

2. Flushing shall be performed at **135%** of design flow, but in no case less than **2 FPS**. Each circuit shall be separately flushed and purged.
3. A closed loop-flushing unit with removable strainers shall be utilized.
4. The flushing shall be considered complete when no less than 3 volumes have been re-circulated through the system without cleaning required in the strainers.
5. Flushing shall be performed for each vertical circuit, before connection to the lateral header.
6. This test shall be performed in the presence of the Engineer or Owner's Representative. Provide **48-hour** notice.

C. Pressure and Flow Testing: Utilizing the purging unit, conduct a pressure and flow test on the ground heat exchanger to ensure the system is free of blockage.

1. If the flow test indicates blockage:
   a. Locate blockage using manufacturer's recommendation, remove blockage, then re-purge and conduct the pressure and flow test again until all portions of the system are flowing properly.
2. The flow test must be observed and approved by the OWNER or his designate before the system is to be considered completed.
3. Conduct a pressure and flow test on each circuit to ensure that the system is free from blockage.
4. This test shall be performed in the presence of the Engineer or Owner's Representative.
5. Provide **48-hour** notice.

3.6 TEST BORE DRILLING LOG:

A. South Test Bore

1. Location: N 40° 38.687' W 111° 54.902'
2. Drilling Log:

Footage	Description and Notes
0' – 20'	Brown Clay
20' – 40'	Brown clay, blue clay
40' – 60'	Clay, loose gravel
60' – 200'	Gravel
200' – 220'	Gravel with clay stringers
220' – 240'	Cemented gravel
240' – 260'	Gravel with clay stringers
260' – 305'	Hard bedrock

B. North Test Bore

1. Location: N 40° 38.738’ W 111° 54.905’

2. Drilling Log:

Footage	Description and Notes
0’ – 60’	Clay
60’ – 240’	Gravel
240’ – 260’	Gravel, clay
260’ – 305’	Gravel with hard ledges

END OF SECTION 232700

SECTION 23 3113

METAL DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Double-wall round ducts and fittings.
4. Exhaust Air Stacks
5. Guy wires and connectors.
6. Sheet metal materials.
7. Duct liner.
8. Sealants and gaskets.
9. Hangers and supports.
10. Seismic-restraint devices.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC".
2. Division 23 Section "Non-Metal Ducts".
3. Division 23 Section "Air Duct Accessories".
4. Division 23 Section “Duct Insulation”.
5. Division 23 Section “Vibration Isolation and Seismic Restraint”.

1.03 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. Seismic Performance: Duct hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 23 0548 "Vibration and Seismic Controls for HVAC."

1. For equipment with a seismic importance factor of 1.0 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."

2. For equipment with a seismic importance factor of 1.5 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."

C. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

D. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
13. The shop drawings shall include the rectangular and round ductwork construction and reinforcement methods which the contractor is proposing for this project. This shall be determined by the contractor by following the latest edition of SMACNA “HVAC duct construction Standards”. Duct fabrication shall not begin until these shop drawings have been submitted and reviewed.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.05 INFORMATIONAL SUBMITTALS

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

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including, but no limited to the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

B. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.01 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 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 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.

B. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Sheet Metal Connectors, Inc.
5. Spiral, Inc.
6. Vent-Line, Inc.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60-Inches in Diameter: Flanged.

D. Longitudinal Seams: Not allowed.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 DOUBLE-WALL ROUND DUCTS AND FITTINGS

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

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Sheet Metal Connectors, Inc.
5. Spiral, Inc.
6. Vent-Line, Inc.

B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Transverse Joints in Ducts Larger Than 60-Inches in Diameter: Flanged.

2. Longitudinal Seams: Not allowed.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.

1. Inner duct shall be solid sheet steel a minimum of 10 feet downstream of humidifiers and/or air washers.

D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

2.04 EXHAUST AIR STACKS

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.

B. Freestanding Stacks: Fabricate freestanding chimneys according to SMACNA's "Guide for Steel Stack Design and Construction."

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Not allowed.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Design Wind Loads: 150 mph.

G. Design for seismic conditions at Project site.

H. Accessories: Terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as duct straight sections.

1. Termination: Antibackdraft damper.

I. Drain: Provide drain section incorporated into base of stack with trap. Seal depth design to prevent seal blowout at highest estimated static pressure.

J. Guying and Bracing Materials

1. Cable: Three minimum galvanized or stainless steel, stranded wires of the following thickness: [Four] <Insert number> [stainless steel]

a. Minimum Size: 1/4 inch in diameter.
b. For ID Sizes 4 to 15 Inches: 5/16 inch.
c. For ID Sizes 18 to 24 Inches: 3/8 inch.

2. Cable Hardware: Provide duct angle ring, turnbuckles, cable loop thimbles, cable clamps and all hardware necessary to brace stack.

2.05 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.

1. Galvanized Coating Designation: G90**.**
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.06 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, provide products by one of 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 at 75 deg F mean temperature.
    b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4. Water-Based Liner Adhesive:

    a. Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    b. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

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

    a. Aeroflex USA Inc.
    b. Armacell LLC.
    c. Rubatex International, LLC

2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

    a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, , length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

    a. 0.135-inch-diameter shank.

2. Insulation-Retaining Washers: With beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Self-locking washers formed from 0.016-inch-thick aluminum.

D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12-inches transversely; at 3-inches from transverse joints and at intervals not exceeding 18-inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.07 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. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches**.**
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg**,** positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F**.**
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg**,** positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg**,** positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.08 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 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. 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.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.09 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Seismic-restraint of ducts shall comply with Division 23 Section “Vibration and Seismic Controls for HVAC”.

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

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.
5. Mason Industries.
6. Unistrut Corporation; Tyco International, Ltd.

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.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts 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, 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.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 3300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines".

M. **Wet duct liner or insulation, even if later dried, must be removed from the site and replaced with new insulation. NO EXCEPTIONS**.

3.02 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 12-feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

D. Install grease duct with minimum clearance to combustibles as required by IBC and local codes. Installations that do not meet the minimum required clearances shall be fire wrapped as specified in Division 23 Section “Duct Insulation”.

E. Provide approved fire-wrap insulation that meets ASTM C 656.

3.04 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class A.
4. Outdoor, Return-Air Ducts: Seal Class A.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class A.
8. Unconditioned Space, Return-Air Ducts: Seal Class A.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class A.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
11. Conditioned Space, Exhaust Ducts: Seal Class A.
12. Conditioned Space, Return-Air Ducts: Seal Class A.

3.05 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4-inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24-inches of each elbow and within 48-inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16-feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.06 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 the requirements specified in Division 23 Section "Vibration and Seismic Controls for HVAC."
   1. Comply with ASCE/SEI 7.
   2. Space lateral supports a maximum of 40-feet o.c., and longitudinal supports a maximum of 80-feet o.c.
   3. Brace a change of direction longer than 12 feet**.**

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.

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.

G. Drilling for and Setting Anchors:

   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Set anchors to manufacturer's recommended torque, using a torque wrench.
   5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.07 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 23 3300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.08 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09 9113 "Exterior Painting" and Section 09 9123 "Interior Painting."

3.09 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
    b. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    d. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
    e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Evaluate Test Sections of metal duct system, chosen randomly by Owner and Engineer, for cleanliness according to NADCA ACR 2013, "Assessment, Cleaning and Restoration of HVAC Systems".

    a. Method 1 – Visual Inspection

        1) A visual inspection of porous and non-porous HVAC system components shall be conducted to assess that the HVAC system is visibly clean. An interior surface is considered clean when it is free from non-adhered substances and debris. If a component is visibly clean then no further cleanliness verification methods are necessary.

    b. If Method 1 is inconclusive or disputed, then use Method 2- Surface Comparison Testing to verify cleanliness.
    c. Method 2 - Surface Comparison Testing to verify cleanliness. The component’s surface conditions shall be evaluated by comparing visisble characteristics of the test surface before and after implementing the specific procedure of contact vacuuming define in NADCA ACR 2013 Section 5.

d. If Method 2 is inconclusive or disputed, then use Method 3 – NADCA Vacuum Test to verify cleanliness.
e. Method 3 - NADCA Vacuum Test is a scientifically method to evaluate particulate levels on HVAC component surfaces using standard equipment and procedures detail in NADCA ACR 2013 Section 5.4.

1) Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

2. Any section of duct that fails Method 1, 2 or 3 Cleanliness Evaluation must be replaced or remediated using the Duct Cleaning Methodology define in Article 3.10.
3. Any duct with liner showing evidence that is has wet at any time shall be removed and the duct replaced with new duct with new liner installed per Article 2.6 in this Section.

D. When the Duct System has passed the Leakage and Cleanliness Tests:

1. Prepare test and inspection reports.
2. Proceed with Testing, Adjusting and Balancing.

3.10 DUCT CLEANING

A. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 3300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

B. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

C. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

D. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.11 START UP

A. Air Balance: Comply with requirements in Section 23 0593 "Testing, Adjusting, and Balancing for HVAC."

3.12 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Underground ducts shall be as specified in Section 23 3116 "Nonmetal Ducts".

B. Ductwork running in areas where there are no ceilings or when noted on the drawings shall be doubled wall duct and shall meet the requirements indicated below.

C. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 16.
   d. SMACNA Leakage Class for Round: 8.

D. Return Ducts:

1. Ducts connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 16.
   d. SMACNA Leakage Class for Round: 8.

E. Exhaust Ducts:

1. Ducts connected to Fans exhausting ASHRAE 62.1, Class 1 and 2 air and Fans relieving air:

a. Pressure Class: Negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 16.
d. SMACNA Leakage Class for Round: 4.

2. Ducts Connected to Type I (Grease) Commercial Kitchen Hoods: Comply with NFPA 96.

a. Exposed to View: 18 gauge Type 304 stainless-steel sheet, No. 4B finish.
b. Concealed: 16 gauge black steel 18 gauge or Type 304 stainless-steel sheet, No. 4B finish.
c. Pressure Class: Positive or negative 4-inch wg**.**
d. Welded seams and joints.
e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
f. SMACNA Leakage Class: 2.

3. Ducts Connected to Type II (Heat) Commercial Kitchen Hoods:

a. Type 304, stainless-steel sheet.
b. Exposed to View: No. 4B finish.
c. Concealed: No. 2D finish.
d. Pressure Class: Positive or negative 3-inch wg.
e. Welded seams and joints.
f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
g. SMACNA Leakage Class: 2.

4. Ducts Connected to Dishwasher and Low Temperature Vapor and Odor Hoods:

a. Type 304, stainless-steel sheet.
b. Exposed to View: No. 4B finish.
c. Concealed: No. 2D finish.
d. Pressure Class: Positive or negative 3-inch wg.
e. Welded seams and joints.
f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.

5. Ducts connected to Clothes Dryers:

a. Dryer Vent is to be round aluminum duct.
b. Do not penetrate Dryer Vent duct with screws.
c. Comply with all manufactures written recommendations for materials, equipment and installation requirements.
d. Provide manufacturer recommended termination at discharge.

6. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 4-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 4.
d. SMACNA Leakage Class for Round: 2.

F. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units**:**

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 16.
d. SMACNA Leakage Class for Round and Flat Oval: 4.

2. Ducts Connected to Equipment Not Listed Above:

    a. Class: Positive or negative 3-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 16.
    d. SMACNA Leakage Class for Round: 4.

G. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

2. PVC-Coated Ducts:

    a. Exposed to Airstream: Match duct material.
    b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

    a. Exposed to Airstream: Match duct material.
    b. Not Exposed to Airstream: Match duct material.

4. Aluminum Ducts: Aluminum.

H. Liner:

1. Supply Air Ducts: Fibrous glass, Type I, 1-inch thick.
2. Return Air Ducts: Fibrous glass, Type I, 1-inch thick.
3. Exhaust Air Ducts: Fibrous glass, Type I, 1-inch thick.
4. Supply Fan Plenums: Fibrous glass, Type I, 1-inch thick.
5. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II**,** 1-inch thick.
6. Transfer Ducts: Fibrous glass, Type I, 1-inch thick.

I. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows." and Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows"; stamped, segmented or segmented standing seam; pleated or adjustable elbows are not acceptable.

    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) 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

    b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped.
    c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

J. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

    a. Rectangular Main to Rectangular Branch: 45-degree entry high efficiency take-off.
    b. Rectangular Main to Round Branch: 45-degree entry high efficiency take-off.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees."

    a. Lateral taps, fittings: 45-degree or 90-degree entry high efficiency taps, conical taps. 90-degree taps are not acceptable.

END OF SECTION

SECTION 23 3114

SAWDUST EXHAUST DUCTS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes round metal ducts and hoods for saw dust and welding fume collection ductwork and hoods.

1.03 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select and size air-moving and -distribution equipment and other components of air system. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without collection and transportation capability of duct system.

B. All ductwork is to be by spiral manufacturer out of Minneapolis, MN. Provide the following:

1. 45 lateral.
2. Tapered reducing laterals.
3. Multi branch laterals.
4. Floor sweeps
5. Duct nozzles.
6. Ball Joints.
7. Aluminum contoured hinged cleanouts.
8. Flexible steel hose.
9. Flexible rubber hose.
10. Blast Gates
11. Angle rings

1.04 SUBMITTALS

A. Coordinate Shop Drawings: Provide scaled (1/4" = 1'-0") drawing for all ductwork showing details of the following 1.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating dimensions, duct gauges, and sizes on plans.
3. Fittings.
4. Reinforcement and spacing.
5. Seam and joint construction.
6. Hangers and supports, including methods for building attachment, vibration isolation, seismic restraints, and duct attachment.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

C. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.05 QUALITY ASSURANCE

A. Comply with SMACNA's "Round Industrial Duct Construction Standards, 2nd Edition." & “Rectangular Industrial Duct Construction Standards.”

PART 2 - PRODUCTS

2.01 SHEET METAL MATERIALS

A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.

B. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

2.02 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

1 Joint and Seam Tape: 2-inches wide; glass-fiber fabric reinforced.
2. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with tape to form a hard, durable, airtight seal.
3. Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant, formulated with a minimum of 75 percent solids.
4. Flanged Joint Mastics: One-part, acid-curing, silicone, elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

2.03 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, cast in place inserts, or structural-steel fasteners appropriate for building materials.

B. Hanger Materials: Galvanized, sheet steel or round, threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rod or galvanized rods with threads painted after installation.
2. Straps and Rod Sizes: Comply with SMACNA Standards for sheet steel width and thickness and for steel rod diameters.

C. Duct Attachments: Sheet metal rivets, bolted flanges, or welded joints.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized steel shapes and plates.

2.04 ROUND DUCT FABRICATION

A. Round Ducts: Fabricate exhaust ducts with standard spiral lock seams or with butt-welded longitudinal seams according to SMACNA's "Round Industrial Construction Standards."

1. Construction shall be for Class 2 materials.
2. Pressure Class: negative 10-inch wg.
3. Minimum SMACNA Seal Class: A.
4. SMACNA Leakage Class: 2.

B. All bends shall be long sweeping radius type, centerline radius 2.5 times the duct diameter and with a minimum of seven (7) segments, if segmented elbows are used.

C. Duct Construction Gauges.

Size	Gauge
4"-8"	22
10"-12"	20
14"-16"	18
18"-20"	16
22"-48"	16, with reinforcing flanges at 10-feet on center.
50"-78"	16, with reinforcing flanges at 5-feet on center.

D. All fittings to be constructed from one gauge heavier than connecting ducts.

E. All rectangular hoods to be 16-gauge welded construction.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION, GENERAL

A. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts, fittings, and accessories.

B. Construct and install each duct system for the specific duct pressure classification indicated.

C. Install round ducts in lengths not less than 12-feet, unless interrupted by fittings.

D. Install ducts with fewest possible joints.

E. Install fabricated fittings for changes in directions, changes in size and shape, and connections.

F. Install couplings tight to duct wall surface with a minimum of projections into duct.

G. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

3.02 SEAM AND JOINT SEALING

A. General: Seal duct seams and joints according to the duct pressure class indicated and as described in SMACNA Standards.

3.03 HANGING AND SUPPORTING

A. Install rigid round metal duct with support systems indicated in SMACNA Standards.

B. Support horizontal ducts within 24-inches of each elbow and within 48-inches of each branch intersection.

C. Support vertical ducts at a maximum interval of 8-feet and at each floor.

D. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

E. Install concrete inserts before placing concrete.

F. Install vertical and horizontal supports for ductwork located from the ceiling and other structures. The support is to be per SMACNA’s supporting standards. Supports are to be for lateral and longitudinal.

3.04 CONNECTIONS

A. Connect equipment with flexible connectors according to Division 23 Section "Duct Accessories."

3.05 FIELD QUALITY CONTROL

A. Disassemble, reassemble, and seal segments of systems as required to accommodate leakage testing and as required for compliance with test requirements.

B. Conduct tests, in presence of Architect, at static pressures equal to maximum design pressure of system or section being tested. If pressure classifications are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Determine leakage from entire system or section of system by relating leakage to surface area of test section.

D. Maximum Allowable Leakage: Comply with requirements for Leakage per referenced SMACNA Standard.

E. Remake leaking joints and retest until leakage is less than maximum allowable.

F. Leakage Test: Perform tests according to SMACNA's "HVAC Air Duct Leakage Test Manual."

3.06 ADJUSTING

A. Adjust volume-control dampers in ducts, outlets, and inlets to achieve design airflow.

B. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed procedures.

3.07 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect the system. Vacuum ducts before final acceptance to remove dust and debris.

END OF SECTION

SECTION 23 3115

DUST COLLECTOR

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Dust Collector.
2. Provide an extra set of bags for the sawdust collector (and final filters).
3. Provide modified sawdust dumpster lid with hose connection and lifting system. Dumpster is provided by owner.

1.02 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. Motor ratings and electrical characteristics, plus motor and electrical accessories.
3. Material gages and finishes, including color charts.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Operation and maintenance data.

1.03 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.

PART 2 - PRODUCTS

2.01 MANUFACTURERS: Subject to compliance with requirements, provide products by the following.

a. Donaldson/Torit
b. American Air Filter
c. AQC Dust Collections Systems Inc.
d. Sternvent
e. United air specialist

2.02 DUST-COLLECTORS: (with retracting air lock valve)

A. The dust collector shall be a pulse-jet modular baghouse system. The pulse-jet modular bag-house collector shall be supplied in factory assembled units sized to meet airflow capacities and design requirements scheduled.

B. The collector shall have bolted and welded construction and be complete with pulse-jet pipework, sprinkler access ports, 1” single diaphragm valves, pilot solenoid valves in NEMA 4 control boxes. Unit shall be complete with tubing compressed air manifold, structural support legs with cross bracing, lifting lugs, and discharge hoppers.

C. Filter packs shall be supplied per specification with CPC-24. (24) filter packs for a total of 1608 square feet of filter media. The filter packs shall easily install into tubesheet from the clean air side of the collector and shall be retained in place with removable hold down brackets. Filter removal shall accomplished without the need for tools.

D. Dust-laden air shall enter the collector through the hopper with deflector plate and flow pattern engineered to minimize abrasion and provide even dust loading on the media surface. Clean air will pass through the media and enter the clean air chamber and exit the collector.

E. The collector shall be controlled by a solid-state printed circuit cleaning Delta-P control. The cleaning control shall progressively energize pilot solenoid valves, which cause corresponding diaphragm to send a pulse of 90-100 PSIG supply compressed air into the blowpipe. The pulse will be discharged from the air manifold through the diaphragm valves, through the blowpipe, and into the filter bags. The high pressure pulse will enter inside of the bags blowing the dust from the surface of the media. One row of bags shall be cleaned per pulse. Dust will be discharged from the hoppers at the base of the collector.

F. Provide dumpster with custom lid and flexible duct assembly. Dumpster shall be standard size coordinated with local waste collection company adapted to provide Dust Collector. Barrels are not acceptable.

G. Collector safeties shall include:
1. Explosion relief vents on Dust Collector.
2. No return valve.
3. High speed abort damper.
4. Control panel with motor starter with equipment shut down with no return valve and high speed abort damper controls.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Support units using restrained spring isolators having a static deflection specified in Division 23 Section "Mechanical Vibration and Seismic Controls."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

B. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are by this division.

C. Coordinate exact locations of controls to operate unit with the user.

3.02 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.03 FIELD QUALITY CONTROL

A. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Shut unit down and reconnect automatic temperature-control operators.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

E. Replace fan and motor pulleys as required to achieve design airflow.

F. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

END OF SECTION

SECTION 23 3116

NONMETAL DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Thermoset FRP ducts and fittings.
2. HDPE ducts and fittings.

B. Related Sections:

1. Section 23 0593 "Testing, Adjusting, and Balancing for HVAC".
2. Section 23 3113 "Metal Ducts".
3. Section 23 3300 "Air Duct Accessories".
4. Section 23 0713 “Duct Insulation” for duct insulation.

1.03 PERFORMANCE

A. Delegated Duct Design for FRP Duct: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with SMACNA's " Thermoset FRP Duct Construction Manual" and performance requirements and design criteria indicated.

1. Static-Pressure Classes:

a. Supply Ducts: 2-inch wg.

B. Delegated Duct Design for HDPE Duct: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with SMACNA's "Thermoplastic Duct Construction Manual" and performance requirements and design criteria indicated.

1. Static-Pressure Classes:

a. Supply Ducts: 2-inch wg.

C. Seismic Performance: Duct hangers and supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and with the requirements specified in Section 23 0548 "Vibration and Seismic Controls for HVAC."

1. For equipment with a seismic importance factor of 1.0 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."

2. For equipment with a seismic importance factor of 1.5 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."

D. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Thermoset FRP ducts and fittings.
2. HDPE ducts and fittings.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevation of top of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings, including transitions metal duct.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Hangers and supports, including methods for duct to building attachment, vibration isolation and seismic restraints.

C. Delegated-Design Submittal:

1. Duct materials and thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Design Calculations: Calculations for selecting hangers and supports.
5. Transition fitting for connection to metal duct.

1.05 INFORMATIONAL SUBMITTALS

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

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Foundation footings.

B. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

C. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.01 THERMOSET FRP DUCTS AND FITTINGS

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

1. McGill AirFlow LLC.
2. Perry Fiberglass Products, Inc.
3. Spunstrand Inc.

B. Duct and Fittings:

1. Thermoset FRP Resin: Manufacture duct with resin that complies with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL according to ASTM E 84.
2. Inner Liner: FSK liner rated by an NRTL to comply with UL 181, Class 1.
3. Round Duct: ASTM D 2996, Type I, Grade 2, Class E, filament-wound duct, minimum 0.125-inch wall thickness, with tapered bell and spigot ends for adhesive joints, or plain ends with couplings.
4. Round Fittings: Compression or spray-up/contact, molded of same material, pressure class, and joining method as duct.
5. Rectangular Fittings: Minimum 0.125-inch-thick flat sheet with fiberglass roving and resin-reinforced joints and seams.

C. Joining Materials: Roving and polyester resin.

1. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Fabrication:

1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoset FRP Duct Construction Manual," Chapter 7, "Requirements."
2. Fabricate 90-degree rectangular mitered elbows to include turning vanes, 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

E. Drains: Formed drain pockets with a minimum of NPS 1 threaded pipe connections.

2.02 HDPE DUCTS AND FITTINGS

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

1. AQC Industries.

B. Duct and Fittings:

1. All underground air ducts shall be HDPE integrally insulated underground ductwork constructed of polyethylene.
2. All fittings, boots, and duct sections connectors shall be constructed of Polyethylene material (as described above) in accordance with manufacture's specifications.

C. Joining Materials:

1. All joints shall be gasketed and sealed with screws or clamps per the manufacturer’s instructions.
2. Caulks and sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Fabrication:

1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoplastic Duct Construction Manual.”

2.03 HANGERS AND SUPPORTS

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

B. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables: ASTM A 603, galvanized steel with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

A. Install ducts with fewest possible joints.

B. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

C. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

D. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

E. 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. Overlap openings on four sides by at least 1-1/2 inches.

F. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 3300 "Air Duct Accessories" for fire and smoke dampers.

G. Protect duct interiors from the moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

H. Install thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual."

I. Install HDPE ducts and fittings to comply with the manufacturer’s recommendations and SMACNA's "Thermoplastic Duct Construction Manual."

3.02 HANGER AND SUPPORT INSTALLATION

A. Install hangers and supports for thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual," Chapter 7, "Requirements."

B. Install hangers and supports for HDPE ducts and fittings to comply with SMACNA's "Thermoplastic Duct Construction Manual."

C. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

D. 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.

E. Install underground duct in bed of pea gravel or sand.

3.03 PAINTING

A. Paint interior of thermoset FRP and HDPE ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09 9123 "Interior Painting."

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

    a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of nonmetal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.05 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch duct as recommended by duct manufacturer. Comply with Section 23 3300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
2. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of ducts or duct accessories.
3. Clean fibrous-glass duct with HEPA vacuuming equipment; do not permit duct to get wet. Replace fibrous-glass duct that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
5. Provide drainage and cleanup for wash-down procedures.
6. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.06 START UP

A. Air Balance: Comply with requirements in Section 23 0593 "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION

SECTION 23 3119
HVAC CASINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Factory-fabricated, field-assembled, single- and double-wall casings for HVAC equipment.

1.03 PERFORMANCE REQUIREMENTS

A. Static-Pressure Classes:

1. Upstream from Fan(s): 2-inch wg.
2. Downstream from Fan(s): 4-inch wg.

B. Structural Performance:

1. Casings shall be fabricated to withstand 133 percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed 1/8 inch per foot of width.

a. Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft. and snow load of 30 lbf/sq. ft..

C. Seismic Performance: HVAC casings shall withstand the effects of earthquake motions determined according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

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."

1.04 SUBMITTALS

A. Product Data: For each type of the following products:

1. Factory-fabricated casings.
2. Liners and adhesives.
3. Sealants and gaskets.
4. Seismic-restraint devices.

B. Shop Drawings: For HVAC casings. Include plans, elevations, sections, components, and attachments to other work.

1. Detail HVAC casing assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Sheet metal thickness(es).
3. Reinforcement and spacing.
4. Seam and joint construction.
5. Access doors including frames, hinges, and latches.
6. Filter, coil, humidifier, and other apparatus being installed in and mounted on casing.
7. Locations for access to internal components.
8. Hangers and supports including methods for building attachment, vibration isolation, seismic restraints, and casing attachment.
9. Interior lighting, including switches.

C. Welding certificates.

D. Product Certificates: For acoustically critical casings, from manufacturer.

1. Show sound-absorption coefficients in each octave band lower than those scheduled when tested according to ASTM C 423.
2. Show airborne sound transmission losses lower than those scheduled when tested according to ASTM E 90.

E. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

B. 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 casing joint and seam welding.

1.06 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate sizes and locations of steel supports. Supports are specified in Division 05 Section "Metal Fabrications."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.01 GENERAL CASING FABRICATION REQUIREMENTS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 6, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

1. Fabricate casings with more than 3-inch wg negative static pressure according to SMACNA's "Rectangular Industrial Duct Construction Standards."
2. Casings with more than 2-inch wg positive static pressure may be fabricated according to SMACNA's "Rectangular Industrial Duct Construction Standards."

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Exterior Surface Galvanized Coating Designation: G90.
2. Interior Surface Galvanized Coating Designation:

a. Sections Not Exposed to Moisture: G90.
b. Sections Housing and Downstream from Cooling Coil and Humidifiers: G90.

C. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the interior sheet metal surfaces of casing in contact with the airstream. Apply untreated clear coating to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H minimum when tested according to ASTM D 3363.
4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 according to UL 723; certified by an NRTL.
5. Applied Coating Color: Standard.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

E. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.

F. Penetrations: Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation. Provide shaft seals where fan shafts penetrate casing.

G. Access Doors: Fabricate access doors according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-11, "Casing Access Doors - 2-inch wg," and Figure 6.12, "Casing Access Doors - 3-10-inch wg"; and according to pressure class of the plenum or casing section in which access doors are to be installed.

1. Size: 20 by 54 inches.
2. Vision Panel: Double-glazed, wire-reinforced safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
3. Hinges: Piano or butt hinges and latches, number and size according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
4. Latches: Minimum of two wedge-lever-type latches, operable from inside and outside.
5. Neoprene gaskets around entire perimeters of door frames.

6. Doors shall open against air pressure.

H. Condensate Drain Pans: Formed sections of Type 304, stainless-steel sheet complying with requirements in ASHRAE 62.1. Pans shall extend a minimum of 12 inches past coil.

1. Double-wall construction shall have space between walls filled with foam insulation and sealed moisture tight.
2. Intermediate drain pan or drain trough shall collect condensate from top coil for units with stacked coils or stacked eliminators.
3. Insulation: Polystyrene or polyurethane.
4. Slopes shall be in a minimum of two planes to collect condensate from cooling coils (including coil piping connections and return bends), eliminators, and humidifiers when units are operating at maximum catalogued face velocity across cooling coil.
5. Each drain pan connection shall have a trap. Drain traps with depth and height differential between inlet and outlet equal or greater to the design static pressure plus 2-inch wg. Include slab height in trap calculation.

2.02 SHOP-FABRICATED CASINGS

A. Double-Wall Casing Inner Panel: Perforated, galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.

B. Double-Wall Casing Inner Panel: Solid sheet steel. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.

C. Interstitial Insulation: Polyurethane foam complying with NFPA 90A or NFPA 90B.

D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Coat insulation with antimicrobial coating.
3. Cover insulation with polyester film complying with UL 181, Class 1.

E. Interstitial Insulation: Flexible-elastomeric duct liner complying with ASTM C 534, Type II for sheet materials and with NFPA 90A or NFPA 90B.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

F. Fabricate casings with standing seams and angle-iron reinforcements unless otherwise indicated.

G. Fabricate close-off sheets from casing to dampers, filter frames, and coils and between stacked coils. Use galvanized sheet steel of same thickness as casing and with a galvanized coating designation of G90.

H. Bolt close-off sheets to frame flanges and housings. Support coils on stands fabricated from galvanized-steel angles or channels.

I. Reinforce casings with galvanized-steel angles.

2.03 MANUFACTURED CASINGS

A. Description: Double-wall, insulated, pressurized equipment casing.

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

1. Acoustical Surfaces, Inc.
2. AeroSonics, Inc.; a division of TUTCO, Inc.
3. Buffalo Air Handling.
4. CertainTeed Corp.; Insulation Group.
5. CLEANPAK International.
6. D&D Sound Control.
7. IACL.
8. Industrial Noise Control, Inc.
9. McGill AirSilence LLC.
10. Ruskin.
11. SEMCO Incorporated.
12. Vibro-Acoustics.

C. Double-Wall Panel Fabrication: Solid, galvanized sheet steel exterior wall and solid perforated, galvanized sheet steel interior wall; with space between wall filled with insulation.

1. Wall Thickness: 2 inches 4 inches.
2. Fabricate with a minimum number of joints.
3. Weld exterior and interior walls to perimeter; to interior, longitudinal, galvanized-steel channels; and to box-end internal closures. Paint welds.
4. Sheet metal thickness shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for static-pressure class indicated for casing.
5. Sheet Metal Thicknesses:

    a. Exterior Wall Thickness: 0.040 inch minimum.
    b. Interior Wall Thickness: 0.034 inch minimum.

6. Double-Wall Casing Inner Panel: Perforated, galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.
7. Double-Wall Casing Inner Panel: Solid sheet steel.
8. Fill each panel assembly with insulating material that is noncombustible, inert, mildew resistant and vermin proof and that complies with NFPA 90A.
9. Fabricate panels with continuous tongue-and-groove or self-locking joints effective inside and outside each panel.

D. Trim Items: Fabricate from a minimum of 0.052-inch galvanized sheet steel, furnished in standard lengths for field cutting.

2.04 CASING LINER

A. Fibrous-Glass 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, provide products by one of the following:

    a. CertainTeed Corp.; Insulation Group.
    b. Johns Manville.
    c. Knauf Insulation.
    d. Owens Corning.

2. Antimicrobial Erosion-Resistant Coating: Apply to surface of the liner that will form the interior surface of casing to act as a moisture repellent and an erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

B. Natural-Fiber Casing Liner: 85 percent cotton, 10 percent borate, and 5 percent polybinding fibers, treated with a microbial growth inhibitor, and complying with NFPA 90A or NFPA 90B.

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

    a. Bonded Logic, Inc.
    b. Reflectix Inc.

2. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested according to ASTM C 518.
3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

C. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized steel, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

D. Shop or Factory Application of Casing 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 casing liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of casing 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 casings or cut and fit to ensure butted-edge overlapping.
5. Apply adhesive coating on longitudinal seams in casings with air velocity of 2500 fpm.
6. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from casing wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined casing preceding unlined duct.
    c. Upstream edges of transverse joints in casings where air velocities are higher than 2500 fpm or where indicated.

8. Secure insulation between perforated sheet metal inner wall of same thickness as specified for outer wall. Use mechanical fasteners that maintain inner wall at uniform distance from outer wall without compressing insulation.

2.05 SEALANT MATERIALS

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, positive or negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel or stainless steel.

C. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. VOC: Maximum 395 g/L.
9. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
10. Service: Indoor or outdoor.
11. Substrate: Compatible with galvanized sheet steel or stainless steel.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single component, acid curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine concrete bases roof curbs and steel supports for compliance with requirements for conditions affecting installation and performance of HVAC casings.

B. Examine casing insulation materials and liners before installation. Reject casings that are wet, moisture damaged, or mold damaged.

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

3.02 INSTALLATION

A. Install casings according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Equipment Mounting: Install HVAC casings on concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

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

C. Install seismic restraints on casings. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Apply sealant to joints, connections, and mountings.

E. Field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Support casings on floor or foundation system. Secure and seal to base.

G. Support components rigidly with ties, braces, brackets, seismic restraints, and anchors of types that will maintain housing shape and prevent buckling.

H. Align casings accurately at connections, with 1/8-inch misalignment tolerance and with smooth interior surfaces.

3.03 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual."

2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
3. Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.

B. HVAC casings will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 23 3119

SECTION 23 3300

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Backdraft dampers.
2. Pressure relief dampers.
3. Barometric relief dampers.
4. Manual volume dampers.
5. Control dampers.
6. Fire dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Duct silencers.
10. Turning vanes.
11. Remote damper operators.
12. Duct-mounted access doors.
13. Flexible connectors.
14. Flexible ducts.
15. Duct accessory hardware.

B. Related Requirements:

1. Division 23 "HVAC Gravity Ventilators".
2. Division 23 “Diffusers, Registers and Grilles”.
3. Division 26 "Fire-Alarm System".

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

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

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, pressure relief-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Wiring Diagrams: For power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.06 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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480, Type 304, and having a No. 2D finish for concealed ducts and No. 4B finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36-inches or less; 3/8-inch minimum diameter for lengths longer than 36-inches.

G. Carbon-Steel Sheets: ASTM A366A, cold rolled sheets, commercial quality, with oiled, exposed matte finish.

2.03 BACKDRAFT DAMPERS

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

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Pottorff.
5. Ruskin Company.

B. Function:

1. Designed to allow airflow in one direction and prevent reverse airflow.
2. Keeps outside air out of the space by sensing and closing against mass flow.

C. Description:

1. Gravity balanced.

D. Maximum Air Velocity:

1. 1000 fpm

E. Maximum System Pressure:

1. 2-inch wg.

F. Frame: Hat-shaped, with welded corners or mechanically attached and mounting flange:
1. 16 GA 0.063-inch- thick extruded aluminum or 18 GA 0.05-inch- thick, galvanized sheet steel.

G. Blades: Multiple single-piece blades, maximum 6-inch width noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges:

1. Center pivoted: 16GA 0.050-inch- thick aluminum sheet**.**

H. Blade Action: Parallel.

I. Blade Seals: Mechanically locked.

1. Neoprene.

J. Blade Axles: 0.20 inch diameter:

1. Material: Stainless steel.

K. Tie Bars and Brackets:

1. Aluminum.

L. Return Spring: Adjustable tension.

M. Bearings:

1. Steel ball.

N. Accessories.

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Screen Mounting: Front mounted in sleeve.
    a. Sleeve Thickness: 20 gage minimum.
    b. Sleeve Length: 6 inches minimum.
4. Screen Mounting: Rear mounted.
5. Screen Material:
    a. Aluminum.
6. Screen Type:
    a. Bird
7. 90-degree stops.

2.04 BAROMETRIC RELIEF DAMPERS

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

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Pottorff.
5. Ruskin Company.

B. Function:

1. Senses and compares outdoor ambient and indoor pressures.
2. Allows any higher pressure indoor air to escape.

C. Description: Suitable for horizontal or vertical mounting.

D. Maximum Air Velocity:

1. 1000 fpm

E. Maximum System Pressure:

1. 2-inch wg.

F. Frame: Hat-shaped, with welded corners or mechanically attached and mounting flange.

1. 13GA 0.094-inch- thick, galvanized sheet steel.

G. Blades: Multiple:

1. 16GA 0.050-inch- thick aluminum sheet].
2. Maximum Width: 6 inches.
3. Action: Parallel.
4. Balance: Gravity.
5. Pivot:
   a. Eccentric.

H. Blade Seals:

1. Neoprene

I. Blade Axles:

1. Stainless steel.

J. Tie Bars and Brackets: Rattle free with 90-degree stop.

1. Material:
   a. Galvanized steel .

K. Return Spring: Adjustable tension.

L. Bearings:

1. Synthetic

M. Accessories:

1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.

2.05 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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

   a. American Warming and Ventilating; a division of Mestek, Inc.
   b. McGill AirFlow LLC.
   c. Nailor Industries Inc.
   d. Pottorff.
   e. Ruskin Company.

2. Standard leakage rating **,** with linkage outside airstream.
3. Suitable for horizontal or vertical applications.

4. Frames: Hat-shaped, Mitered and welded corners. Flanges for attaching to walls and flangeless frames for installing in ducts.

   a. 16GA 0.064-inch thick, galvanized sheet steel.

5. Blades:
   a. Multiple or single blade. Parallel- or opposed-blade design. Stiffened damper blades for stability.
   b. Material:
      1) Galvanized -steel, 16GA 0.064 inch thick.

6. Blade Axles:
   a. Stainless steel.
   b. Shall extend full length of damper blades in ducts with pressure classes of 2-inch wg or more.

7. Bearings:
   a. Material:
      1) Molded synthetic.
   b. Bearings at both ends of damper operating shafts in ducts with pressure classes of 2-inch wg or more.

8. Tie Bars and Brackets: Galvanized steel.

2.06 CONTROL DAMPERS

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

1. Greenheck Fan Corporation.
2. Pottorff.
3. Ruskin Company.
4. Young Regulator Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Section:
   a. Hat shaped.
2. Material:
   a. 20 GA 0.40-inch- thick galvanized steel .
3. Corners:
   a. Mitered-and-welded.

D. Blades: Multiple.

1. Maximum blade width:
   a. 6 inches.
2. Opposed-blade design.
3. Material:
   a. Galvanized-steel.
4. Thickness:

a. 20 GA 0.40-inch- thick galvanized steel

5. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
   a. Closed-cell neoprene

E. Blade Axles:

1. Section:
   a. 3/8-inch-square
2. Material:
   a. Stainless steel.
3. Blade-linkage hardware:
   a. Zinc-plated steel and brass.
   b. Ends sealed against blade bearings:
4. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Type:
   a. Molded synthetic.
2. Axles: Dampers in ducts with pressure classes of 3-inch wg or more shall have axles full length of damper blades.
3. Bearings: Thrust bearings at each end of every blade. Bearings at both ends of each operating shaft.

2.07 FIRE DAMPERS

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

1. Arrow United Industries; a division of Mestek, Inc.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Pottorff.
5. Ruskin Company.

B. Type:

1. Dynamic.

C. Standard: Rated and labeled according to UL 555 by an NRTL.

D. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

E. Fire Rating:

1. 1-1/2 hours or 3 hours as noted on Plans.

F. Frame:

1. Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream.

2. Material:
    a. Fabricated with roll-formed galvanized steel; with mitered and interlocking corners.
    b. Thickness:
        1) 20GA-0.040-inch.

G. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel. Length to suit application.

1. Minimum Thickness:
    a. 18GA-0.05 inch, as indicated.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

H. Mounting Orientation: Vertical or horizontal as indicated.

I. Blades: Roll-formed, interlocking, galvanized sheet steel.
1. Thickness:
    a. 24GA-0.024-inch.
2. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

J. Horizontal Dampers: Include blade lock and Type 301 constant force stainless-steel closure spring.

K. Heat-Responsive Device: Replaceable, 212 deg F rated, fusible links.

2.08 SMOKE DAMPERS

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

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Pottorff.
4. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

1. Type: Photoelectric.

D. Frame: Galvanized sheet steel. With or without mounting flange as required.

1. Thickness:
    a. Hat-shaped, 16GA-0.064-inch.
2. Corners:
    a. Welded.

E. Blades: Horizontal, galvanized sheet steel.

1. Section;
    a. Roll-formed.
2. Fit:
    a. Interlocking.
3. Thickness:
    a. 14GA-0.079-inch.

F. Leakage:
1. Class II.

G. Seals:
1. Blade: Inflatable silicone fiberglass material to maintain smoke leakage rating to a minimum of 450 deg F .
    a. Prohibited: Glue-on or grip type seals are not acceptable.

H. Rated pressure and velocity to exceed design airflow conditions.

I. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
1. Minimum 17-inches long.
2. Thickness:
    a. 0.05-inch-.

J. Damper Motors:
1. Action:
    a. Two-position
2. Mode: Fail close.
3. Mounting: External.

K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 23 0900 "Instrumentation and Control for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. 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 and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

7. Electrical Connection: 115 V, single phase, 60 Hz.

L. Accessories:

1. Auxiliary switches for signaling:
   a. Position indication.
2. Test Switch type:
   a. Momentary test switch.
3. Test Switch Mounting:
   a. Damper.

2.09 COMBINATION FIRE AND SMOKE DAMPERS

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

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Pottorff.
4. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum velocity of:

1. 2000-fpm

D. Fire Rating:

1. 1-1/2 hours or 3 hours, as noted on plans.

E. Frame: Hat shaped, galvanized sheet steel. With or without mounting flange as required.
1. Thickness:
   a. 16GA-0.064-inch
2. Corners:
   a. Welded.

F. Heat-Responsive Device: Replaceable, 212 deg F rated, fusible links.

G. Heat-Responsive Device: Electric link and switch package, factory installed, 212 deg F rated.

H. Smoke Detector: Integral, factory mounted and wired for single-point connection.

1. UL Listed S1383.

I. Blades: Horizontal, galvanized sheet steel.

1. Type:
   a. Air-foil.
2. Fit:,

a. Interlocking.

3. Thickness:

a. 0.063-inch.

J. Leakage:

1. Class I.

K. Rated pressure and velocity to exceed design airflow conditions.

L. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

1. Thickness:

a. 18GA 0.05-inch.

M. Master control panel for use in dynamic smoke-management systems.

N. Damper Motors:

1. Locate outside air stream unless otherwise indicated,
2. Action:

a. Two-position.

3. Voltage: to match fire alarm system (coordinate).
4. Listed: UL, as part of damper assembly.
5. Outdoor Motors and Motors in Outside-Air Intakes:

a. Gaskets: O-ring gaskets designed to make motors weatherproof.
b. Internal heaters: Equip to permit normal operation at minus 40 deg F .

O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 23 0900 "Instrumentation and Control for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. 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 and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

P. Accessories:

1. Auxiliary switches:

a. Signaling.
b. Position indication.

2. Test Switch type:

a. Momentary test switch.

3. Test Switch Mounting:

a. Damper.

2.10 DUCT SILENCERS

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

1. Industrial Acoustics Company.
2. Dynasonics.
3. Price.
4. Ruskin Company.
5. SEMCO Incorporated.
6. Vibro-Acoustics.

B. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Shape:

1. Rectangular straight with center bodies or pods.
2. Rectangular elbow with center bodies or pods.

D. Rectangular Silencer Outer Casing: Galvanized sheet steel.

1. ASTM A 653:

a. G90.

2. Thickness:

a. 20GA-0.040 inch.

E. Inner Casing and Baffles: Galvanized sheet metal with 1/8-inch diameter perforations.

1. ASTM A 653:

a. G90.

2. Thickness:

a. 22GA-0.034 inch.

F. Special Construction:

1. Suitable for outdoor use.
2. High transmission loss to achieve STC 45.

G. Connection Sizes: Match connecting ductwork unless otherwise indicated.

H. Principal Sound-Absorbing Mechanism:

1. Dissipative or Film-lined type with fill material:

a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression
b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
c. Prohibited: Mineral wool will not be permitted as a substitute for glass fiber.

2. Lining:
a. Material:

1) Tedlar

b. Prohibited: Mesh, screen or corrugated perforated liner will not be acceptable as a substitute for the specified spacer.

I. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Joints:

a. Lock formed and sealed.

2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.
4. Structural Criteria: The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gage.
5. Spot Welds: All spot welds shall be painted.

J. Accessories:

1. Factory-installed end caps to prevent contamination during shipping.

K. Performance:

1. Silencer dynamic insertion loss shall not be less than that scheduled in Silencer Schedule.
2. Silencer generated noise shall not be greater than that scheduled in the Silencer Schedule.
3. All silencer ratings shall be determined in a duct-to-reverberant room test facilitywhich provides for airflow in scheduled direction(s) through the test silencer in accordance with the ASTM E-477-06a Test Standard.
4. Silencer pressure losses shall not be greater than that scheduled in Silencer Schedule. Silencer pressure loss measurements shall be made in accordance with the ASTM E-477-06a Test Standard. Test shall be conducted and reported for identical units for which acoustical data is presented.

2.11 TURNING VANES

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

1. METALAIRE, Inc.
2. SEMCO Incorporated.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

4. Ductmate Industries, 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.

1. Fabricate single blade vanes to comply with SMACNA's "HVAC Duct Construction Standards-Metal and Flexible."

2. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Double wall.

E. Vane Construction: Single wall for ducts up to 48-inches wide and double wall for larger dimensions.

2.12 REMOTE DAMPER OPERATORS

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

1. Pottorff.
2. Ruskin Company; Tomkins PLC.
3. Young Regulator Company.

B. Cable Type:

1. Description: Cable system designed for remote manual damper adjustment. Unit shall be provided with all necessary controls, tools, accessories for a completely function system.
2. Tubing/Sheathing: Galvanized, Brass, Copper or Aluminum.
3. Cable: Stainless steel or Steel.
4. Wall-Box Mounting: Coordinate with Architect.
5. Wall-Box Cover-Plate Material: Coordinate with Architect.

C. Activated Electric Type:

1. Description: Electrically activated zone control damper for remote adjustment. When an adjustment is needed the system is powered up. Unit shall be provided with all necessary controls, tools, accessories for a completely function system.
2. Means: Factory mounted actuator factory wired to damper.
3. Portable 9 volt system. No field power requirement.
4. Mounting: Recessed Wall Box or Diffuser or Hand Held.
5. Wall-Box Cover Finish: Coordinate with Architect.
6. Wall-Box Porting: 1 to 6 ports or more.

2.13 DUCT-MOUNTED ACCESS DOORS

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

1. Greenheck Fan Corporation.
2. McGill AirFlow LLC.
3. Pottorff.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
5. Ductmate Industries, Inc.
6. Nailor Industries Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - 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 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 Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square:
      1) Hinges:
         a) Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches, provide outside and inside handles:
      1) Hinges:
         a) Three hinges and two compression latches.
   d. Access Doors Larger Than 24 by 48 Inches, provide outside and inside handles:
      1) Hinges:
         a) Continuous and two compression latches with outside and inside handles.

2.14 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Ventfabrics, Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
4. Duro Dyne 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 wide fabric strip attached to two narrower metal strips. Provide strips of metal compatible with connected ducts.

1. Wide Strip:

a. 3-1/2 inches.

2. Narrow Strips:

a. 0.028-inch- thick, galvanized sheet steel.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.15 FLEXIBLE DUCTS

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

1. Flexmaster U.S.A., Inc.
2. McGill AirFlow LLC.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Ducts shall conform to the requirements for Class I connectors when tested in accordance with "Standard for Factory Made Air Ducts Materials and Air Duct Connectors" (UL 181).

C. Ducts shall also pass the 15 minute U.L. flame penetration test as specified in the UL 181 Standard.

D. Insulated, Flexible Duct: Two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

E. Flexible Duct Connectors:

1. Clamps: in sizes 3 through 18 inches, to suit duct size.

a. Material: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action.

2.16 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

C. Splitter Damper Accessories: Zinc-plated damper blade bracket; 1/4-inch, zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.

D. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Use the Remote Damper Operator when they are called out on the drawings or when the damper cannot be easily accessed.

D. Install flexible connectors to connect ducts to equipment.

E. Flexible duct connections from the main trunk ducts to diffuser boots shall be furnished and installed as shown on the drawings. Flexible ductwork shall only be used as indicated on the drawings.

F. Where flexible duct is indicated, use insulated flexible duct for supply air return and exhaust air.

G. Flexible ductwork shall be run in straight lengths.

H. Provide support in flexible duct every three feet.

I. Flexible ducts shall have compression fittings on both ends.

J. Flexible ductwork is not allowed to bend 90 degrees. If a bend is needed use sheet-metal hard elbows. Hard turns, offsets, or kinks will not be allowed.

K. Flexible ducts shall connect to trunk duct with high efficiency takeoffs.

L. Connect flexible ducts to metal ducts with draw bands.

M. Connect ducts to duct silencers:

1. With flexible duct connectors.

N. Connect terminal units to supply ducts:

1. With maximum 12-inch lengths of flexible duct.

O. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to ducts:

1. With maximum 60-inch lengths of flexible duct clamped or strapped in place.

Q. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

R. Install pressure relief damper immediately upstream of main fire damper.

S. 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.
2. Install aluminum volume dampers in aluminum ducts.

T. Set dampers to fully open position before testing, adjusting, and balancing. Exception: Pressure relief damper.

U. A balance damper with locking quadrant will be provided downstream of take-off from trunk duct.

V. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

W. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

X. Install duct test holes where required for testing and balancing purposes.

Y. Install test holes at fan inlets and outlets and elsewhere as indicated.

Z. Install fire and smoke dampers according to UL listing.
1. Install fusible links in fire dampers.

AA. For round ductwork 24-inch and smaller a true round fire damper with the same rating may be used.

BB. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be standard access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum **50-foot** spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere, as indicated.

CC. Install access doors with swing against duct static pressure.

DD. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

EE. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

3.02 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. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

3.03 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION

SECTION 23 3423

POWER VENTILATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

   A. Centrifugal Roof Ventilators.
   B. In-line Centrifugal Fans.
   C. Kitchen Upblast Exhaust Fans.
   D. Ceiling-Mounted Ventilators.
   E. Roof Mounted Hooded Propeller Supply Fan

B. Related Sections: The following Sections contain requirements that relate to this Section:

   A. Division 7 Section "Manufactured Roof Specialties" for roof curbs and equipment supports.
   B. Division 23 Section "Instrumentation and Controls for HVAC" for control devices.
   C. Division 26 Section "Disconnects and Circuit Breakers" for disconnect switches.
   D. Division 26 Section "Motor Controllers" for motor starters.

C. Products furnished, but not installed, under this Section include roof curbs for roof-mounted exhaust fans.

D. Provide neoprene gasket between fan-mounted curbs and the fan for sound transmission also isolated fans with rubber grommet.

1.03 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base air ratings on actual site elevations.

B. Operating Limits: Classify according to AMCA 99.

C. Fan Unit Schedule: The following information is described in an equipment schedule on the Drawings.

   A. Fan performance data including capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
   B. Fan arrangement including wheel configuration, inlet and discharge configurations, and required accessories.

1.04 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data including rated capacities of each unit, weights (shipping, installed, and operating), furnished specialties, accessories, and the following:

   A. Certified fan performance curves with system operating conditions indicated.
   B. Certified fan sound power ratings.
   C. Motor ratings and electrical characteristics plus motor and electrical accessories.
   D. Material gages and finishes, including color charts.
   E. Dampers, including housings, linkages, and operators.

C. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

D. Coordination Drawings, according to Division 15 Section "Basic Mechanical Requirements," for roof penetration requirements and for reflected ceiling plans drawn accurately to scale and coordinating penetrations and units mounted above ceiling. Show the following:

   A. Roof framing and support members relative to duct penetrations.
   B. Ceiling suspension assembly members.
   C. Size and location of initial access modules for acoustical tile.
   D. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

E. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.

F. Maintenance data for power ventilators to include in the operation and maintenance manual specified in Division 1 and in Division 15 Section "Basic Mechanical Requirements."

1.05 QUALITY ASSURANCE

A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.

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

   A. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
   B. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

C. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.

D. NEMA Compliance: Provide components required as part of fans that comply with applicable NEMA standards.

E. UL Standard: Provide power ventilators that comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.06 PROJECT CONDITIONS

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

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

1.07 COORDINATION AND SCHEDULING

A. Coordinate the size and location of structural steel support members.

B. Coordinate the installation of roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

1.08 EXTRA MATERIALS

A. Furnish two sets of belts for each belt-driven fan; one installed on the fan and second set that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

   A. Cook (Loren) Co.
   B. Greenheck
   C. Captiveaire
   D. Trane Co. (The).
   E. Twin City Fan & Blower Co.

2.02 CENTRIFUGAL ROOF DOME VENTILATORS

A. Description: Belt-driven or direct-drive centrifugal fans, as indicated, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

C. Housing: Removable, extruded-aluminum, rectangular top; square, one-piece, aluminum base with venturi inlet cone.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Direct-Drive Units: Motor mounted outside of airstream within fan housing.

   1. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

F. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust air stream.

G. Accessories: The following items are required as indicated:

1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Parallel-blade, motorized dampers mounted in curb base; damper motor voltage to match exhaust fan motor voltage.
4. Variable-Speed Controller: For direct drive fans, provide a solid-state control to reduce speed from 100 to less than 50 percent.
5. Roof Curbs: Galvanized steel; mitered and welded corners; 2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 2-inch wood nailer. Size as required to suit roof opening and fan base.

A. Configuration: Self-flashing without a cant strip, with mounting flange.
B. Overall Height: 14 inches.

2.03 IN-LINE CENTRIFUGAL FANS

A. Description: In-line, centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, drive assembly, motor and disconnect switch, mounting brackets, and accessories.

B. Housing: Heavy gauge steel with straightening vanes; inlet and outlet flanges; and support bracket.

C. Direct-Drive Units: Motor mounted outside of airstream within fan housing.

1. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Steel backward inclined blades welded to steel hub.

F. Accessories: The following accessories are required as indicated:

1. Companion Flanges: For inlet and outlet duct connections.
2. Fan Guards: Expanded metal in removable frame. Provide belt guards for units not connected to ductwork.
3. Dampers: Counterbalanced, parallel-blade, motorized dampers mounted in curb base; damper motor voltage to match exhaust fan motor voltage.
4. Variable-Speed Controller: For direct drive fans, provide a solid-state control to reduce speed from 100 to less than 50 percent.

2.04 KITCHEN CENTRIFUGAL UPBLAST EXHAUSTERS

A. Description: Belt-driven or direct-drive centrifugal fans, as indicated, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum, upblast top; square, one-piece, aluminum base with venturi inlet cone.

C. Spark-Resistant Construction: AMCA 99, Type C. Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

E. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.

F. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L_{-50} of 200,000 hours.

1. External Lubrication Lines: Lubricating tubes from fan bearings extended to accessible location outside of fan housing.

G. Pulleys: Cast-iron, adjustable-pitch motor pulley.

H. Fan and motor isolated from exhaust air stream.

I. Accessories: The following items are required:

1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable 1/2-inch mesh, aluminum or brass wire.
3. Ventilated Roof Curbs: Galvanized steel; mitered and welded corners; 2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 2-inch wood nailer. Size as required to suit roof opening and fan base.

M. The motor and bearing shall not come into contact with the discharge air and shall be readily accessible without removal of fan or housing from location.

N. The fan shall have a hinged base allowing inspection and cleaning of the ductwork by tilting the fan assembly on the curb. The fan shall have a grease collector.

O. Fan shall meet NFPA Restaurant requirements. Power ventilators for use for restaurant kitchen exhaust shall comply with UL 762.

2.05 CEILING-MOUNTED VENTILATORS

A. Housing: Steel, lined with acoustical insulation.

B. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.

C. Back-draft damper: Integral.

D. Grille: Aluminum, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

1. Accessories:
   A. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   B. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
   C. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
   D. Motion Sensor: Motion detector with adjustable shutoff timer.
   E. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
   F. Filter: Washable aluminum to fit between fan and grille.
   G. Isolation: Rubber-in-shear vibration isolators.
   H. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.06 ROOF MOUNTED HOODED PROPELLER SUPPLY FAN

A. Description: Hooded, low profile. Roof mounted, direct drive, propeller supply fan

B. Fan shall be manufacturered at an ICO 9001 certified facility. Fan shall be UL 705 listed.

C. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The motor shall be mounted on a welded tubular steel power assembly. The power assembly shall be rigidly secured to the fan housing. The powder coated steel fan housing shall include a minimum 14 gauge base with integral spun venturi and continuously welded curb cap corners. The fan shall be enclosed with a minimum 18 gauge galvanized steel hood bolted to the fan housing. The hood shall have a removable top cap to allow unobstructed access to the motor and power assembly without removing entire hood. The fan inlet shall be protected from entry of foreign material by ½" x ½" galvanized steel screen. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM and static pressure. Unit shall be shipped in ISTA certified transit tested packaging.

D. Coating: All non-galvanized steel fan components shall be Lorenized™ with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

E. Propeller: Propeller shall be extruded aluminum airfoil design with cast aluminum hub. The blade pitch shall be factory set and locked using set screws and roll pin. The hub shall be keyed and locked to the shaft utilizing two set screws or a taper lock bushing. Propeller shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.

2.07 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Enclosure Type: Open Drip Proof.

2.08 FACTORY FINISHES

A. Sheet Metal Parts: Prime coat before final assembly.

B. Exterior Surfaces: Baked-enamel finish coat after assembly.

C. Aluminum Parts: No finish required.

2.09 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required as indicated:

1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

A. Install power ventilators according to manufacturer's written instructions.

B. Support units using the vibration-control devices indicated. Vibration-control devices are specified in Division 23 Section "Vibration Control and Seismic Restraint"

1. Support utility set fans on steel bases or roof supports using housed spring isolators. Secure units to anchor bolts installed in housekeeping base.
2. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

    a. Installation of roof curbs is specified in Division 7 Sections.

3. Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Division 23 Section "Mechanical Identification."

3.03 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

B. Electrical: Conform to applicable requirements in Division 26 Sections.

C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 FIELD QUALITY CONTROL

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

3.05 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

3.06 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.07 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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

B. Final Checks before Startup: Perform the following operations and checks before startup:

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. Starting procedures for fans are as follows:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
2. Measure and record motor voltage and amperage.

C. Shut unit down and reconnect automatic temperature-control operators.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.

D. Replace fan and motor pulleys as required to achieve design conditions.

E. Prepare and submit test and inspection report.

3.08 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

B. Review data in the operation and maintenance manuals. Refer to Division 1 Section "Contract Closeout."

C. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

D. Demonstrate operation of power ventilators. Conduct walking tour of the Project. Briefly identify location and describe function, operation, and maintenance of each power ventilator.

END OF SECTION

SECTION 23 3533

LISTED KITCHEN VENTILATION SYSTEM EXHAUST DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Listed grease ducts.
2. Access doors.

1.03 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 listed grease ducts.

B. Shop Drawings: For listed grease ducts.

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.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.05 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 listed grease ducts and field-fabricated grease ducts.

PART 2 - PRODUCTS

2.01 LISTED GREASE DUCTS

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

1. AMPCO
2. Heat-Fab, Inc.
3. McGill AirFlow LLC
4. Metal-Fab, Inc
5. Schebler Co.
6. Selkirk Corporation
7. Sisneros Bros Mfg., LLC
8. Van-Packer Company, Inc.
9. Ventilation Direct

B. Description: Factory-fabricated, -listed, and -labeled, double-wall ducts tested according to UL 1978 and rated for 500 deg F continuously, or 2000 deg F for 30 minutes; with positive or negative duct pressure and complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 2-inch annular space filled with high-temperature, ceramic-fiber insulation.

1. Inner Shell: ASTM A 666, Type 304 stainless steel.
2. Outer Jacket: Aluminized steel where concealed. Stainless steel where exposed.

D. Gaskets and Flanges: Ensure that gaskets and sealing materials are rated at 1500 deg F minimum.

E. Hood Connectors: Constructed from same material as grease duct with internal or external continuously welded or brazed joints.

F. Accessories: Tees, elbows, increasers, 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. Include unique components required to comply with NFPA 96 including cleanouts, transitions, adapters, and drain fittings.

G. Grease Duct Supports: Construct duct bracing and supports from non-combustible material.

1. Design bracing and supports to carry static and seismic loads within stress limitations of the International Building Code.
2. Ensure that bolts, screws, rivets and other mechanical fasteners do not penetrate duct walls.

H. Comply with ASTM E 2336.

I. Factory Tests: Test and inspect fire resistance of grease duct system according to ASTM E 2336 in presence of Owner.

1. Allow consultant five days' minimum notification before test is performed.

2.02 ACCESS DOORS

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

1. 3M
2. Acudor Products, Inc.
3. Ductmate Industries, Inc.
4. Sachwin Products, Inc.

B. Description: Factory-fabricated, -listed, and -labeled, double-wall personnel and maintenance access doors tested according to UL 1978 and rated for 500 deg F continuously, or 2000 deg F for 30 minutes; with positive or negative duct pressure and complying with NFPA 211.

1. Construction: 0.0625 inch ASTM A 666, Type 304 stainless-steel inner shell and aluminized-steel outer cover with two handles.
2. Fasteners: Stainless-steel bolts and wing nuts.
    a. Ensure that bolts do not penetrate interior of duct space.
3. Maintenance Access Door Dimensions: 7 x 7 inches.
4. Personnel Access Door Dimensions: 22 x 20 inches.
5. Door Label: Mark door with uppercase lettering as follows: "ACCESS PANEL. DO NOT OBSTRUCT."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Comply with requirements in Section 077200 "Roof Accessories."

B. Coordinate connections to kitchen exhaust hoods described in the Food Service drawings and specifications.

C. Coordinate connections to exhaust fans with requirements in section 233423 “HVAC Power Ventilators”.

D. Coordinate firestopping where grease ducts penetrate fire separations with requirements in Section 078413 "Penetration Firestopping."

E. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211 and UL 2221, whichever is most stringent.

F. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease and condensation sloped a minimum of 2 percent to drain grease back to the hood.

G. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 12 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.

H. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

I. Connections: Make grease duct connections according to the International Mechanical Code.

1. Grease duct to exhaust fan connections: Connect grease ducts to inlet side of fan using flanges, gaskets, and bolts.
2. Grease duct to hood connections:

a. Make grease duct to hood joints connections using internal or external continuously welded or brazed joints.
b. Make watertight grease duct to hood joints connections using flanges, gaskets, and bolts.

J. Seal between sections of grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

K. Perform a light test of grease ductwork per International Mechanical Code prior to concealment by insulation or covered by shaft.

L. Perform light test in the presence of local Inspector/Engineer.

M. Document whether test passed or failed.

N. Repair any joints or duct welds that fail light test to the point the ductwork passes the light test.

O. Install grease duct with minimum clearance to combustibles as required by IBC and local codes. Installations that do not meet the minimum required clearances shall be fire wrapped as specified in Section 230713 “Duct Insulation”.

P. Provide approved fire-wrap insulation that meets ASTM C 656.

Q. Support ducts at intervals recommended by manufacturer to support weight of ducts and accessories, without applying loading on kitchen hoods.

1. Securely attach supports and bracing to structure.

R. Grease Duct Enclosures: Comply with requirements of the International Building Code and ASTM E 2336.

S. Coordinate fire-rated enclosure construction with Section 092116.23 "Gypsum Board Shaft Wall Assemblies."

T. Repair damage to adjacent materials caused by listed kitchen ventilation system exhaust ducts installation.

3.03 FIELD QUALITY CONTROL

A. Perform air leakage test in presence of Owner before concealment of any portion of the grease duct system.

1. Notify Owner a minimum of five days before test is performed.

END OF SECTION 23 3533

SECTION 233700

HEAT EXCHANGERS

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 shell-and-tube heat exchangers and plate heat exchangers for HVAC and plumbing applications.

1.3 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each type of product indicated. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Maintenance Data: For heat exchangers to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of heat exchangers and are based on the specific equipment indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

B. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. ITT Fluid Handling; Div. of ITT Fluid Technology Corp.
2. Mueller Paul Company.
3. Taco, Inc.

2.2 PLATE HEAT EXCHANGERS

A. Configuration: Freestanding assembly consisting of frame support, fixed and movable end plates, tie rods, plates, and one-piece gaskets.

B. End-Plate Material: Painted carbon steel with steel tie-rods.

C. End-Plate Material: ASTM A 666, Type 304 stainless steel.

D. Plate Material: ASTM A 666, Type 316 stainless-steel shell.

E. Gasket Material: EPDM.

F. Piping Connections: Threaded. Fouling factor shall be 0.0005.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

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

3.2 HEAT EXCHANGER INSTALLATION

A. Install heat exchangers according to manufacturer's written instructions.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.

C. Install piping with threaded or flanged connections at heat exchangers.

D. Install shutoff valves at heat exchanger inlet and outlet connections.

E. Install relief valves on heat exchanger heated-fluid connection.

F. Install vacuum breaker at heat exchanger steam inlet connection.

3.4 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.5 COMMISSIONING

A. Verify that heat exchangers are installed and connected according to the Contract Documents.

B. Adjust flows and controls to deliver specified performance.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining heat exchangers.
2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 233700

SECTION 23 3713

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This section includes ceiling- and wall-mounted diffusers, registers, and grilles.

B. Related Sections:

1. Section 23 3714 "Fixed Louvers".
2. Section 23 3300 "Air Duct Accessories".
3. Section 23 0594 "General Testing, Adjusting and Balancing"

1.03 ACTION 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.
3. Provide manufacturer’s color chart for units scheduled for “custom color selected by Architect”.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

1.05 QUALITY ASSURANCE

A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated.

B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Air Factors
2. Carnes.
3. Kruegar.
4. Metal Aire, Inc.
5. Nailor Industries Inc.
6. Price Industries.
7. Titus.
8. Tuttle & Bailey.

2.02 REGISTERS, GRILLES, & DIFFUSERS

A. General: The frames for all registers, grilles, and diffusers shall match type of ceiling where they are to be installed. Special frames shall be provided for narrow T-bar ceilings. Refer to reflected ceiling plan and other specification divisions for ceiling type. See Drawings and Diffuser Schedules for additional information.

B. PERSONAL SELF-MODULATING DIFFUSER

C. VAV cooling and VAV heating modes. Diffuser shall provide variable air volume control and regulate supply air volume to maintain room temperature settings. The VAV actuator mechanism shall be fully electronic direct drive with immediate response to control signals from the controller board. High torque 12-volt DC gear motor. Remote mounted thermostat. Duct temperature sensor for auto changeover. Thermal expansion devices are not acceptable. Provide and install all necessary control wiring and control voltage transformer. See Drawings and Diffuser Schedules for additional information.

2.03 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

3.01 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.

3.02 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, coordination drawings, original design, and referenced standards.

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.

3.03 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.04 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION

SECTION 23 3714

FIXED LOUVERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Fixed, extruded-aluminum louvers.

B. Related Requirements:

1. Section 09 9113 "Exterior Painting" for field painting louvers.

1.03 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).

C. Vertical Louver: Louver with vertical blades (i.e., the axes of the blades are vertical).

D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
2. Show mullion profiles and locations.

1.05 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.07 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.02 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.

B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

D. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.03 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Drainable-Blade Louver :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Airolite Company, LLC (The).
   b. Pottorff.
   c. Ruskin Company; Tomkins PLC.

2. Louver Performance Ratings:

   a. Free Area: Not less than 8.5 sq. ft. for 48-inch- wide by 48-inch- high louver.
   b. Point of Beginning Water Penetration: Not less than 1250 fpm.
   c. Air Performance – intake: Not more than 0.10-inch wg static pressure drop at 900-fpm free-area velocity.
   d. Air Performance – exhaust: Not more than 0.15-inch wg static pressure drop at 1000-fpm free-area velocity.

3. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.04 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

   1. Screen Location for Fixed Louvers: Interior face.
   2. Screening Type: Bird screening.

B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of 6 inches from each corner and at 12 inches o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

   1. Metal: Same type and form of metal as indicated for louver to which screens are attached.
   2. Finish**:** Same finish as louver frames to which louver screens are attached.
   3. Type: Rewirable frames with a driven spline or insert.

D. Louver Screening for Aluminum Louvers:
   1. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.051-inch wire.

2.05 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Use types and sizes to suit unit installation conditions.
   1. Contractor shall use Phillips flat-head or hex-head screws for exposed fasteners screws for exposed fasteners unless otherwise indicated.
   2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
   3. For color-finished louvers, use fasteners with heads that match color of louvers.

D. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.06 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: Channel Exterior flange unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.07 ALUMINUM FINISHES

A. Finish louvers after assembly.

B. Color Anodic Finish: AAMA 611, or thicker.

1. Color: As selected by Architect from full range of industry colors and color densities.

C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As selected by Architect from manufacturer's full range color and gloss.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.02 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.03 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather-tight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weather-tight louver joints are required. Comply with Section 07 9200 "Joint Sealants" for sealants applied during louver installation.

3.04 ADJUSTING AND CLEANING

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

SECTION 23 3723

HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Roof hoods.

B. Products furnished, but not installed, under this Section include roof curbs for roof-mounted exhaust fans.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design ventilators, including comprehensive engineering analysis by a qualified professional engineer, using structural and seismic performance requirements and design criteria indicated.

B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

   1. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft. inward or outward.

C. Seismic Performance: Ventilators, including attachments to other construction, 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."

D. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.04 ACTION SUBMITTALS

A. Product Data:

   1. For Louvered-Penthouse Ventilators specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

2. Drawings from each manufacturer detailing equipment assemblies. Indications of dimensions, loadings, required clearances, method of field assembly, components and location and size of each field connection.

3. Rated capacities of each unit, weights (shipping, installed and operating), furnished specialties, accessories and the following:

   a. Material gages and finishes, including color charts.
   b. Dampers, including housings, linkages and operators.

B. Shop Drawings: For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

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

1. Detail fabrication and assembly of shop-fabricated ventilators.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which roof curbs and ventilators will be attached.
2. Sizes and locations of roof openings.

B. Seismic Qualification Certificates: For ventilators, 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.

1.06 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Fasteners: 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use Phillips flat, hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

2.02 FABRICATION, GENERAL

A. Factory or shop fabricated gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.03 ROOF HOODS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Mfg. Corporation.
2. Aerovent.
3. Greenheck Fan Corporation.
4. Loren Cook Company.

B. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.

C. Materials: Aluminum sheet, minimum 0.063-inch thick base and 0.050-inch thick hood; suitably reinforced.

D. Roof Curbs: Galvanized-steel sheet; with 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 fit roof opening and ventilator base.
1. Configuration: Self-flashing without a cant strip [Built-in cant] [Built-in raised cant] and mounting flange.
2. Overall Height: 14 inches.

E. Insect Screening: Aluminum, 1/24-inch square mesh, 0.051-inch wire.

F. Capacities and Characteristics: refer to schedules.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Install gravity ventilators with clearances for service and maintenance.

C. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

D. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 07 9200 "Joint Sealants" for sealants applied during installation.

E. Label gravity ventilators according to requirements specified in Section 23 0553 "Identification for HVAC Piping and Equipment."

F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

G. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.03 CONNECTIONS

A. Duct installation and connection requirements are specified in Section 23 3113 "Metal Ducts". Drawings indicate general arrangement of ducts and duct accessories.

3.04 ADJUSTING

A. Adjust damper linkages for proper damper operation.

3.05 CLEANING

A. Clean interiors to remove foreign material, dirt and construction debris.

3.06 DEMONSTRATION

A. Train Owner’s maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing and preventative maintenance.

B. Review data in the operation and maintenance manuals.

C. Schedule training with Owner, through Architect with at least seven (7) days' advance notice.

END OF SECTION

SECTION 23 5100

BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Type B and BW vents.
2. Special Gas Vents, Category IV, positive pressure, condensing.
3. Guy wires and connectors.

B. Related Sections include the following:

1. Division 23 Section "Condensing Boilers".

1.03 ACTION SUBMITTALS

A. Product Data: For the following:

1. Type B and BW vents.
2. Special Gas Vents, Category IV, positive pressure, condensing.
3. Guy wires and connectors.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Flue Draft Analysis: Provide a Flue Draft Analysis showing the flue and combustion air duct comply with the Boiler Manufacturer's flue and combustion air duct requirements. Analysis shall use project design altitude and flue/duct shop drawings based on actual project conditions including all required elbows, fittings and terminations.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Manufacturer Seismic Qualification Certification: Submit certification that factory-fabricated breeching, chimneys, and stacks; accessories; and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2. Dimensioned Outline Drawings of Breeching, Chimneys, and Stacks: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of anchorage devices on which the certification is based and their installation requirements.

C. Warranty: Special warranty specified in this Section.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.

C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.06 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 LISTED TYPE B AND BW VENTS

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:

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

1. Ampco.
2. Cleaver-Brooks; Div. of Aqua-Chem Inc.
3. Heat-Fab, Inc.
4. Metal-Fab, Inc.
5. Schebler Co. (The).
6. Selkirk Inc.; Selkirk Metalbestos and Air Mate.
7. Simpson Dura-Vent Co., Inc.; Subsidiary of Simpson Manufacturing Co.
8. Tru-Flex Metal Hose Corp.
9. Van-Packer Company, Inc.

D. 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.

E. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace.

F. Inner Shell: ASTM B 209 Type 1100 aluminum.

G. Outer Jacket: Galvanized steel.

H. 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.

2.02 LISTED SPECIAL GAS VENTS (Category IV) Positive pressure condensing.

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:

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

1. AMPCO
2. Heat-Fab, Inc.
3. Metal-Fab, Inc.
4. Schebler Co. (The).
5. Selkirk Inc.; Selkirk Metalbestos and Air Mate.
6. Z-Flex; Flexmaster Canada Limited.

D. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive flue pressure complying with NFPA 211.

E. Construction: Inner shell and outer jacket separated by minimum 1/2-inch airspace.

F. Inner Shell: ASTM A 959, Type AL29-4C stainless steel.

G. Outer Jacket: Aluminized steel.

H. 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.

2.03 GUYING AND BRACING MATERIALS

A. Cable: Three galvanized, stranded wires of the following thickness:

1. Minimum Size: 1/4 inch (6 mm) in diameter.
2. For ID Sizes 4 to 15 Inches (100 to 381 mm): 5/16 inch (8 mm).
3. For ID Sizes 18 to 24 Inches (457 to 610 mm): 3/8 inch (9.5 mm).
4. For ID Sizes 27 to 30 Inches (685 to 762 mm): 7/16 inch (11 mm).
5. For ID Sizes 33 to 36 Inches (838 to 915 mm): 1/2 inch (13 mm).
6. For ID Sizes 39 to 48 Inches (990 to 1220 mm): 9/16 inch (14.3 mm).
7. For ID Sizes 51 to 60 Inches (1295 to 1524 mm): 5/8 inch (16 mm).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.02 APPLICATION

A. Listed Type B and BW Vents: Vents for certified gas appliances.

B. Listed Special Gas Vent: Condensing gas appliances.

3.03 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

B. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

E. Lap joints in direction of flow.

F. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.

G. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.

H. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.

3.04 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION

SECTION 23 5216

CONDENSING BOILERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

B. This Division shall arrange and pay to have the State of Utah inspect the Boilers for operation.

C. The Boiler manufacturer shall supply as part of the boiler package a completely integrated Boiler Management System (equal to Aerco Model 5R5-384, with a BACnet/LONworks gateway).

D. Boiler Management System shall control all operations and energy input into the boiler plant. The Boiler Management System shall be comprised of a microprocessor based controller utilizing LONworks or BACnet protocol to communicate with the boilers via the RS-485 port. The Boiler Management System panel is to ship loose for mounting by this contractor. Boiler Management System shall have the ability to reset the water temperature setpoint via a 4-20 MA signal from the Building Management system.

E. Control wiring shall be performed by temperature control contractor. Control contractor to supply 4-20 MA signal to BMS panel. Control contractor to wire between the BMS and boilers per manufacturers instructions. The Boiler manufacturer is to supply remote temperature setpoint ability via a 4-20 MA signal from the Building Management system.

F. The Boiler shall come with all controls to operate and interface with the Building Management System.

1.03 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

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

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

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

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

F. Utah State Boiler Code.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:

a. Leakage and Materials: 10 years from date of Substantial Completion.
b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 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:

1. AERCO International Benchmark Series.
2. Cleaver Brooks Clearfire Series.
3. HydroTherm KN Series.

2.02 MANUFACTURED UNITS

A. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

B. Heat Exchanger: Stainless Steel or Cast Iron combustion chamber.

C. Pressure Vessel: Stainless Steel or Cast Iron with welded heads and tube connections.

D. Burner: Natural gas, forced draft.

E. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.

1. Motors: Comply with requirements specified in Division 15 Section "Common Motor Requirements for HVAC Equipment."

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

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

H. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Powder-coated protective finish.
4. Insulation: Minimum 2-inch- (50-mm-) thick, polyurethane-foam insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.
6. Mounting base to secure boiler.

a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

2.03 TRIM

A. Include devices sized to comply with ANSI B31.1, "Power Piping."

B. Aquastat Controllers: Operating, firing rate, and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Automatic.

F. Drain Valve: Minimum NPS 3/4 (DN 20) hose-end gate valve.

G. Factory condensate neutralization device.

2.04 CONTROLS

A. Refer to Section "Building Management and Control Systems"

B. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms.

1. Hardwired Points:

a. Monitoring: On/off status, common trouble alarm low water level alarm.
b. Control: On/off operation, hot water supply temperature set-point adjustment.

2. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.05 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to fused disconnect switch.
5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
6. Provide each motor with over-current protection.

2.06 VENTING KITS

A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.07 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.02 BOILER INSTALLATION

A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Vibration Isolation: Elastomeric isolation pads with a minimum static deflection of 0.25 inch. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install gas-fired boilers according to NFPA 54.

D. Assemble and install boiler trim.

E. Install electrical devices furnished with boiler but not specified to be factory mounted.

F. Install control wiring to field-mounted electrical devices.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Install air vent, drain valve, condensate neutralization device and piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC."

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Install piping from safety relief valves to nearest floor drain.

H. Boiler Venting:

1. Install flue venting kit and combustion-air intake.
2. Connect full size to boiler connections.

I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

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

B. Tests and Inspections:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and steam pressure.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.

    a. Test for full capacity.

4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

E. Arrange for inspection by the Utah State Boiler Inspector.

END OF SECTION

SECTION 23 5533

FUEL-FIRED UNIT HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:
   1. Gas-fired unit heaters.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of fuel-fired unit heater indicated. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings: **For fuel-fired unit heaters** Include plans, elevations, sections, details, and attachments to other work.

   1. Prepared by or under the supervision of a qualified professional engineer detailing fabrication and assembly of fuel-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. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   4. Wiring Diagrams: **Power, signal, and control** wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

   1. Structural members to which equipment will be attached.
   2. Items penetrating roof and the following:

      a. Vent and gas piping rough-ins and connections.

B. Manufacturer Seismic Qualification Certification: Submit certification that fuel-fired unit heaters, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

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

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.06 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. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace heat exchanger of fuel-fired unit heater that fails in materials or workmanship within specified warranty period.

1. Warranty Period: **Two** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GAS-FIRED UNIT HEATERS

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. Modine Manufacturing Company.
2. Reznor/Thomas & Betts Corporation.
3. Sterling HVAC Products; Div. of Mestek Technology Inc.

C. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.

D. Fuel Type: Design burner for natural or propane gas having characteristics same as those of gas available at Project site.

E. Type of Venting: **Indoor, separated combustion, power** vented.

F. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.

1. External Casings and Cabinets: **powder coating** over corrosion-resistant-treated surface.
2. Suspension Attachments: Reinforce suspension attachments at connection to fuel-fired unit heaters.

    a. Seismic Fabrication Requirements: Fabricate suspension attachments of fuel-fired unit heaters, accessories mountings, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when fuel-fired unit heater is anchored to building structure.

G. Heat Exchanger: **Aluminized** steel.

H. Burner Material: **Aluminized steel with stainless-steel inserts**.

I. Unit Fan: **Formed-steel** propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.

1. Fan-Blade Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
2. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

    a. Motors: Totally enclosed with internal thermal-overload protection and complying with Division 23 Section "Common Motor Requirements for HVAC Equipment."
    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. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

J. Unit Fan: Steel, centrifugal fan dynamically balanced and resiliently mounted.

1. Direct-Drive Units: Motor and fan guard resiliently mounted to housing in blow-through configuration.

2. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

    a. Motors: Totally enclosed with internal thermal-overload protection and complying with Division 23 Section "Common Motor Requirements for HVAC Equipment."
    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. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

K. 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. **Thermostat:** Single-stage, wall-mounted, electronic setback type with **50 to 90 deg F** operating range and fan on switch.

L. Discharge Louvers: Independently adjustable horizontal blades.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install and connect gas-fired unit heaters and associated fuel and vent features and systems according to **NFPA 54**, applicable local codes and regulations, and manufacturer's written installation instructions.

B. 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. Restrain the unit to resist code-required horizontal acceleration.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to fuel-fired unit heater to allow service and maintenance.

C. **Gas Piping**: Comply with **Division 23 Section "Facility Natural-Gas Piping."** Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Vent Connections: Comply with Division 23 Section "Breechings, Chimneys, and Stacks."

E. Electrical Connections: Comply with applicable requirements in Division 26 Sections.

1. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.03 FIELD QUALITY CONTROL

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

B. Perform tests and inspections and prepare test reports.

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

C. 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.

D. Remove and replace malfunctioning units and retest as specified above.

3.04 ADJUSTING

A. Adjust initial temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.05 DEMONSTRATION

A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain fuel-fired unit heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 235533

SECTION 23 6800

COOLING TOWERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Open-circuit, induced-draft, crossflow cooling towers.

1.03 DEFINITIONS

A. BMS: Building management system.

B. FRP: Fiber-reinforced polyester.

1.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design cooling tower support structure[and seismic restraints] [and wind restraints], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Cooling towers shall withstand the effects of earthquake motions determined according to SEI/ASCE 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."
2. 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."

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, pressure drop, fan performance data, rating curves with selected points indicated, furnished specialties, and accessories.

1. Maximum flow rate.
2. Minimum flow rate.
3. Drift loss as percent of design flow rate.
4. Volume of water in suspension for purposes of sizing a remote storage tank.

5. Sound power levels in eight octave bands for operation with fans off, fans at minimum, and design speed.
6. Performance curves for the following:

    a. Varying entering-water temperatures from design to minimum.
    b. Varying ambient wet-bulb temperatures from design to minimum.
    c. Varying water flow rates from design to minimum.
    d. Varying fan operation (off, minimum, and design speed).

7. Fan airflow, brake horsepower, and drive losses.
8. Pump flow rate, head, brake horsepower, and efficiency.
9. Motor amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
10. Electrical power requirements for each cooling tower component requiring power.

B. Shop Drawings: Complete set of manufacturer's prints of cooling tower assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Sizes and locations of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

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

1. Detail fabrication and assembly of support structure.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
4. Design Calculations: Calculate requirements for selecting vibration isolators and wind restraints and for designing vibration isolation bases.
5. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and wind restraints and for designing vibration isolation bases.

1.06 INFORMATIONAL SUBMITTALS

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

1. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Seismic Qualification Certificates: For cooling towers, accessories, and components, from manufacturers.

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.

D. Source quality-control reports.

E. Field quality-control reports.

F. Startup service reports.

G. Warranty: Sample of special warranty.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

1.08 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by CTI.
B. Testing Agency Qualifications: An NRTL.

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

D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. CTI Certification: Cooling tower thermal performance according to CTI STD 201, "Certification Standard for Commercial Water-Cooling Towers Thermal Performance."

1.09 COORDINATION

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

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:

1. Fan assembly including fan, drive, and motor.
2. All components of cooling tower.

3. Warranty Period: [Five] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 OPEN-CIRCUIT, INDUCED-DRAFT, CROSSFLOW COOLING TOWERS

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

1. Baltimore Aircoil Company.
2. Marley Cooling Technologies, an SPX Corporation.
3. Evapco.

B. Fabricate cooling tower mounting base with reinforcement strong enough to resist cooling tower movement during a seismic event when cooling tower is anchored to field support structure.

C. Cooling tower designed to resist wind load of 30 lbf/sq. ft.

D. Casing and Frame:

1. Casing and Frame Material: Galvanized steel, ASTM A 653, G235 coating .
2. Casing and Frame Material: [FRP with UV inhibitors] [Galvanized steel, ASTM A 653, G235 coating] [Polymer-coated galvanized steel] [Stainless steel].
3. Fasteners: Galvanized steel.
4. Fasteners: Stainless steel.
5. Joints and Seams: Sealed watertight.
6. Welded Connections: Continuous and watertight.

E. Collection Basin:

1. Material:
   a. Galvanized steel, ASTM A 653, G235 coating.
   b. Stainless steel, 304 or 316.
   c. FRP with UV inhibitors (exclusive to Marley Quadra and Marley AquaTower).
   d. Fiberglass (exclusive to Marley Quadra).
   e. “Tri-Armor” with G235 coating over Stainless Steel (exclusive to Baltimore AC).
2. Strainer: Removable strainer with openings smaller than nozzle orifices.
3. Strainer: Removable stainless-steel strainer with openings smaller than nozzle orifices.
4. Overflow and drain connections.
5. Makeup water connection.
6. Outlet Connection: ASME B16.5, Class 150 flange.
7. Removable equalization flume plate between adjacent cells of multiple-cell towers.
8. Basin Sweeper Distribution Piping and Nozzles:
   a. Pipe Material: PVC.
   b. Nozzle Material: Plastic.
   c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.

F. Mechanically Operated, Collection Basin Water-Level Control: Manufacturer's standard adjustable, mechanical float assembly and valve.

G. Pressure Reducing Valve: Field installed Direct Type Water Pressure-Reducing Valve. ASME 1003. 150-psig rated working pressure. Bronze body.

H. Ultrasonic Collection Basin Water-Level Controller with Solenoid Valve:

1. Enclosures: NEMA 250, Type 4 .
2. Enclosures: NEMA 250, Type 4X.
3. Controller: Ultrasonic level sensor/transmitter and relays factory wired to a terminal strip to control water makeup valve and signal a level alarm. Controller shall provide continuous level indication through a 4- to 20-mA signal for connection to BMS .
4. Water Stilling Chamber: Corrosion-resistant material.
5. Water Stilling Chamber: [FRP] [Galvanized steel] [PVC pipe] [Stainless steel].
6. Solenoid Valve: Slow closing with stainless-steel body; controlled and powered through level controller in response to water-level set point.
7. Electrical Connection Requirements: 120 V, single phase, 60 Hz.

I. Electric Basin Heater:

1. Stainless-Steel Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
2. Heater Control Panel: Mounted on the side of each cooling tower cell.
3. Enclosure: NEMA 250, Type 4.
4. Enclosure: NEMA 250, [Type 3R] [Type 4X] .
5. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
6. Control-circuit transformer with primary and secondary side fuses.
7. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
8. Single-point, field-power connection to a circuit breaker and heater branch circuiting complying with NFPA 70.
9. Single-point, field-power connection to a [nonfused disconnect switch] [fused disconnect switch] and heater branch circuiting complying with NFPA 70.
10. Factory Wiring Method: Metal raceway for factory-installed wiring outside of enclosures, except make connections to each electric basin heater with liquidtight conduit.

J. Gravity Water Distribution Basin: Non-pressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated.

1. Galvanized steel, ASTM A 653, G235 coating.
2. Stainless steel, 304 or 316.
3. FRP with UV inhibitors (exclusive to Marley Quadra and Marley AquaTower).
4. Fiberglass (exclusive to Marley Quadra).
5. “Tri-Armor” with G235 coating over Stainless Steel (exclusive to Baltimore AC).
6. Location: Over each bank of fill with easily replaceable plastic spray nozzles mounted in bottom of basin.
7. Inlet Connection: ASME B16.5, Class 150 flange.
8. Joints and Seams: Sealed watertight.
9. Partitioning Dams: Same material as basin to distribute water over the fill to minimize icing while operating throughout the flow range indicated.
10. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable corrosion-resistant hardware.
11. Removable Panels: Same material as basin to completely cover top of basin. Secure

panels to basin with removable stainless-steel hardware.

12. Valves: Manufacturer's standard valve installed at each inlet connection and arranged to balance or shut off flow to each gravity distribution basin.
13. Single-Inlet, Field Pipe Connection:
    Piping arranged to provide balancing of flow within cooling tower cell without the need for additional balancing valves:
    1) Galvanized-steel pipe.
    2) PVC pipe.
    b. Pipe each cooling tower cell internally to a single, field connection suitable for mating to an ASME B16.5, Class 150 flange:
    1) Connection located on the bottom unless otherwise indicated.
    2) Connection located on the side unless otherwise indicated.

K. Fill:

1. Materials: PVC, with maximum flame-spread index of 25 according to ASTM E 84:
2. Materials: PVC, with maximum flame-spread index of 5 according to ASTM E 84:
3. Minimum Thickness: 15 mils, before forming.
4. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
5. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 deg F.

L. Drift Eliminator:

1. Material: Maximum flame-spread index of 5 according to ASTM E 84.
   a. PVC.
   b. FRP.
   c. FRP or PVC.
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Configuration: Multipass, designed and tested to reduce water carryover to achieve performance indicated.
4. Location: Integral to fill.
5. Location: Separate and removable from fill.

M. Air-Intake Louvers:

1. Material: Matching casing.
2. Material: [FRP] [PVC].
3. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
4. Louver Blades: Arranged to uniformly direct air into cooling tower, to minimize air resistance, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.
5. Location: Integral to fill.
6. Location: Separate from fill.

A. Removable Air-Intake Screens:

1. Galvanized –steel wire mesh.
2. Polymer-coated, galvanized–steel wire mesh.
3. Stainless-steel wire mesh.

B. Axial Fan: Balanced at the factory after assembly.

1. Blade Material: Aluminum.
2. Blade Material: [FRP] [Galvanized steel] .
3. Hub Material: Aluminum.
4. Hub Material: [FRP] [Galvanized steel] .
5. Blade Pitch: Field adjustable.
6. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
7. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F.
    a. Bearings designed for an L-10 life of 50,000 hours.
    b. Bearings designed for an L-10 life of 40,000 hours.
8. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.

C. Belt Drive:

1. Service Factor: 1.5 based on motor nameplate horsepower.
2. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
3. Belt: Multiple V-belt design with a matched set of cogged belts.
4. Belt: One-piece, multigrooved, solid-back belt.
5. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
6. Belt-Drive Guard: Comply with OSHA regulations.
7. Two-Motor, Single-Fan Drive:
    a. Two single-speed motors per fan, one sized for full speed and load and the other sized for 67 percent of full-load speed.
    b. Each motor with belt drive and configured for operation when other motor fails.
    c. Controls and wiring same as two-speed, two-winding motor.

D. Gear Drive: Right angle, reduced speed, and designed for cooling tower applications according to CTI STD 111. Motor and gear drive shall be aligned before shipment.

1. Gear Drive and Coupling Service Factor: [2.0] <Insert value> based on motor nameplate horsepower.
2. Housing: Cast iron, with epoxy or polyurethane finish, beveled high-strength steel gears continuously bathed in oil, and with lubrication to other internal parts at all operating speeds.
3. Mounting: Directly mounted to fan hub and connected to motor so motor shaft is in horizontal position.
4. Operation: Able to operate both forward and in reverse.
5. Drive-to-Motor Connection: [Close coupled to motor using a flexible coupling] [Connected to motor located outside of cooling tower casing by a full-floating drive shaft].
6. Drive Shaft Material: [Corrosion resistant] [Stainless steel], and fitted with flexible couplings on both ends. Provide exposed shaft and couplings with guards according to OSHA regulations.
7. Extend oil fill, drain, and vent to outside of cooling tower casing using galvanized-steel piping. Provide installation with oil-level sight glass.

E. Fan Motor:

1. General Requirements for Fan Motors: Comply with NEMA designation and temperature-rating requirements specified in Division 23 "Common Motor Requirements for HVAC Equipment" and not indicated below.
2. Motor Enclosure: Totally enclosed air over (TEAO).
3. Motor Enclosure: [Totally enclosed] [Totally enclosed fan cooled (TEFC)] [with epoxy or polyurethane finish] .
4. Energy Efficiency: Comply with ASHRAE/IESNA 90.1 .
5. Energy Efficiency: NEMA Premium Efficient .
6. Service Factor: 1.15.
7. Insulation: Class F.
8. Insulation: Class H.
9. Variable-Speed Motors: Inverter-duty rated per NEMA MG-1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
10. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
11. Severe-duty rating with the following features:
    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.
    b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F
    c. Internal heater automatically energized when motor is de-energized.
12. Motor Base: Adjustable, or other suitable provision for adjusting belt tension.

F. Fan Discharge Stack:

1. Material shall match casing, manufacturer's standard design.
2. Material shall match casing, velocity recovery design.
3. Stack Extension: Fabricated to extend above fan deck unless otherwise indicated.
4. Stack Termination: Wire-mesh, galvanized-steel screens; complying with OSHA regulations.

G. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4X.
2. Enclosure: NEMA 250, Type 4.
3. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
4. Provide switch; Field connection to a BMS and hardwired connection to fan motor electrical circuit.
5. Provide switch; [With manual-reset button] for [field connection to a BMS and] hardwired connection to fan motor electrical circuit.
6. Switch shall, on sensing excessive vibration, signal an alarm through the BMS and shut down the fan.

H. Gear-Drive, Oil-Level Switch: Low-oil-level warning switch[for connection to a BMS].

1. Switch shall, on reaching a low-oil-level set point recommended by cooling tower manufacturer, signal an alarm [through the BMS].

I. Capacity-Control Dampers: [Galvanized-steel] [Stainless-steel] dampers, with linkages, electric operator, controller, limit switches, transformer, and weatherproof enclosure.

J. Controls: Comply with requirements in Division 23 "Instrumentation and Control for HVAC."

K. Control Package: Factory installed and wired, and functionally tested at factory before shipment.

1. NEMA 250, [Type 3R] enclosure with removable internally mount backplate.
2. Control-circuit transformer with primary and secondary side fuses.
3. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
4. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
5. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
6. Collection basin level controller complying with requirements in ["Ultrasonic Collection Basin Water-Level Controller with Solenoid Valve"] Paragraph.
7. Electric basin heaters with temperature control and low-water-level safety switch for each cell, complying with requirements in "Electric Basin Heater" Paragraph.
8. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
9. Oil-level switch for each fan with a gear drive, complying with requirement in "Gear-Drive, Oil-Level Switch" Paragraph.
10. Single-point, field-power connection to a [non-fused disconnect switch] [for each cooling tower cell].

    a. Branch power circuit to each motor and electric basin heater and to controls[with a disconnect switch or circuit breaker].
    b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

11. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
12. Visual indication of status and alarm[with momentary test push button] for each motor.
13. Audible alarm and silence switch.
14. Visual indication of elapsed run time, graduated in hours for each motor.
15. Cooling tower shall have hardware to enable BMS to remotely monitor and display the following:

    a. Operational status of each motor.
    b. Position of dampers.
    c. Cooling tower leaving-fluid temperature.
    d. Fan vibration alarm.
    e. Oil-level alarm.
    f. Collection basin [high] [low] [high- and low]-water-level alarms.
    g. <Insert conditions to be monitored>.

L. Personnel Access Components:

1. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
2. External Ladders with Safety Cages: Aluminum, galvanized- or stainless-steel, fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.

3. External Platforms with Handrails: Aluminum, FRP, or galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
4. Handrail: Aluminum, galvanized steel, or stainless steel complete with kneerail and toeboard, around top of cooling tower. Comply with 29 CFR 1910.23.
5. Internal Platforms: Aluminum, FRP, or galvanized-steel bar grating.

    a. Spanning the collection basin from one end of cooling tower to the other and positioned to form a path between the access doors. Platform shall be elevated so that all parts are above the high water level of the collection basin.
    b. Elevated internal platforms with handrails accessible from fixed vertical ladders to access the fan drive assembly when out of reach from collection basin platform.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting tower performance, maintenance, and operation.

1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

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

3.02 INSTALLATION

A. Install cooling towers on support structure indicated.

B. Equipment Mounting:

1. Install cooling towers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in:
    a. Section 033000 "Cast-in-Place Concrete."
    b. Section 033053 "Miscellaneous Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Division 23 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Division 23 "Vibration Controls for HVAC."

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

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

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general

arrangement of piping, fittings, and specialties.

B. Install piping adjacent to cooling towers to allow service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Provide drain piping with valve at cooling tower drain connections and at low points in piping.

E. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.

F. Domestic Water Piping: Comply with applicable requirements in Division 22 "Domestic Water Piping." Connect to water-level control with shutoff valve and union, flange, or mechanical coupling at each connection.
   1. Install fill line PRV in a heated or freeze proof location. Set pressure to ensure fill to just below the topmost piping point and chiller condenser is always flooded.

G. Supply and Return Piping: Comply with applicable requirements in Division 23 "Hydronic Piping" and Division 23 Hydronic Piping Specialties." Connect to entering cooling tower connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a:

   1. Union.
   2. [Flange].
   3. [Mechanical coupling].
   4. [Union, flange, or mechanical coupling].

H. Equalizer Piping: Piping requirements to match supply and return piping. Connect an equalizer pipe, full size of cooling tower connection, between tower cells. Connect to cooling tower with shutoff valve.

I. Hot-Water Piping: Comply with applicable requirements in Division 23 "Hydronic Piping" and Division 23 Hydronic Piping Specialties." Connect to supply and return basin heater with shutoff valve, strainer, control valve, and union or flange on supply connection and union or flange and balancing valve on return connection. Provide supply and return piping with pressure gage and thermometer.

J. Steam and Condensate Piping: Comply with applicable requirements in Division 23 "Steam and Condensate Heating Piping" and Division 23 Steam and Condensate Piping Specialties." Connect steam supply to basin heater with shutoff valve, strainer, control valve, and union or flange and condensate piping with union or flange, shutoff valve, strainer, and an appropriate steam trap.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform field tests and inspections.

C. Perform tests and inspections.

   1. Manufacturer's Field Service: Engage a factory-authorized service representative to

inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections: Comply with;

1. ASME PTC 23, "ASME Performance Test Codes - Code on Atmospheric Water Cooling Equipment.
2. CTI ATC 105, "Acceptance Test Code for Water Cooling Towers."

E. Cooling towers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.05 STARTUP SERVICE

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

C. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

D. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Clean entire unit including basins.
b. Verify that accessories are properly installed.
c. Verify clearances for airflow and for cooling tower servicing.
d. Check for vibration isolation and structural support.
e. Lubricate bearings.
f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
g. Adjust belts to proper alignment and tension.
h. Verify proper oil level in gear-drive housing. Fill with oil to proper level.
i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
j. Check vibration switch setting. Verify operation.
k. Verify water level in tower basin. Fill to proper startup level. Check makeup water-level control and valve.
l. Verify operation of basin heater and control.
m. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
n. Replace defective and malfunctioning units.
o. Adjust fill PRV to ensure flooded piping and condenser.

E. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

F. For systems with galvanized components, perform an anti-corrosion passivation rinse with appropriate acid-solution. Follow correct procedure to rinse acid-solution away as required.

G. Prepare a written startup report that records the results of tests and inspections.

3.06 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

3.07 DEMONSTRATION

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

1. Field performance test to include:
    a. Verification of capacity at several load steps
    b. Demonstration of fan control across full range of VFD output, showing the ability of the system to avoid any fan harmonics that are potentially damaging.

B. Train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

1. Field performance test to include:
    a. Verification of capacity at several load steps
    b. Demonstration of fan control across full range of VFD output, showing the ability of the system to avoid any fan harmonics that are potentially damaging.

END OF SECTION 23 6500

SECTION 23 7333

INDIRECT GAS-FIRED, PACKAGED H&V UNITS

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.

1.2 SUMMARY

A. This Section includes the following:

1. Indirect gas-fired outdoor makeup air units.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section "Vibration Isolation and Seismic Restraints".

1.3 SUBMITTALS

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

B. Product data including weights, dimensions, metal gages, and data on features and components. Include plan and elevation views of units, minimum clearances, and data on ratings and capacities.

C. Maintenance data for products for inclusion in "Operating and Maintenance Manual".

D. Wiring diagrams from manufacturers detailing requirements for electrical power and control wiring for heaters. Include ladder-type wiring diagrams for interlock and control wiring required for field installation. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

E. Certified fan performance curves with system operating conditions indicated.

F. Motor ratings and electrical characteristics plus motor and fan accessories.

G. Materials gages and finishes.

H. Filters with performance characteristics.

I. Dampers, including housings, linkages, and operators.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70, "National Electrical Code."

B. Approvals: Installed equipment shall be AGA design certified and U.L. listed.

C. Performance: Capacities and air deliveries to be certified by manufacturer as meeting national standards substantiated by valid test information. Airflow capacities to be AMCA rated.

1.5 EXTRA MATERIALS

A. General: Furnish extra materials matching products installed, as described below, packaged with protective covering for storage, and identified with labels clearly describing contents.

B. Fan Belts: Furnish quantity equal to 15 percent of the number of belts installed for centrifugal fans, but not less than one set.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Greenheck.
2. Captive Aire.
3. Reznor.
4. Sterling.

2.2 MAKEUP AIR UNITS, GENERAL

A. Types, Minimum Ratings, Locations, and Mountings: As indicated.

B. Equipment Casing and Base:

1. Casing shall be constructed of aluminized steel to insure long rust-free life.
2. Access panels shall be provided to allow easy access to motors, filters and electrical controls.
3. Casing shall have a rinse primer and an enamel finish.
4. Base frame channels shall be constructed of aluminized steel.

C. Blower Section:

1. Blower wheels shall be statically and dynamically balanced, forwardly curved double width double inlet class 1.
2. Blower wheels shall be mounted on a solid ground shaft with keyway for driven sheave.
3. Bearings shall be ball bearing self-aligning, permanently lubricated.
4. Blower scrolls, bearings, and adjustable motor base shall be mounted and properly reinforced to insure rigidity and quiet operation.
5. Cabinet shall be of 16 gauge aluminized steel with a primed and enamel finish.
6. The driver and driven sheaves shall be of the keyed hub type. The driven sheave shall be of a fixed pitch diameter and the driver sheave shall be of variable pitch diameter through 10 HP and fixed pitch above 10 HP. V-belt drives shall be sized for 135% of motor horsepower.

7. Cabinet side panels shall be of 20 gauge cold rolled steel and drain pans of 20 gauge aluminized steel. Side panels and drain pans to be finished with enamel.

D. Furnace Section:

1. Heat exchanger(s) shall have all electric welded construction with Type 321 (chrome-nickel) stainless steel tubes and either Type 321 or 409 header plates with stainless steel internal baffles.
2. Burners shall be made of 18 gauge aluminized steel with Type 430 stainless steel ribbon inserts.
3. Gas and electrical components shall consists of not less than the following: 24 volt combination gas valve containing main and pilot gas cocks, main and pilot gas pressure regulators, redundant solenoid gas valves, pilot solenoid gas valve and 100% safety shut-off, also high limit control and 115/24 volt control transformer.

E. Temperature Controls:

1. Makeup Air Models:

a. Modulating gas valve with solid state electronic modulation, down to 30% of rated input, provides constant leaving air temperature. A temperature selector mounted in the control cabinet or remote from unit permits adjustment of leaving air temperature from a convenient location.

F. Motor: A T-frame, ODP, 1800 RPM prelubricated ball bearing type motor shall be furnished for voltage as scheduled.

G. Assembly: The system shall be factory assembled and wired with the exception of controls that are remote to the unit.

H. Accessories: The following items are to be furnished:

1. Motor starter.
2. Insulation of blower section.
3. Electric ignition.
4. Modulating gas valve.
5. Power venter and adapter.
6. Blower "on-off-auto" switch.
7. NEMA 1 remote control station with operating switches and indicating lights.
8. Fan time delay relay.
9. Filters - 2" throw-away, cleanable or extended surface.
10. Fresh air intake hood with birdscreen.
11. Fresh air shut-off damper with 2 position motor, linkage and end switch.
12. **Seismic restrained spring vibration isolation base**.
13. Electronic modulating thermostat with sensor on discharge air stream.
14. Low outlet temperature shut-off.
15. Blocked intake switch and signal light.
16. Step down transformer.
17. Fused disconnect switch.
18. High efficiency motor.
19. High gas pressure regulator - 1/2 PSIG and over.
20. Air washer cooling section.
21. Down discharge plenum.

I. Air Washer Cooling Section:

1. 12" CELdek evaporative media, submersible water pump, Schedule 40 P.V.C. water distribution system with splash tube spray over media, cast brass float type fill valve and manual bleed valve for constant sediment drainage. Cabinet shall be constructed of 18 gage aluminized steel painted exterior. Reservoir shall be 20-gauge stainless steel.

2.3 FINISHES

A. External Casings and Cabinets: Baked enamel over corrosion-resistant treated surface.

PART 3 - EXECUTION

3.1 INSTALLATION AND CONNECTION

A. Installation and connection of makeup air units and associated fuel and vent features and systems installed and connected in accordance with NFPA 54, applicable local codes and regulations, and manufacturer's printed installation instructions.

1. Connect gas piping in accordance with Division 23 Section "Natural Gas Systems."
2. Connect vents in accordance with Division 23 Section "Breechings, Chimneys and Stacks."

B. Install controls as specified in Division 23 Section "Control System."

C. Connect ducts in accordance with Division 23 Section "Metal Ductwork."

D. Install units level and plumb, maintaining manufacturer's recommended clearances. Install according to ARI Guideline B.

E. Curb Support: Install roof curb on roof structure, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure rooftop air conditioners on curbs and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.

F. Provide seismically restrained spring curbs. The RTU is to be anchored to the spring curb, the spring curb to the factory curb, the factory curb to the leveling sub base and the leveling sub base to the roof structure. Seismically restrained spring curbs and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

3.2 IDENTIFICATION

A. Identify makeup air units and connections in accordance with Division 23 Section "Mechanical Identification."

3.3 COMMISSIONING

A. Test functions, operations, and control sequences and protective features. Adjust to assure operation is in accordance with design.

B. Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.4 CLEANING AND ADJUSTING

A. Cleaning: Upon completion of installation, inspect heaters and associated components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

B. Adjusting: Make burner and other unit adjustments for optimum heating performance and efficiency. Adjust heat distribution features, including louvers, vanes, shutters, dampers, and reflectors, to provide optimum heat distribution for objects, personnel, and spaces served.

3.5 DEMONSTRATION

A. Training: Arrange and pay for the services of a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of heaters and heater systems and to train Owner's personnel.

1. Conduct training as specified under "Instructions to Owner's Employees" in the "Project Closeout" Section of these specifications.
2. Schedule training with at least 7-day advance notification.

END OF SECTION

SECTION 237433
DEDICATED OUTDOOR-AIR 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 factory-packaged units capable of supplying up to 100 percent outdoor air and providing heating only.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Prepare the following by or under the supervision of a qualified professional engineer:

    a. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
    b. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

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

1. Size and location of unit-mounted rails and anchor points and methods for anchoring units to roof curb.
2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

B. Startup service reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Fan Belts: One set for each belt-driven fan.
2. Filters: One set for each unit.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Five years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Greenheck.
2. Captive Aire.
3. Reznor.
4. Sterling.

2.2 MANUFACTURED UNITS

A. Unit with Integral Indirect gas-fired Heating shall be fully assembled at the factory and consist of an insulated metal cabinet, curb assembly, louvered outdoor air intake with aluminum mesh, motorized intake damper, filter assembly for intake air, sensors, supply air blower assembly, and electrical control unit with all specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.

2.3 CABINET

A. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
1. Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Pre-painted components as supplied by the factory

shall have polyester urethane paint on 18 gauge G60 galvanized steel. Base rail is 12 gauge, galvazined (G90) steel.

2. Internal Assemblies: 24 gauge galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.

B. Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
   1. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
      a. Thickness: 1 inch (25 mm)
      b. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
      c. Location and application: Floor of each unit shall be insulated with either one half inch thick or 1 inch thick rigid fiberglass insulation, covered on one surface with integral aluminum foil.

C. Access panels: Unit shall be equipped with hinged access panels to provide easy access to all major components.

D. Supply Air blower assembly: Blower assembly consists of an electric motor and a belt driven, double width, double inlet forward curve blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on minimum 1.125 inch thick neoprene vibration isolators.

E. Control panel / connections: Unit shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections.

F. Indirect Gas-Fired Furnace:
   1. Shall be ETL Certified as a component of the unit.
   2. Shall have an integral combustion gas blower.
   3. Shall be ETL Certified for installation downstream of a cooling coil.
   4. Shall have fault sensors to provide fault conditions to optional digital controller or building controls.
   5. Shall have 4-pass tubular heat exchangers, constructed of aluminized steel. Heat exchanger tubes shall be installed on the vest plate by means of swaged assembly, welded connections are not acceptable. Heat exchanger tubes shall be supported by a minimum of two fabricated assemblies that support the tubes and also permit expansion and contraction of the tubes.
   6. Heat exchanger shall have a one year warranty.
   7. Furnace control shall be 26.6:1 electronic modulating.
   8. Shall be encased in a weather-tight metal housing with intake air vents. Large, metal lift-off or hinged door shall provide easy access to the enclosed vest plate, control circuitry, gas train, burner assembly and exhaust blower.
   9. Shall include a kit for Outdoor mounting with Standard venting.

G. Dampers: Motorized Intake Air dampers of low leakage type shall be factory installed.

H. Sensors are considered to be part of various optional operational modes or device controllers and are to be factory supplied and installed as specified by the A/E.

I. Curb Assembly: A curb assembly made of 14 gauge galvanized steel shall be provided by the factory for assembly and installation as part of this division. The curb assembly shall provide perimeter support of the entire unit and shall have duct adapters for supply air. Curb assembly shall enclose the underside of the unit and shall be sized to fit into a recess in the bottom of the unit. Contractor shall be responsible for coordinating with roofing contractor to ensure curb unit

is properly flashed to provide protection against weather/moisture penetration. Contractor shall provide and install appropriate insulation for the curb assembly.

2.4 BLOWER

A. Blower section construction, Supply Air: Belt drive motor and blower shall be assembled onto a minimum 14 gauge galvanized steel platform and must have neoprene vibration isolation devices, minimum of 1 - 1/8 inches thick.

B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

C. Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.

D. Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.

E. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

2.5 MOTORS

A. General: Blower motors greater than .75 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be supplied with an adjustable drive pulley. Comply with requirements in Division 23 05 13, matched with fan load.

2.6 UNIT CONTROLS

A. The unit shall be constructed so that it can function as a stand-alone heating system controlled by factory-supplied controllers, thermostats and sensors or it can be operated as a heating system controlled by a Building Management System (BMS).

B. Variable Frequency Drive (VFD): Unit shall have factory installed variable frequency drive for modulation of the supply air blower assembly. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.

C. Sensors to be provided with the unit include:
1. Heating Inlet Air Sensor
2. Dirty Filter Sensor

2.7 FILTERS

A. Unit shall have disposable pleated filters located in the outdoor air intake and shall be accessible from the exterior of the unit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.

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

3.2 INSTALLATION

A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.

B. Curb Support (curb provided by manufacturer) : Install roof curb on roof structure according to "The NRCA Roofing Manual."

1. Install and secure units on curbs and coordinate roof penetrations and flashing with roof construction.
2. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."
3. Coordinate size, location, and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.

C. Equipment Mounting:

1. Install air units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03.

D. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."

E. Install separate devices furnished by manufacturer and not factory installed.

F. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

G. Install drain pipes from unit drain pans to sanitary drain.

1. Drain Piping: Drawn-temper copper water tubing complying with ASTM B 88, Type L, with soldered joints.

a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
c. Retain first subparagraph below if required for LEED for Schools Credit IEQ 4 or if required by Project requirements or authorities having jurisdiction.
d. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2. Pipe Size: Same size as condensate drain pan connection.

3.3 CONNECTIONS

A. Where installing piping adjacent to units, allow space for service and maintenance.

B. Gas Piping Connections:

1. Comply with requirements in Section 231123 "Facility Natural-Gas Piping."
2. Connect gas piping to furnace, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
3. Install AGA-approved flexible connectors.

C. Hydronic Piping Connections:

1. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."
2. Install shutoff valve and union or flange on each supply connection and install balancing valve and union or flange on each return connection.

D. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.

1. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.4 STARTUP SERVICE

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

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect units for visible damage to furnace combustion chamber.
3. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

a. Measure gas pressure at manifold.
b. Measure combustion-air temperature at inlet to combustion chamber.
c. Measure flue-gas temperature at furnace discharge.
d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

4. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
    a. High-limit heat exchanger.
    b. Alarms.
5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
6. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
    a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
    b. Cooling coil entering-air, dry- and wet-bulb temperatures.
    c. Condenser coil entering-air dry-bulb temperature.
    d. Condenser coil leaving-air dry-bulb temperature.
7. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
8. Inspect casing insulation for integrity, moisture content, and adhesion.
9. Verify that clearances have been provided for servicing.
10. Verify that controls are connected and operable.
11. Verify that filters are installed.
12. Clean coils and inspect for construction debris.
13. Clean furnace flue and inspect for construction debris.
14. Inspect operation of power vents.
15. Purge gas line.
16. Verify bearing lubrication.
17. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
18. Adjust fan belts to proper alignment and tension.
19. Start unit.
20. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
21. Operate unit for run-in period.
22. Calibrate controls.
23. Adjust and inspect high-temperature limits.
24. Inspect outdoor-air dampers for proper stroke.
25. Verify operational sequence of controls.
26. Measure and record the following airflows. Plot fan volumes on fan curve.
    a. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

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

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

3.6 DEMONSTRATION

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

END OF SECTION 237433

SECTION 238113

PACKAGED TERMINAL AIR-CONDITIONERS

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 terminal air conditioners and their accessories and controls, in the following configurations:

1. Through-the-wall air conditioners.
2. Heat-pump units.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for packaged terminal air conditioners.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged terminal air conditioners to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

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

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.7 COORDINATION

A. Coordinate layout and installation of packaged terminal air conditioners and wall construction with other construction that penetrates walls or is supported by them.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged terminal air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Sealed Refrigeration System: Manufacturer's standard, but not less than five years from date of Substantial Completion, including components and labor.
2. Warranty Period for Nonsealed System Parts: Manufacturer's standard, but not less than five years from date of Substantial Completion, including only components and excluding labor.
3. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

1. Cooper and Hunter
2. Carrier Corporation; a United Technologies company.
3. Friedrich Air Conditioning Co.
4. General Electric Company; GE Consumer & Industrial - Appliances.
5. Trane; a business of American Standard Companies.

2.2 MANUFACTURED UNITS

A. Description: Factory-assembled and -tested, self-contained, packaged terminal air conditioner with room cabinet, electric refrigeration system, heating, and temperature controls; fully charged with refrigerant and filled with oil; with hardwired chassis.

2.3 CHASSIS

A. Cabinet: 0.052-inch thick steel with removable front panel with concealed latches.

1. Mounting: Wall with wall sleeve

2. Discharge Grille: Punched-louver discharge grille allowing four-way discharge-air pattern.
3. Louvers: Extruded aluminum with white enamel finish.
4. Finish: Baked enamel.
5. Access Door: Hinged door in top of cabinet for access to controls.
6. Cabinet Extension: Matching cabinet in construction and finish, allowing diversion of airflow to adjoining room; with grille.
7. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
8. Subbase: Enameled steel with adjustable leveling feet and adjustable end plates**,** with factory-installed and -wired, fused disconnect switch and receptacle sized for unit.
9. Wall Sleeves: Galvanized steel with polyester finish.

B. Refrigeration System: Direct-expansion indoor coil with capillary restrictor; and hermetically sealed scroll compressor with vibration isolation and overload protection.

1. Indoor and Outdoor Coils: Seamless copper tubes mechanically expanded into aluminum fins with capillary tube distributor on indoor coil.
2. Accumulator.
3. Constant-pressure expansion valve.
4. Reversing valve.
5. Charge: R-32 or R454B.
6. Refrigerant safety monitor for A2L refrigerants if required by code.

C. Indoor Fan: Forward curved, centrifugal; with motor and positive-pressure ventilation damper with concealed manual operator locked to closed position.

D. Filters: Washable polyurethane in molded plastic frame.

E. Condensate Drain: Drain pan to direct condensate to outdoor coil for re-evaporation.

1. Comply with ASHRAE 62.1 for drain pan construction and connections.

F. Outdoor Fan: Forward curved, centrifugal type with separate motor.

1. Indoor and Outdoor Fan Motors: Two speed; comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Fan Motors: Permanently lubricated split capacitor.
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. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.4 HEATING

A. Electric-Resistance Heating Coil: Nickel-chromium-wire, electric-resistance heating elements with contactor and high-temperature-limit switch.

2.5 CONTROLS

A. Control Module: Unit-mounted digital panel with touchpad temperature control and with touchpad for heating, cooling, and fan operation. Include the following features:

1. Low Ambient Lockout Control: Prevents cooling-cycle operation below 40 deg F outdoor air temperature.
2. Heat-Pump Ambient Control: Field-adjustable switch changes to heat-pump heating operation above 40 deg F and to supplemental heating below plus 25 deg F.
3. Temperature-Limit Control: Prevents occupant from exceeding preset setup temperature.
4. Building Automation System Interface: Allows remote on-off control with setback temperature control.
5. Reverse-Cycle Defrost: Solid-state sensor monitors frost buildup on indoor coil and reverses unit to melt frost.

B. Remote Control: Standard unit-mounted controls with remote-mounted, low-voltage adjustable thermostat with heat anticipator, heat-off-cool-auto switch, and on-auto fan switch.

C. Outdoor Air: Manual intake damper.

2.6 CAPACITIES AND CHARACTERISTICS

A. See drawings.

2.7 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Factory test to comply with ARI 300, "Sound Rating and Sound Transmission Loss of Packaged Terminal Equipment."

B. Unit Performance Ratings: Factory test to comply with ARI 310/380/CSA C744, "Packaged Terminal Air-Conditioners and Heat Pumps."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, maintaining manufacturer's recommended clearances and tolerances.

B. Install wall sleeves in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

C. Install and anchor wall sleeves to withstand, without damage to equipment and structure, seismic forces required by building code.

3.2 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

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

C. Tests and Inspections:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing packaged terminal air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
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. Packaged terminal air conditioners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

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

B. After installation, verify the following:

1. Unit is level on base and is flashed in exterior wall.
2. Unit casing has no visible damage.
3. Compressor, air-cooled condenser coil, and fans have no visible damage.
4. Labels are clearly visible.
5. Controls are connected and operable.
6. Shipping bolts, blocks, and tie-down straps are removed.
7. Filters are installed and clean.
8. Drain pan and drain line are installed correctly.
9. Electrical wiring installation complies with manufacturer's submittal and installation requirements in electrical Sections.
10. Installation. Perform startup checks according to manufacturer's written instructions, including the following:

a. Lubricate bearings on fan.
b. Check fan-wheel rotation for correct direction without vibration and binding.

C. After startup service and performance test, change filters.

3.5 ADJUSTING

A. Adjust initial temperature set points.

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

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain packaged terminal air conditioners.

END OF SECTION 238113

SECTION 23 8126

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

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

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Detailed description of equipment anchorage devices their installation requirements.

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

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators [and seismic restraints] and for designing vibration isolation bases.

1.04 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For evaporator-fans, compressor-condensers, accessories, and components, provide from manufacturer:

1. Basis for Certification: Indicate whether “withstand” certification is based on actual test of assembled components or on calculation.

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

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.06 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: Two [One] <Insert number> sets for each unit. One filter to be installed for use during startup and Testing & Balancing. The contractor shall install the second filter at the time of Substantial Completion.
2. Gaskets: [One] <Insert number> set(s) for each access door.
3. Fan Belts: [One] <Insert number> set(s) for each air-handling unit fan.

1.07 QUALITY ASSURANCE

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

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

D. [National Roofing Contractors Association (NRCA) Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.]

1.08 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000

"Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.09 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor, parts and labor: Five [One] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Provide one of the following:

1. Carrier Corporation; a unit of United Technologies Corp.;
2. Mitsubishi Electric & Electronics USA, Inc.;
3. Sanyo North America Corporation
4. York; a Johnson Controls company

2.02 INDOOR UNITS

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in, manufacturers standard color [color selected by Architect] <insert color>, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
d. Mount unit-mounted disconnect switches on interior [exterior] of unit.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Condensate Drain Pans: Comply in all respects with ASHRAE 62.1. Provide condensate pump with minimum 9 inch [24 inch] <Insert value> lift and safety shutoff switch.

7. Air Filtration Section: Permanent, cleanable.

B. Concealed (Ceiling Mounted) Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
5. Fan Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    b. Multi-tapped, multispeed with internal thermal protection and permanent lubrication.
    c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Air Filtration Section:

    a. General Requirements for Air Filtration Section:

        1) Comply with NFPA 90A.
        2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
        3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

    b. Disposable Panel Filters:

        1) Factory-fabricated, pleated disposable type. UL listed Class 2.
        2) Thickness: 2 inches [1 inch] <Insert value>.
        3) Arrestance according to ASHRAE 52.1: [80] <Insert value>.
        4) Merv according to ASHRAE 52.2: [5] <Insert value>.
        5) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
        6) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

8. Condensate Drain Pans:

    a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

        1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
        2) Depth: A minimum of 2 inches <Insert depth> deep.

    b. Single-wall, stainless-steel sheet.
    c. Drain: Provide condensate pump with minimum 9 inch [12 inch] <Insert value> lif

and safety shutoff switch.

d. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

C. Floor-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.

   a. Discharge Grille: Steel with surface-mounted frame.
   b. Insulation: Faced, glass-fiber duct liner.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:

   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Multi-tapped, multispeed with internal thermal protection and permanent lubrication.

5. Air Filtration Section:

   a. General Requirements for Air Filtration Section:

      1) Comply with NFPA 90A.
      2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

   b. Disposable Panel Filters:
      1) Factory-fabricated, pleated disposable type. UL listed Class 2.
      2) Thickness: 2 inches.
      3) Arrestance according to ASHRAE 52.1: 80.
      4) MERV according to ASHRAE 52.2: 5.
      5) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
      6) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

6. Condensate Drain Pans:

   a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

      1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
      2) Depth: A minimum of 2 inches <Insert depth> deep.

   b. Single-wall, stainless-steel sheet.
   c. Drain Connection: Located at lowest point of pan and sized to prevent overflow.

Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1 <Insert size>.

2.03 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, manufacturers standard finish and color [color selected by Architect] <insert color>, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Scroll.
    b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
    c. Refrigerant Charge: R-410A
    d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid sub-cooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Provide additional components to permit operation down to 10 deg F.

2.04 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

D. Automatic-reset timer to prevent rapid cycling of compressor.

E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

2.05 CAPACITIES AND CHARACTERISTICS

A. Capacities and characteristics shall be as scheduled on Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install units level and plumb.

B. Evaporator-fan Components Mounting: Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Compressor-condenser Components Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Concrete equipment bases shall comply with overall size, thickness, and edge distance for anchor bolts required in Section 230548 “Vibration and Seismic Controls” Submittal. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Install roof-mounted, compressor-condenser components on roof curb provided by manufacturer in compliance with NRCA requirements. Secure equipment to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts required in Section 230548 “Vibration and Seismic Controls” Submittal.
4. Coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories."

D. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

E. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.02 CONNECTIONS

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

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

D. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Equipment”.

E. Electrical Connections: Comply with requirements in Division 26 Section for power wiring, switches, and motor controls

3.03 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

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

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test & inspection reports and corrective actions. Submit written reports to the Architect.

3.04 STARTUP SERVICE

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

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

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel on procedures and schedules related to adjusting, operating, startup and shutdown; troubleshooting; servicing and preventative maintenance of Units.

1. Review data in the Operation and Maintenance Manual. Refer to Division 1 Section “Contact Closeout”.
2. Schedule training with Owner through the Architect with at least 14 days advance notice.

END OF SECTION 23 8126

SECTION 238146

FLUID TO AIR HEAT PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following types of water-source heat pumps:

1. Concealed horizontal or vertical units, two-stage compressor, 6 tons and smaller. (See schedule for configurations.)
2. Concealed vertical units, dual refrigerant circuits, 7 tons and larger. (See schedule for configurations.)
3. Refrigerant is to be R-454-b.
4. Unit shall be provided with factory installed 2-position motorized valve unless otherwise noted in Schedule.

1.03 SUBMITTALS

A. First three paragraphs below are defined in Division 1 Section "Submittal Procedures" as "Action Submittals."

B. Product Data: Include rated capacities, furnished specialties, and accessories for each model.

C. 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.

D. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which heat pumps will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.

e. Access panels.

E. Product Certificates: For each type of water-source heat pump, signed by product manufacturer.

F. Manufacturer Seismic Qualification Certification: Submit certification that water-source heat pumps, accessories, and components will withstand seismic forces defined in Division 23 Section "Mechanical Vibration and Seismic Controls." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

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

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For water-source heat pumps to include in emergency, operation, and maintenance manuals.

I. Warranty: Special warranty specified in this Section.

1.04 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of water-source heat pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASHRAE Compliance:

1. ASHRAE 15.
2. Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Comply with NFPA 70.

F. Comply with safety requirements in UL 484 for assembly of free-delivery water-source heat pumps.

G. Comply with safety requirements in UL 1995 for duct-system connections.

1.05 COORDINATION

A. Coordinate layout and installation of water-source heat pumps and suspension components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components, and partition assemblies.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water-source heat pumps that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, refrigeration components.
2. **Warranty Period: 18-month parts warranty.**

1.07 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. Two set(s) of filters for each unit. One set to be used during startup, testing, adjusting and balancing. Install second set at Substantial Completion when system is turned over to the owner.

2. Two sets of fan belts (one for startup and operation; one to be turn over to the Owner) for the 7 ton and larger units.

PART 2 - PRODUCTS

2.01 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 by one of the following.

2.02 CONCEALED WATER-SOURCE HEAT PUMPS

A. Manufacturers:

1. Carrier Corporation.
2. ClimateMaster, Inc.
3. FHP Manufacturing Inc.

4. Trane.

B. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ARI-ISO-13256-1.

2.03 INDOOR WATER TO AIR HEAT PUMPS (See drawings for configurations)

A. The ground source heating and cooling units shall be reverse cycle vertical type with horizontal air inlet and vertical discharge or horizontal type (6 tons and smaller units) with horizontal air inlet and discharge. Units shall be ground source closed loop performance certified and listed by a nationally recognized safety testing laboratory or agency, such as ETL Testing Laboratory or Canadian Standards Association (CSA). Ground source units shall be designed to operate with entering liquid temperature between 20 - 120 degrees Fahrenheit. Each unit shall be factory run tested and computer verified prior to shipping from factory. Each unit shall be separately palletized and shipped in a corrugated container from the factory.

B. **Indoor Water to Air Heat Pumps 6 tons and smaller.** Each unit shall have a full-load minimum COP of 3.7 in the heating mode and a full-load minimum EER of 18.1 in the cooling mode. Each unit shall have a part-load minimum COP of 3.9 in the heating mode and a part-load minimum EER of 23.2 in the cooling mode. COPs and EERs measured at ARI-ISO 13256-1 GSHP conditions of the following; heating EWT = 32 deg (full-load), EWT = 41 deg (part-load); heating EAT = 68 deg db; cooling EWT = 77 deg (full-load), EWT = 68 deg (part-load); cooling EAT = 80.6 deg DB, 66.2 deg WB.

C. **Indoor Water to Air Heat Pumps 7 tons and larger.** Each unit shall have a minimum COP of 3.6 in the heating mode and a minimum EER of 15.8 in the cooling mode at ARI-ISO 13256-1 GSHP conditions of the following; heating EWT = 32 deg; heating EAT = 68 deg DB; cooling EWT = 77 deg; cooling EAT = 80.6 deg db, 66.2 deg WB.

D. The manufacturer shall warrant entire unit for a period of one year from Substantial Completion for all parts only. The installing contractor shall be responsible to perform service and administrate the warranty.

E. The cabinet shall be fabricated from heavy gauge no-lead galvanized steel. The interior shall be insulated with ½"-thick multi-density, coated glass fiber with edges sealed or tucked under flanges to prevent the introduction of glass fibers into the discharge air stream. One or two blower compartment and three compressor compartment access panels shall be provided as standard and shall be removable with all duct work in place. The internal component layout shall provide for major service with the unit in place for restricted access installations. A 1-inch duct collar shall be provided on the supply air duct opening. The units shall have a totally insulated divider panel between the air handling section and the compressor section to minimize the transmission of compressor noise, and to permit operational service testing without air bypass.

F. The condensate drain pan shall be Type 304 stainless steel or high density polyethylene (HDPE). The drain pan construction shall fully comply with ASHRAE 62.1-2007 paragraph 5.11. Provide solid-state electronic condensate overflow protection in the drain pan and interlocked with the heat pump controls to prevent operation with a flooded drain pan.

G. All units shall contain a sealed refrigerant circuit including a hermetic motor-compressor, bi-directional thermal expansion valve, finned tube air-to-refrigerant heat exchanger, reversing valve, coaxial tube water-to refrigerant heat exchanger DX coil and service ports factory installed and tested. Compressors shall be high-efficiency scroll types designed for ground source duty and mounted on vibration isolators. Compressor motors shall be single or three phase with internal overload protection. The finned tube coil shall be designed for low face

velocity and constructed of lanced aluminum fins bonded to rifled copper tubes in a staggered pattern not less than three rows deep. R-410, Refrigerant.

H. The coaxial water-to-refrigerant heat exchanger shall be designed for close approach temperatures and be constructed of cupronickel or copper inner tube and a steel outer tube, and capable of 300 psi water and 600 psi refrigerant working pressures. The thermal expansion valve shall provide proper superheat over the entire liquid temperature range with minimal “hunting”. The valve shall operate bi-directionally without the use of check valves. The water-to-refrigerant heat exchanger and refrigerant suction lines shall be insulated to prevent condensation at extended ground loop temperatures.

I. **Indoor Water to Air Heat Pumps 6 tons and smaller.** The fan shall be a direct drive centrifugal type with a dynamically balanced wheel. The housing and wheel shall be designed for quiet, low outlet velocity operation. The fan housing shall be of galvanized steel construction and shall be removable from the unit without disconnecting the supply air ductwork for servicing of the fan motor. The fan motor shall be provided with a variable speed ECM controller for capacity adjustment. The ECM fan motor shall be soft-starting, shall maintain constant CFM over its operating static range, and shall provide 12 CFM settings. The fan motor shall be isolated from the housing by rubber grommets. The motor shall be permanently lubricated and have thermal overload protection. Motors shall be permanently lubricated ball bearing type. Fan ratings shall be based on “wet-coil” and the specified filters.

J. **Indoor Water to Air Heat Pumps 7 tons and larger.** The fan shall be belt-drive dual centrifugal type with a dynamically balanced wheel. The housing and wheel shall be designed for quiet, low outlet velocity operation. The fan housing shall be of galvanized steel construction and shall be removable from the unit without disconnecting the supply air ductwork for servicing of the fan motor. The fan motor shall be isolated from the housing by rubber grommets. The motor shall be permanently lubricated and have thermal overload protection. Motors shall be permanently lubricated ball bearing type. Fan ratings shall be based on “wet-coil” and the specified filters.

K. A microprocessor-based controller or manufacturer’s standard electromechanical controls shall be provided that communicates with a thermostat to monitor and control unit operation. The control shall provide operational sequencing, fan speed controller for ECM fan motors, high and low pressure switch monitoring, general lockout, freeze protection, condensate overflow sensing that will turn off the unit if water in the pan is above ½" (adjustable), hot water limit thermistor sensing, auxiliary heat staging, hot water and LED status and fault indicators, field selectable options, and accessory output. A terminal block with screw terminals shall be provided for field low voltage wiring. A 75 VA low voltage transformer shall be provided. Line voltage box lugs shall be provided for unit wiring. Units shall have knockouts for entrance of low and line voltage wiring. The fan motor and control box shall be harnessed plug-connected for easy removal. Each heat pump shall have a pump relay connection for interlocking with the geothermal circulation pumps.

L. Each unit shall have a single point power connection. Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with NEC requirements and shall conform to all applicable U.L. Standards. All wiring shall be number coded per the electrical wiring diagrams. All electrical components shall be labeled according to the electrical diagram and be U.L. recognized where applicable. Each unit shall have a 24 volt control circuit transformer and control circuit fuse.

M. The supply air fan, compressor branch circuits shall be furnished for each compressor and fan motor branch circuits shall be furnished for each compressor and fan motor. The supply air fan motors shall have contactors and overload protection.

N. A terminal board shall be provided for the low voltage control wiring. Knockouts shall be provided in the bottom of the main control panel for field wiring entrance.

O. Each unit shall be furnished with a factory installed motor starter(s) and electrical disconnect switch.

P. Supply and return water connection shall be swivel-type FPT factory installed eliminating the need for back up wrenches when making field hose kit connections. See Schedules for sizes of supply, return and condensate connections.

Q. Hanger kit (field installed-horizontal units only) - The hanger kit shall consist of galvanized steel brackets, bolts, lock washers, and spring-isolators and shall be designed to fasten to the unit bottom panel for suspension from 3/8” threaded rods. Rods shall be supplied by the contractor at the time of installation.

R. Wiring diagrams with details of wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring shall be provided with the units.

S. Coordinate layout and installation of water-source heat pumps and suspension components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components, and partition assemblies.

T. Filter housings shall be 2”, factory fabricated with removable access door. Filter housing may be factory installed or field installed by the contractor. Provide sample of make to be approved by the engineer prior to ordering heat pumps. Provide 2” MERV 8 filters.

U. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

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

W. All heat pumps; vertical, horizontal, and all sizes; shall all be the same manufacturer.

2.04 HEAT PUMP CONTROLS COORDINATION:

A. The heat pumps shall be provided with random start relays, interlocks, safeties, controllers, etc, necessary to make the units compatible with the Sequence of Controls described in Section 23 0900. The heat pump manufacturer shall review the Sequence of Controls prior to the Bidding and immediately bring to the engineers attention in writing any conflicts, difficulties, etc. Any control items which could be normally supplied with the heat pumps and are necessary to facilitate the Sequence of Control will be required to be provided and installed at no additional costs to the project.

B. The thermostats are to be provided by the ATC contractor as specified in Section 23 0900. Heat pumps shall be configured and wired capable of running off terminations compatible with conventional thermostat wiring.

2.05 HOSE KITS FOR HEAT PUMPS:

A. Piping Connections: Drawings indicate the general arrangement of piping, fittings and specialties. Specific connection requirements are as follows:

1. Ball Valves: Full opening ball valves shall be included in the hose kit package on both supply and return lines to the loop.
2. Isolation Valves: Unit shall be provided with factory installed 2-position motorized valve unless otherwise noted.
3. Hoses: Hoses shall consist of stainless steel outer braid with an inner core of tube made of a nontoxic synthetic polymer material. The hoses shall be suitable for fluid temperatures ranging between 27 deg F and 211 deg F. Hoses shall be 24” in length.
4. Automatic Flow Devices: The automatic self-balancing device shall automatically limit the rate of flow to within 5-percent of the specified amount. For the ½- through 2-inch configuration, the cartridge shall be removable from the Y-body housing without the use of special tools to provide access for regulator change-out, inspection and cleaning without breaking the main piping. (Similar to that provided for removal of a Y-strainer screen). True operating ranges of 2 -32 psig psig shall be required. Each valve shall have two pressure/temperature ports to verify differential pressure and flow rate. The internal wear surfaces of the valve cartridge shall be constructed of electroless nickel or stainless steel for long wear.
5. An in-line strainer shall be provided with each hose kit for installation on the supply line.
6. Provide crossover piping with ball valves between supply and return line at each heat pump to allow circulation of the main supply and return lines without pumping through the heat pumps for initial cleaning and testing.
7. Hose kits shall be Armstrong, Griswold, Flow Design, Hayes, or Trane.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of water-source heat pumps.

B. Examine roughing-in for piping and electric installations for water-source heat pumps to verify actual locations of piping connections and electrical conduit before installation.

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

3.02 INSTALLATION

A. Suspend water-source heat pumps from structure with threaded steel rods and minimum 1-inch static deflection spring vibration isolators and seismic restraints. Mount vertical heat pumps on elastomeric isolation pads with minimum 0.15-inch deflection and seismic restraints. Vibration isolators are specified in Division 23 Section "Mechanical Vibration and Seismic Controls."

B. Examine areas and conditions for compliance with requirements for installation tolerances, other specific conditions, and other conditions affecting performance of water-source heat pumps. Do not proceed with installation until unsatisfactory conditions have been corrected. Examine piping and electric rough installations for water-source heat pumps to verify actual locations of piping connections before installation. Install water-source heat pumps according to manufacturer's written instructions. Install units level and plumb, anchor as specified in Division 23 Section "Mechanical Vibration and Seismic Controls", in locations indicated, and maintain manufacturer's recommended clearances.

C. Test and adjust controls and safeties.

D. Replace damaged and malfunctioning controls and equipment.

3.03 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Connect supply and return hydronic piping to heat pump with unions and shutoff valves and hose kits.
2. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts. Specific connection requirements are as follows:

1. Connect supply and return ducts to water-source heat pumps with flexible duct connectors specified in Division 23 Section "Duct Accessories."

C. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

D. Install piping adjacent to machine to allow service and maintenance.

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

F. Connect wiring according to Division 26 Section "Conductors and Cables." Connect supply and return piping to heat pump with unions and shutoff valves.

G. Connect heat-pump drain pan to nearest indirect waste connection, or as indicated. The pan shall be 304 SS or HDPE to inhibit corrosion.

H. Duct Connections: Connect supply and return ducts to heat pumps with flexible duct connections. Provide transitions to match unit duct-connection size.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. After installing water-source heat pumps 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.

C. Remove and replace malfunctioning units and retest as specified above.

3.05 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service. A manufacturer's factory start-up shall be required for each installed water source heat pump unit. The installing contractor is not to be considered as the start-up entity.

B. The factory startup is to be performed competent personal trained specifically by the manufacturer of the installed equipment. The credentials of the personal that actually do the startup shall be submitted for approval. The contractor is not assumed to be qualified as the factory-authorized service representative unless he can provide adequate credentials. A start up report must be submitted for review by the owner and engineer. Start up report shall include gpm measurements, COP, EER, Amp readings, temperature readings, fan rpm, etc. Operate fan motors and verify proper rotation and connections. Operate controls and verify proper response to control inputs.

C. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, coils, and fans.
3. Inspect internal insulation.
4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Adjust vibration isolators.
9. Inspect operation of barometric dampers.
10. Verify bearing lubrication on fan.
11. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
12. Start unit according to manufacturer's written instructions.
13. Complete startup sheets and attach copy with Contractor's startup report.
14. Inspect and record performance of interlocks and protective devices; verify sequences.
15. Operate unit for an initial period as recommended or required by manufacturer.
16. Verify thermostat and humidistat calibration.
17. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
18. Start refrigeration system and measure and record the following:

    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.

19. 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.

3.06 ADJUSTING

A. Adjust initial temperature and humidity set points.

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

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

3.07 CLEANING

A. Replace filters used during construction prior to Substantial Completion.

B. After completing installation of exposed, factory-finished water-source heat pumps, inspect exposed finishes and repair damaged finishes.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water-source heat pumps. Refer to Division 1 Section "Demonstration and Training."

B. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance. Review data in the maintenance manuals specified in Division 1. Schedule training with Owner, through Architect, with at least 7 days' advance notice. The contractor shall notify & coordinate with the school prior to training so that the school district can arrange to have the training sessions video taped.

END OF SECTION

SECTION 23 8200
SPRAY PAINTING BOOTH

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work in this section.

1.02 DESCRIPTION OF WORK

A. Provide a Dry Filter Booth System as specified herein or as shown on the drawings.

1.03 REFERENCES

A. OSHA – Occupational Safety and Health Administration

B. UL – Fire Hazard Classifications

1.04 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum 5-years documented experience.

1.05 SUBMITTALS

A. Provide product data on unit construction, size, configuration, jointing methods, and attachment method.

B. Provide manufacturer’s installation instructions, indicating any special installation criteria to interfacing with adjacent components.

C. Provide shop drawings in the submittal showing all dimensions, controls and wiring. Provide a single point electrical connection for all electrical requirements.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable Code for UL and FM requirements
B. Current codes for:

1. International Building Code
2. International Mechanical Code
3. International Fire Code

PART 2 – PRODUCTS

2.02 SPRAY BOOTH SYSTEM

A. Dry Filter Booth shall be manufactured by Spray Systems or approved equal. Outside and inside work dimensions shall be as scheduled on the drawings.

1. Booth shall be 18-ga G90 galvanized steel and a 12-ga base angle.
2. Lighting: Manufacturer's standard UL approved lighting package. Two lights required.
3. Exhaust System:
   a. Provide high efficiency tube axial fans with AMCA Type B rating, performance as scheduled.
   b. Average face velocity through the booth shall be 100 FPM.
   c. System shall carry a 5-year manufacturer's warranty.
4. Exhaust Filters: American Air Filters, AG28, 20" x 25"x 2" with holding hardware, UL approved. Refer to schedule for quantity.
5. Draft Gauge: Dwyer Mark II manometer to indicate replacement of filters.
6. Provide all necessary hardware and caulking as required for a complete working system.

B. Units are to be constructed for Structural tube frame, continuously welded with corrosion coating. Provide lead proof wiper seal at base and Brixon safety latches.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Coordinate with installation of Division 23.

3.02 PROTECTION OF FINISHED WORK

A. Protect adjacent surfaces from damage by material installation.

B. Protect installation during construction activities.

END OF SECTION 238200

SECTION 23 8240

ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cabinet unit heaters with coils.
2. Propeller unit heaters with coils.

1.3 DEFINITIONS

A. BAS: Building automation system.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Location and size of each field connection.
3. Details of anchorages and attachments to structure and to supported equipment.
4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
5. Location and arrangement of integral controls.
6. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

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

6. Perimeter moldings for exposed or partially exposed cabinets.

D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.
E. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.
F. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

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

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Field quality-control test reports.
H. Operation and Maintenance Data: For cabinet unit heaters 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
C. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 EXTRA MATERIALS

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

1. Cabinet Unit Heater Filters: Furnish spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

A. Manufacturers

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

a. Airtherm; a Mestek Company.
b. McQuay International.

c. Trane.
d. Qmark

B. Description

1. Factory-assembled and -tested unit complying with AHRI 440.
2. 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.
3. Comply with UL 2021.

C. Coil section insulation

1. Insulation Materials: ASTM C 1071; surfaces exposed to airstream shall have aluminum-foil facing to prevent erosion of glass fibers.

D. Cabinets

1. Material: Steel with factory prime coating, ready for field painting.
2. Horizontal Unit, Exposed Bottom Panels: Removable panels secured with tamperproof cam fasteners and safety chain.

    a. Minimum thickness: 17GA-0.0538-inch- sheet steel.

3. Recessed Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.

E. Filters

1. Minimum Arrestance: According to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

    a. Washable Foam: 70 percent arrestance and MERV 3.

F. Coils

1. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

G. Controls

1. Basic Unit Controls:
2. Thermostat with the following features:

    a. Wall-mounted.
    b. Heat-off switch.
    c. Fan on-auto switch.
    d. Adjustable deadband.
    e. Set point:
        1) Concealed.
    f. Indication:
        1) Concealed.

2) Deg F.

H. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.

I. Electrical Connection: Factory-wired motors and controls for a single field connection.

2.2 WALL HEATER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Airtherm; a Mestek Company.
2. McQuay International.
3. Trane.
4. Qmark

B. Description
1. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
2. 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. Cabinet
1. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
2. 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.
3. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

D. Coil
1. 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.

E. Fan and Motor
1. Fan: Aluminum propeller directly connected to motor.
2. Motor: Permanently lubricated multispeed. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

F. Controls
1. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.
2. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.3 PROPELLER UNIT HEATERS

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

1. Airtherm; a Mestek Company.
2. McQuay International.
3. Trane.
4. Qmark

B. Description: An assembly including casing, coil, fan, and motor in [vertical] [and] [horizontal] discharge configuration with adjustable discharge louvers. (See drawings for configurations).

C. Comply with UL 2021.

D. Comply with UL 823.

E. Cabinet: Removable panels for maintenance access to controls.

F. Cabinet Finish: Manufacturer's baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

H. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

I. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.

2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

J. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

K. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Type: Permanently lubricated, multispeed.

L. Control Devices:

1. Wall-mounting fan-speed switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
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 cabinet unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.
C. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Division 73 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
D. Suspend propeller unit heaters from structure with all-thread hanger rods. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
E. Install wall-mounting 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.
F. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Duct Accessories."
B. Ground equipment according to Division 29 Section "Grounding and Bonding."
C. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections Report results in writing.
B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.
B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 238240

SECTION 26 0500

ELECTRICAL GENERAL PROVISIONS

RESOLUT HAS PREVIOUSLY PROCURED THE CT/MS AND MDP SWITCHGEAR DUE TO PROJECT SCHEDULE CONSTRAINTS. DIVISION 26 SHALL INCLUDE WITHIN THEIR BID PACKAGE THE RECEIVING AND INSTALLATION OF THE PREVIOUSLY PROCURED CT/MS AND MDP ALONG WITH THE ENTIRETY OF THE REMAINING GEAR, EQUIPMENT, FEEDERS, AND THE COMPREHENSIVE INSTALLATION OF THE ENTIRE ONE-LINE AND ELECTRICAL INFRASTRUCTURE WITHIN THEIR BID. DIVISION 26 WILL SHOULDER THE RESPONSIBILITY OF BOTH RECEIVING THE ITEMS AND ENSURING THE COMPLETE INSTALLATION OF THE ELECTRICAL SYSTEM, ALONG WITH ALL OTHER NECESSARY PREREQUISITES TO ESTABLISH A FULLY FUNCTIONAL ELECTRICAL SYSTEM. COORDINATE WITH CODALE ELECTRICAL SUPPLY AS REQUIRED.

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 work of this section.

B. Architectural, Structural, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.

1.2 DESCRIPTION OF WORK:

A. The extent of electrical work is indicated on drawings and/or specified in Divisions 26, 27 and 28 sections of the specification. Provide all labor, materials, equipment, supervision and service necessary for a complete electrical system. Work includes, but is not necessarily limited to, the following items.

	ITEM	SECTION
1.	Stage Lighting and Dimming System	11 0600
2.	Electrical General Provisions	26 0500
3.	Mechanical & Electrical Coordination	26 0501
4.	Electrical Submittals and Spare Parts	26 0502
5.	Murray City Power Requirements and Diagrams	26 0503
6.	Electrical Connections for Equipment	26 0507
7.	Elevator Electrical Requirements	26 0510
8.	Conductors and Cables (600V and Below)	26 0519
9.	Grounding	26 0526
10.	Supporting Devices	26 0529
11.	Conduit Raceway	26 0532
12.	Electrical Boxes and Fittings	26 0533
13.	Raceway Systems	26 0536
14.	Electrical Seismic Control	26 0548
15.	Electrical Identification	26 0553
16.	Protective Device Study	26 0573
17.	Occupancy Sensors	26 0923
18.	Lighting Control Equipment	26 0943
19.	Energy & Power Metering System	26 1010

20.	Transformers	26 2200
21.	Switchgear and Switchboards	26 2413
22.	Panelboards	26 2416
23.	Service Entrance	26 2713
24.	Wiring Devices	26 2726
25.	Overcurrent Protective Devices	26 2815
26.	Motor and Circuit Disconnects	26 2816
27.	Motor Starters	26 2913
28.	Emergency Electrical Systems	26 3213
29.	Demolition	26 4119
30.	Surge Protective Devices (SPD)	26 4313
31.	Interior and Exterior Building Lighting	26 5100
32.	Exterior Area Lighting	26 5600
33.	Telephone Data Systems	27 1500
34.	Two-Way Communication	27 3244
35.	Audiovisual Systems	27 4100
36.	Audiovisual System Checklists	27 4101
37.	Intercommunication Systems	27 5123
38.	Public Safety DAS ERRCS	27 5320
39.	Requirements for Intrusion, Access, & Video Surveillance	28 0501
40.	Intrusion Detection System	28 1600
41.	Access Control System	28 2205
42.	IP Video Surveillance System	28 2300
43.	Fire Alarm and Detection System	28 3111
44.	Appendix A – Riverview Jr High School ERRCS Design	

B. Use of standard industry symbols together with the special symbols, notes, and instructions indicated on the drawings describe the work, materials, apparatus and systems required as a portion of this work.

C. Visit the site during the bidding period to determine existing conditions affecting electrical and other work. All costs arising from site conditions and/or preparation shall be included in the base bid. No additional charges will be allowed due to inadequate site inspection.

1.3 DEFINITION OF TERMS

A. The following terms used in Divisions 26, 27 and 28 documents are defined as follows:

1. "Provide": Means furnish, install and connect, unless otherwise indicated.
2. "Furnish": Means purchase and deliver to project site.
3. "Install": Means to physically install the items in-place.
4. "Connect": Means make final electrical connections for a complete operating piece of equipment.

1.4 RELATED SECTIONS:

A. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

B. General and Supplementary Conditions: Drawings and general provisions of contract and Division 1 of the Specifications, apply to all Division 26, 27 and 28 sections.

C. Earthwork:

1. Provide trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, buried cable, in-grade pull boxes, manholes, lighting pole foundations, etc. See Division 31, Sitework, and other portions of Divisions 26, 27 and 28, for material and installation requirements.

D. Concrete Work:

1. Provide forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting as required for underground conduit encasement, light pole foundations, pull box slabs, vaults, equipment pads, etc. See Division 3, Concrete for material and installation requirements.

E. Miscellaneous Metal Work:

1. Provide fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, lighting fixtures, panelboards, distribution boards, switchboards, motor controls centers, etc. See Division 5, Metals for material and installation requirements.

F. Miscellaneous Lumber and Framing Work:

1. Provide wood grounds, nailers, blocking, fasteners, and anchorage for support of electrical materials and equipment. See Division 6, Rough Carpentry for material and installation requirements.

G. Moisture Protection:

1. Provide membrane clamps, sheet metal flashing, counter flashing, caulking and sealants as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors and ceiling slabs and foundation walls. All penetrations through vapor barriers at slabs on grade shall be taped and made vapor tight. See Division 7, Thermal and Moisture Protection for material and installation requirements.

H. Access panels and doors:

1. Provide in walls, ceiling, and floors for access to electrical devices and equipment. See Division 8, Doors and Windows for material and installation requirements.

I. Painting:

1. Provide surface preparation, priming and finish coating as required for electrical cabinets, exposed conduit, pull and junction boxes, poles, surface metal raceways, etc. See Division 9, Finishes for material and installation requirements.

J. Stage Lighting Control Systems & Power for Stage Rigging:

1. Division 26 - Electrical Power Service and Distribution contractor shall provide all labor, materials, equipment, and supervision necessary to install and complete the electrical work as required by the project specifications.
2. Division 26 contractor shall install all raceways, cabling, boxes, supports, and other electrical components required for the installation of the Division 11 0600 Systems in accordance with the project specifications and all applicable codes and standards. Provide a complete and working system.
3. Division 26 contractor shall coordinate with other trades to ensure proper installation and integration of the electrical systems.
4. Division 26 contractor shall ensure that all work is completed in a neat, workmanlike manner and that all materials and equipment are properly secured and supported.
5. The Division 26 contractor shall ensure that all electrical work is tested and inspected in accordance with the project specifications and all applicable codes and standards.
6. All materials shall be new and shall meet or exceed the requirements of the project specifications and all applicable codes and standards.

1.5 WORK FURNISHED AND INSTALLED UNDER ANOTHER SECTION REQUIRING CONNECTIONS UNDER THIS SECTION:

A. Provide electrical service, make requisite connections and perform operational test. Items furnished and installed under other sections and connected under this section, include but are not limited to the following:

1. Electric motors.
2. Package mechanical equipment: fans, fan coil units, pumps, boilers, duplex compressors, etc.
3. Flow switches and valve monitors.
4. Motorized dampers.
5. Fire and smoke dampers
6. Duct mounted smoke detectors.
7. Elevator/Escalator Controllers.
8. Irrigation controllers.
9. Door hold-open/release devices.
10. Motorized projection screens.
11. Wheel chair lifts.
12. Roll down doors.
13. Electric hardware.
14. Laboratory equipment including hoods, cold rooms, autoclaves, drying ovens, glassware washers and dryers, refrigerators, freezers, etc.
15. Shop equipment including saw dust collectors, saws, lathes, grinders, welders, planers, presses, etc.
16. Temperature control panels.
17. Variable frequency controllers.
18. Chiller starters.
19. Motorized Chalkboards/Markerboards/Whiteboards.
20. Display cases.
21. Water coolers.
22. Kitchen equipment including ovens, fryers, mixers, disposers, dishwashers, etc.
23. Paint spray booths.
24. Fire sprinkler alarm bells.
25. Electric heat trace cable for domestic and industrial hot water piping systems.
26. Electric heat trace cable for guttering, drain lines, etc.
27. Anti-sweat heaters, fan coils, etc. for walk-in coolers and freezers.
28. Hand dryers, hair dryers.
29. Dock levelers.
30. Systems/Open Office Furniture

1.6 ITEMS FURNISHED UNDER ANOTHER DIVISION, BUT INSTALLED AND CONNECTED UNDER THIS DIVISION:

A. Items furnished under other Divisions, but turned over to Division 26 for installation and final connection include, but are not necessarily limited to, the following:

1. Wall mounted control stations for motorized roll-up doors/grills.
2. Wall mounted control stations for motorized projection screens.
3. Wall mounted control stations for handicap lift.
4. Lighting fixtures for paint spray booths.
5. Lighting fixtures, receptacles, and switches for fume hoods.
6. Lighting fixtures for kitchen hoods.

7. Lighting fixtures for walk-in freezers and coolers.
8. Stage Lighting Control Systems & Power for Stage Rigging (Per Specifications 11 0600).

1.7 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS:

A. Before bidding, Contractor shall familiarize himself with the drawings, specifications and project site. Submit requests for clarification to Architect/Engineer in writing prior to issuance of final addendum. After signing the contract, the Contractor shall meet the intent, purpose, and function of the Contract Documents. Any costs of materials, labor and equipment arising therefrom, to make each system complete and operable, is the responsibility of the Contractor.

1.8 REQUESTS FOR INFORMATION (RFIs):

A. Contractor shall review all Contract Documents thoroughly before submitting an RFI to avoid unnecessary questions and ensure the question has not already been addressed within the existing Contract Documents.

B. RFIs should be used to seek clarification on issues or areas of confusion that cannot be resolved through a review of the Contract Documents.

C. Each RFI shall contain the following:

1. Description of the Issue/Question: Clearly detail the issue or confusion, referencing the related Contract Document drawings and/or specifications.
2. Relevant Documents: Attach any necessary supporting documents that could aid in understanding the RFI.
3. Proposed Solution: Suggest a possible resolution to the problem or confusion.

D. Non-Compliant RFIs

1. Frivolous or incomplete RFIs will not be accepted. RFIs that do not follow the guidelines set forth in this section, or are deemed unnecessary, may be returned without response at the discretion of the Engineer.

1.9 QUALITY ASSURANCE:

A. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies refers to the latest edition of such publications adopted and published prior to submittal of the bid proposed, unless noted otherwise herein. Such codes or standards are considered a part of this specification as though fully repeated herein.

B. When codes, standards, regulations, etc. allow work of lesser quality or extent than is specified under this Division, nothing in said codes shall be construed or inferred as reducing the quality, requirements or extent of the Drawings and Specifications. Perform work in accordance with applicable requirements of all governing codes, rules and regulations including the following minimum standards, whether statutory or not:

1. National Electric Code (NEC).
2. International Building Code (IBC).
3. International Fire Code (IFC).
4. International Mechanical Code (IMC).

C. Standards: Comply with the following standards where applicable for equipment and materials specified under this Division.

1. UL Underwriters' Laboratories

2. ASTM American Society for Testing Materials
3. CBN Certified Ballast Manufacturers
4. IPCEA Insulated Power Cable Engineers Association
5. NEMA National Electrical Manufacturer's Association
6. ANSI American National Standards Institute
7. ETL Electrical Testing Laboratories

D. All electrical apparatus furnished under this Section shall conform to (NEMA) standards and the NEC and bear the Underwriters' Laboratories (UL) label where such label is applicable.

E. Comply with requirements of State and Local Ordinances. If a conflict occurs between these requirements and the Contract Documents, the most stringent requirements shall govern. The Contractor accepts this responsibility upon submitting his bid, and no extra charge will be allowed after the contract is awarded. This shall not be construed as relieving the Contractor from complying with any requirements of the Contract Documents that may be in excess of the aforementioned requirements, and not contrary to same.

F. Obtain all permits, inspections, etc. required by authority having jurisdiction. Include all fees in bid. Furnish a certificate of approval to the Owner's Representative from the Inspection Authority at completion of the work.

G. Employ only qualified craftsmen with at least three years of experience. Workmanship shall be neat, have a good mechanical appearance and conform to best electrical construction practices. Provide a competent superintendent to direct the work at all times. Any person found incompetent shall be discharged from the project and replaced by satisfactory personnel.

H. Contractor shall have a current state contracting license applicable to type of work to be performed under this contract.

I. Required Pre-Electrical Construction Meeting with Electrical Engineer: Electrical contractor/representative will be required to attend a pre-electrical construction meeting (approximately 30-60 minutes) with engineering representative in the electrical engineers office prior to electrical construction commencement. This meeting will address any questions on the part of the contractor and the expectations of the Engineer with regard to specifications, plans and site visits for both rough and finish electrical work.

1.10 CONSTRUCTION CHANGE ORDER PROPOSALS

A. In the event that a submission of a change order is issued by the contractor, the following information will be required to be submitted by the contractor, prior to any consideration by the owner/architect.
   a. Where project manager or project engineer work is required, the labor cost shall not exceed 2% of the electrical portion of the change order.
   b. All equipment, including conduit and wire, shall be itemized, identifying unit costs and quantities of equipment. Distributor quotes shall accompany all change order requests. The distributor quotes shall include costs for all equipment including conduit and wire. Lot pricing for equipment is not acceptable.
   c. The general contractor shall review and confirm that the quantity and costs of materials submitted appear reasonable for the scope proposed.
   d. Labor units shall not exceed base NECA #1 standards. No adjustment factors shall be approved.
   e. Any research and labeling time, shall be the responsibility of the electrical contractor and shall not be included in the change order request.
   f. Any costs associated with the purchase of tools or transportation shall be fully itemized for review by architect/owner.
   g. Overtime rates shall only be approved where additional manpower cannot achieve the same result.
   h. Change order form shall follow the following format:

i. PCO number
ii. Detailed description of work being performed
iii. Location on project where work is performed
iv. Chosen NECA column
v. Identified material:
    1. QTY
    2. Unit cost
    3. Mark up
    4. Material total
vi. Identified labor:
    1. QTY
    2. Unit cost
    3. Composite labor rate
    4. Labor total

1.11 RECORD DRAWINGS:

A. Contractor shall provide as-built drawings and a record model of the completed project, reflecting all deviations from the original design including but not limited to field conditions, RFIs, ASIs, and other modifications. The as-built drawings shall be provided in both Autodesk Revit and PDF formats.

B. Maintain, on a daily basis, a complete set of “Record Drawings”, reflecting an accurate record of work in accordance with the following:

1. Show the complete routing and location of all feeders rated 100 amps and larger. Contractor shall clearly indicate dimensions on the drawings for work that is hidden beneath the ground or under slabs, concealed above ceiling structures, and within concealed spaces. These dimensions shall be measured from fixed structural elements, rather than from partition walls or other non-structural elements.
2. Show the complete routing and location of all telecommunications conduits, systems raceways, and empty raceways, 1-1/4" and larger. Contractor shall clearly indicate dimensions on the drawings for work that is hidden beneath the ground or under slabs, concealed above ceiling structures, and within concealed spaces. These dimensions shall be measured from fixed structural elements, rather than from partition walls or other non-structural elements.
3. Show all changes, deviations, addendum items, change orders, job instructions, etc., that change the work from that shown on the contract documents, including wall relocations, fixtures and device changes, branch circuiting changes, etc. Where locations of boxes, raceways, equipment, etc. are adjusted in the field to fit conditions, but such new locations may not be obvious by referring to the contract document, show new locations on the record drawings.
4. Provide a copy of the raceway as-builts within the equipment rack for the system indicated below. Provide 11x17 size laminated prints that are legible.
    a. Telecommunications
    b. Audiovisual

C. At the discretion of the Architect/Engineer, the drawings will be reviewed on a periodic basis and used as a pre-requisite for progress payments. This requirement shall not be construed as authorization for the Contractor to make changes in the layout, or work without written authorization for such changes.

D. The Architect/Engineer shall review the drawings and the Contractor shall incorporate the resulting comments into the final record drawings.

E. Certify the “Record Drawings” for correctness by placing and signing the following certifications of the first sheet of the drawings:

"CERTIFIED CORRECT (3/8" high letters)

(Name of General Contractor)

By: _____ Date: _____

(Name of Electrical Contractor)

By: _____ Date: _____

1.12 GUARANTEE:

A. Ensure that electrical system installed under this contract is in proper working order and in compliance with drawings, specifications, and/or authorized changes. Without additional charge, replace any work or materials that develop defect, except from ordinary wear and tear, within one year from the date of substantial completion. Exception: Incandescent and fluorescent lamps shall be guaranteed for a period of two months from the date of substantial completion.

1.13 OTHER:

A. Right to Hire. “Client” agrees that during the project and for a period of twenty four (24) months following substantial completion that it will not, directly or indirectly, employ or solicit to employ BNA Personnel.

PART 2 – PRODUCTS

2.1 GENERAL:

A. Products are specified by manufacturer name, description, and/or catalog number. Discrepancies between equipment specified and the intended function of equipment shall be brought to the attention of the Architect/Engineer in writing prior to bidding. Failure to report any conflict, including catalog numbers, discontinued products, etc., does not relieve the Contractor from meeting the intent of the contract documents nor shall it change the contract cost. If the Contractor is unable to interpret any part of the plans and/or specifications, or should he find discrepancies therein, he shall bring this to the attention of the Architect/Engineer who will issue interpretation and/or additional instructions to Bidders before the project is bid.

2.2 MANUFACTURERS:

A. Provide products of manufacturers specified. Manufacturers catalog numbers and descriptions establish the quality of product required. Substitutions will be considered if a duplicate written application (2-copies) is at the office of the Architect/Engineer eight (8) working days prior to the day of the bidding. The application shall include the following: 1) A statement certifying that the equipment proposed is equal to that specified; that it has the same electrical and physical characteristics, compatible dimensions, and meets the functional intent of the contract documents; 2) The specified and submittal catalog numbers of the equipment under consideration; 3) A pictorial and specification brochure.

B. Any conflict arising from the use of substituted equipment shall be the responsibility of the Contractor, who shall bear all costs required to make the equipment comply with the intent of the contract documents.

C. Samples may be required for non-standard or substituted items before installation during construction. Provide all samples as required.

D. No materials or apparatus may be substituted after the bid opening except where the equipment specified has been discontinued.

E. Provide only equipment specified in the Contract Documents or approved by addendum.

2.3 SPARE PARTS:

A. Provide spare parts (fuses, diffusers, lamps, etc.) as specified. Transmit all spare parts to Owner's Representative prior to substantial completion.

PART 3 – EXECUTION

3.1 INSTALLATION:

A. Layout electrical work in advance of construction to eliminate unnecessary cutting, drilling, channeling, etc. Where such cutting, drilling, or channeling becomes necessary for proper installation; perform with care. Use skilled mechanics of the trades involved. Repair damage to building and equipment at no additional cost to the contract. Cutting work of other Contractors shall be done only with the consent of that Contractor. Cutting structural members shall not be permitted.

B. Provide equipment enclosures appropriate to the environment to which they are installed. For example, provide NEMA 3R for exterior enclosures and NEMA 1 for interior enclosures unless otherwise noted.

C. Since the drawings of floor, wall, and ceiling installation are made at small scale; outlets, devices, equipment, etc., are indicated only in their approximate location unless dimensioned. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned, and coordinate such locations with work of other trades to prevent interferences. Verify all dimensions on the job. Do not scale the electrical drawings, but refer to the architectural and mechanical shop drawings and project drawings for dimensions as applicable.

D. Perform for other trades, the electrical wiring and connection for all devices, equipment or apparatus. Consult Architectural, Mechanical, and other applicable drawings, and all applicable shop drawings to avoid switches, outlets, and other equipment from being hidden behind doors, cabinets, counters, heating equipment, etc., or from being located in chalkboards, tackboards, glass panels, etc. Relocate buried electrical devices and/or connections as directed at no additional cost.

E. Coordinate the location of outlets, devices, connections, and equipment with the supplier of the systems furniture prior to rough-in.

F. Where conduit, outlets or apparatus are to be encased in concrete, it must be located and secured by a journeyman or foreman present at the point of installation. Check locations of the electrical items before and after concrete and/or masonry installation and relocate displaced items.

G. Provide block-outs, sleeves, demolition work, etc., required for installation of work specified in this division.

3.2 CLEAN:

A. Clean up all equipment, conduit, fittings, packing cartons and other debris that is a direct result of the installation of the work of this Division.

B. Clean fixtures, interiors and exteriors of all equipment, and raceways. Replace all filters in electrical equipment upon request for Substantial Completion.

3.3 POWER OUTAGES:

A. All power outages required for execution of this work shall occur during non-standard working hours and at the convenience of the Owner. Include all costs for overtime work in bid.

B. Submit written request at least 7 days in advance of scheduled outage and proceed with outage only after receiving authorization from the Owner's Representative.

C. Keep all outages to an absolute minimum.

3.4 STORAGE AND PROTECTION OF MATERIALS:

A. Provide storage space for storage of materials and apparatus and assume complete responsibility for all losses due to any cause whatsoever. In no case shall storage interfere with traffic conditions in any public thoroughfare or constitute a hazard to persons in the vicinity. Protect completed work, work underway, and apparatus against loss or damage.

3.5 EXCAVATING FOR ELECTRICAL WORK:

A. General: Locate and protect existing utilities and other underground work in manner that will ensure that no damage or service interruption will result from excavating and backfilling. Perform excavation in a manner that protects walls, footings, and other structural members from being disturbed or damaged in any way. Burial depths must comply with NEC Section 300-5 (or State of Utah requirement, whichever is more stringent), unless noted otherwise on drawings.

B. Protect persons from injury at excavations, by barricades, warnings and illumination.

C. Coordinate excavations with weather conditions, to minimize possibility of washouts, settlements and other damages and hazards.

D. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install electrical work on frozen excavation bases or sub-bases.

E. Do not excavate for electrical work until the work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum. See other sections of specification for additional requirements for excavating.

F. Store excavated material (temporarily) near excavation, in a manner that will not interfere with or damage excavation or other work. Do not store under trees (within drip line).

G. Retain excavated material that complies with requirements for backfill material. Dispose of excavated material that is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material. Remove unused material from project site, and dispose of in lawful manner.

3.6 BACKFILL MATERIALS:

A. For buried conduit or cable (other than below slab-on-grade, or concrete encased) - 2" thickness of well graded sand on all side of conduit or cable.

B. For trench backfill to within 6" of final grade - soil material suitable for compacting to required densities.

C. For top 6" of excavation - Top soil.

D. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (percent of maximum density, ASTM D 1557), using power-driven hand-operated compaction equipment.

1. Lawn/Landscaped Areas: 85 percent for cohesive soils, 95 percent for cohesionless soils.
2. Paved Areas, Other than Roadways (90 percent for cohesive soils, 95 percent for cohesionless soils).

E. Subsidence: Where subsidence is measurable or observable at electrical work excavations during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality and condition of the surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.7 UTILITY COORDINATION:

A. Coordinate closely with Murray City Power (MCP), Telco Services (Fiber), and Murray City

School District (MCSD) to finalize the conduit routing shown on the site plan. Verify all equipment dimensions and locations before beginning rough in. Consult all applicable contract drawings and MCP Electrical Service Requirements/Quick Reference Books to insure MCP code clearances required around all electrical equipment, trenching and burial depths, and identification requirements are met. Adjust locations of electrical work, boxes, outlets etc. As necessary to avoid obstructing electrical equipment or building appurtenances. Where job conditions require changes from the contract documents that do not change the scope of installation or nature of work required, the contractor will make such changes without additional cost to the owner. No other changes may be made without written permission of the owner.

B. Trenching and power conduit placement shall be done after the curb and sidewalk is in place to assure proper alignment in the PUE and vertical location of equipment. In the event that conduit must be placed prior to curb and sidewalk the contractor is responsible for correct placement. Any conduit with inadequate cover, or equipment misplaced in elevation or alignment shall be replaced at the contractor's expense.

C. General Responsibilities:

1. Division 26 shall be responsible for the following concerning MCP power pathways for the new building, unless explicitly specified otherwise:

   a. All excavation and trenching required to accommodate MCP-furnished conduit(s).

   b. Backfilling of trenches following conduit installation and inspection.

   c. Coordination with MCP regarding pathway locations, depths, and any special requirements prior to the commencement of excavation.

   d. Pull Box, EUSERC CT Cabinet, and Switchboard.

2. MCP Responsibilities:

   a. Provide all conduit(s) within the excavated trench(es) up and to the utility transformer.

   b. Providing all required sectionalizers and junction cabinets.

   c. Meter

D. Division 26 shall provide transformer pad/vault, conduit and conductors between MCP transformer and CT Cabinet.

E. Submit metering, main breaker, switchgear for approval prior to preconstruction.

F. Contractor to verify all phasing, voltages, and connections prior to energizing of electrical equipment.

3.8 CONCRETE BASES:

A. Unless otherwise noted, provide 4" high reinforced concrete bases for all floor mounted or floor standing electrical equipment, including generators, transformers, switchgear, battery racks, motor control centers, etc. Extend bases 6" beyond equipment or mounting rails on all sides or as shown on the drawings. Notwithstanding this requirement, coordinate with equipment manufacturer, shop drawings, and height of base to ensure compliance with NEC 404.8.

B. Concrete bases shall be provided under Divisions 26, 27 and 28. Coordinate size and location of all bases and furnish all required anchor bolts, sleeves, reinforcing and templates as required to obtain a proper installation.

C. Provide and locate properly sized concrete pads, vaults, etc for power company furnished pad mounted transformers in accordance with power company clearance requirements.

3.9 ROOF PENETRATIONS:

A. Where raceways penetrate roofing or similar structural area, provide appropriate roof jack coordinate with the roofing contractor and the Architect in order to match the vent with the roof construction. The jack shall be sized to fit tightly to raceway for weather-tight seal, and with flange extending a minimum of 9" under roofing in all sides or as required by the roof type of construction. Completely seal opening between inside diameter of roof flashing and outside diameter of penetrating raceways. Coordinate all work with work required under roofing section of specifications.

3.10 FIRE PENETRATION SEALS:

A. Seal all penetrations for work of this section through fire rated floors, walls and ceilings to prevent the spread of smoke, fire, toxic gas or water through the penetration either before, during or after fire. The fire rating of the penetration seal shall be at least that of the floor, wall or ceiling that it is installed, so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electrical Code. Where applicable, provide OZ Type CFSF/I and CAFSF/I fire seal fittings for conduit and cable penetrations through concrete and masonry walls, floors, slabs, and similar structures. Where applicable, provide 3M CID cast-in device for floor slabs. Where applicable, provide 3M fire barrier sealing penetration system, and/or IPC Flame Safe Fire Stop System, and/or Chase Foam fire stop system, including wall wrap, partitions, caps, and other accessories as required. All materials to comply with UL 1479 (ASTM E-814). Comply with manufacturer's instructions and recommendations for installation of sealing fittings and barrier sealing systems.

3.11 PROJECT FINALIZATION AND START-UP:

A. Upon completion of equipment and system installation, assemble all equipment Factory Representatives and Subcontractors for system start-up.

B. Each Representative and Subcontractor shall assist in start-up and check out their respective system and remain at the site until the total system operation is accepted by the Owner's representative.

C. The Factory Representative and/or System Subcontractor shall give personal instruction on operating and maintenance of their equipment to the Owner's maintenance and/or operation personnel. To certify acceptance of operation and instruction by the Owner's Representative, the contractor shall prepare a written statement as follows:

1. This is to certify that the Factory Representative and System Subcontractor for each of the systems listed below have performed start-up and final check out of their respective systems.
2. The Owner's Representative has received complete and thorough instruction in the operation and maintenance of each system.

SYSTEM	FACTORY REPRESENTATIVE
(List systems included)	(List name and address of Factory Representative)

Owner's Representative	Contractor

D. Send copy of acceptance to Architect/Engineer.

3.12 FINAL REVIEW:

A. At the time of final review, the project foreman shall accompany the reviewing party, and remove coverplates, panel covers and other access panels as requested, to allow review of the entire electrical system.

END OF SECTION 26 0500

SECTION 26 0501

MECHANICAL / ELECTRICAL & OWNER-PROVIDED EQUIPMENT COORDINATION

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 work of this section.

B. Architectural, Structural, Vertical Transportation, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.

1.2 CONTRACTOR RESPONSIBILITIES

A. Electrical Contractor shall verify electrical service provided prior to ordering any electrical equipment serving owner-provided equipment / mechanical equipment, and Electrical Contractor shall have the final responsibility for properly coordinating the electrical work, including the exact location, quantity and sizes of the electrical connection(s).

1. Circuit breakers, disconnects, starters, fuses, conduit sizes, wire sizes, VFDs, etc. have been coordinated by Engineers and sized according to the mechanical systems “Basis of Design”. Coordinate with Division 23 Contractor for any changes arising from substituted equipment or changes to the basis of design in any way. Coordinate all requirements of multi-motor VFD control (including fanwall units) and ensure all provisions accordingly. Prepare documentation showing changes in the electrical characteristics of each piece of equipment that has changed and submit for acceptance. All costs arising from said changes shall be the responsibility of Division 23.

2. Circuit breakers, disconnects, starters, fuses, conduit sizes, wire sizes, VFDs, etc. have been coordinated by Engineers and sized according to the owner-provided equipment for the shop (Kilns, compressors, dust collectors, welders, plasma cutters, shop equipment, etc.) as a “Basis of Design”. Coordinate with Owner for any changes arising from substituted equipment or changes to the basis of design in any way. Prepare documentation showing changes in the electrical characteristics of each piece of equipment that has changed and submit for acceptance. Organize meeting with Owner representatives to finalize location and services.

B. **Division-26 responsible for providing conduit and rough-in for all thermostat controls located within walls. Refer to division 21-23 drawings and coordinate with Control Contractor to verify the exact location of all thermostats. Obtain and review submittals of temperature control equipment from the controls contractor and Divisions 21-23**

C. Obtain submittals of all mechanical equipment from Division 21 through 23 contractor(s) as they are submitted to the design team.

1. Notify engineer of any modifications between contract documents and submittals. It shall be the contractor’s responsibility to ensure compliance with the documents.

D. Obtain submittals of all owner-provided equipment from Owner Representative prior to rough-in. It is not acceptable to proceed with the rough-in phase of work until this has been completed—if contractor elects to proceed they do at their <u>own</u> risk.

1. Notify engineer of any modifications between contract documents and submittals. It shall be the contractor's responsibility to ensure compliance with the documents.

E. Electrical contractor shall be responsible for coordinating all their own blockouts and coordinating their space of a shared blockout.

F. Coordinate all interfaces between Mechanical and Electrical/Communications/Security Divisions before submitting any equipment for review or beginning installation.

1.3 ABBREVIATIONS

A. MC: Mechanical Contractor = Divisions 21 through 23 Contractor who provides equipment and motor.

B. TC: Temperature Controls = Division 23 1000 Contractor who provides control.

C. EC: Electrical Contractor = Divisions 26 through 28 Contractor who provides power/data.

D. FA: Fire Alarm Contractor = Division 28 Contractor who furnishes Fire Alarm System.

1.4 RESPONSIBILITY SCHEDULE

A. Responsibility: Unless otherwise indicated, all equipment, motors, and controls for Divisions 21 through 23 equipment shall be furnished, set in place and wired in accordance with the following schedule:

ITEM -	**Furnished Under**	**Set In Place Under**	**Power Wiring Under**	**Control Wiring Under**
Equipment Motors	MC	MC	EC	--
Automatically or Manually Controlled Starters/Contactors: (Note 4)				
-Separate	EC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
Variable Frequency Drives				
-Separate	MC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
In Motor Control Centers (Note 4)	EC	EC	EC	TC
Motor Speed Controllers: (Note 4)				
-Separate	MC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
Disconnect Switches (Note 1)	EC	EC	EC	--
Thermal Overload Switches (Note 1)	EC	EC	EC	--
Switches (Manual or Automatic other than disconnect) (Note 2)	MC or TC	MC or TC	EC or TC	TC or MC
Control Relays (Note 2)	MC or TC	MC or TC	--	TC
Control Transformers	TC	MC or TC	EC (120V)	TC
Thermostat and Controls: Integral with Equipment or Directly Attached to Ducts, Pipes, etc. (Note 2)	TC	MC or TC	TC	TC

ITEM -	Furnished Under	Set In Place Under	Power Wiring Under	Control Wiring Under
Equipment in Temperature Control Panels	TC	TC	EC	TC
Standalone Control Panels (BAS) (Note 5)	TC	TC	EC (120V)	TC
Valve Motors, Damper Motors, Solenoid Valves, etc.	MC & TC	MC & TC	TC	TC
EP Valves or Switches, P.E. Switches, etc.	TC	TC	--	TC
Fire Alarm System (Note 6 & 7)	FA	FA	EC	FA
Fire Sprinkler Alarm	FA	FA	EC	FA
Duct System Smoke Detectors (Note 6)	FA	EC/FA	EC	TC/FA
Relays for Fan Control via duct detectors (Note 6)	MC	EC	EC	FA
Room Smoke Detectors Including Relays for Fan Control (Note 3)	FA	MC	EC	EC
Smoke Management Curtain and Shutters (Note 6)			EC	EC/FA
CO Sensors	FA	FA	EC	FA
Equipment Interlocks (Unless noted otherwise on electrical equipment schedule)	TC	TC	--	TC
Fire/Smoke and Smoke Dampers (Note 6)	MC	MC	EC	FA
Positive Indication Devices (i.e., current sensors, end switches, airflow sensors)	TC	TC	--	FA/TC
Freezer and Refrigerator Temperature Controls (Intrusion/Access Controls)	MC	MC	EC	EC
Domestic Water Flow Switch Located downstream past the cooling tower. Provide 120V power. (Intrusion/Access Controls)	MC	MC	EC	EC
Low Building Temperature Sensor (Intrusion/Access Controls)	MC	MC	EC	EC
Ceiling Mounted Occupancy Sensors & VAV Box Integration (Note 9)	EC	EC	EC	TC
Single Restroom Cabinet Fans (Note 10)	MC	MC	EC	TC
Conduit/raceway/pathway for ATC controls	TC	TC	-	TC

ITEM -	**Furnished Under**	**Set In Place Under**	**Power Wiring Under**	**Control Wiring Under**
Dust Collector – Main Electrical Panel	MC	MC	EC (480V)	FA (INITIATION LOOP TO PANEL ONLY) MC (CONTROL WIRING)
Dust Collector – Dust Collector Fan	MC	MC	EC (480V)	MC
Dust Collector – Rotary Airlock Motor	MC	MC	EC (480V)	MC
Dust Collector – 120V Solenoids	MC	MC	EC (120V)	MC
Dust Collector – Spark Control Panel	MC	MC	EC (120V)	FA (INITIATION LOOP TO PANEL ONLY) MC (CONTROL WIRING)
Dust Collector – Abort Gate Control Panel	MC	MC	EC (120V)	MC
Dust Collector – No Return Valve Control Panel	MC	MC	EC (120V)	MC

B. Responsibility Schedule Notes:

1. If furnished as part of factory wired equipment furnished and set in place by MC, wiring and connections by EC.

2. If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished by MC, but they shall be set in place and connected by EC, except that where such items are an integral part of the mechanical equipment, or directly attached to ducts, piping, or other mechanical equipment, they shall be furnished and set in place by MC and connected by EC. If they do not carry the FULL LOAD CURRENT to

any motor, they shall be furnished, set in place and wired by TC contractor.

3. Electrical contractor is responsible for wiring from starter to motor, unless factory wired.

4. Temperature control contractor shall provide conduit and wire from auxiliary contact in motor starter to the detector so that the unit shuts down in all operating modes. Fire Alarm Contractor to wire from detector to fire alarm panel.

5. Each division shall be fully responsible for any control panels as called for on the drawings or specifications. Div. 26 shall coordinate BMS panel locations with Div. 21-23 drawings and specification and provide power and data to each panel regardless of if they are shown on the electrical plans.

6. Division 26 and 28 shall provide all power and control wiring to fire/smoke and/or smoke dampers. Division 23 shall provide parallel control wiring (with 28 fire alarm having priority signal) to dampers and equipment utilized in both normal and smoke control modes. Refer to Smoke Control and Fire Alarm Drawings and the Fire Alarm Matrix.

    a. Fire alarm system shall override automated building control system during smoke exhaust mode.

    b. TC wiring required only when damper also serves HVAC system.

7. FA wires from the fire alarm control panel necessary for the initiation and monitoring of the Smoke Management System Control Panel. TC wires to components and smoke control fans and dampers utilized in the control and monitoring of the Automated Building Control System.

    a. Provide 120V emergency circuit and fire alarm connections to each curtain and shutter. Coordinate exact locations with curtain and shutter contractor.

8. Division 26 shall provide power to junction box on the exterior of the AHU and associated disconnect/starter or VAV. If required, division 26 shall wire individual fan arrays from overloads to motors as required.

9. Provide ceiling occupancy sensors with additional isolated relay with NO, NC and common outputs for use with HVAC control (VAV Boxes), data logging and other control options. TC to wire VAV to occupancy sensor contacts as required.

10. Ceiling mounted cabinet fans within single restrooms shall be switched on automatically with wall motion activated occupancy sensor. Provide in-line prewired relay, 120/208 to 277V AC, 24V AC/DC, 20A @ 277V to interface with ATC Controls and run fan. Both lights and fan to turn off 10-minutes after vacancy. TC to wire relay/contacts to ATC controls.

C. Power Wiring by Divisions 21 through 23: The electrical power for certain equipment provided under Divisions 21 through 23 has not been specifically indicated on the electrical drawings and must be provided by and field coordinated by the Divisions 21 through 23 trades requiring such power. Electrical contractor shall review Division 21 through 23 drawings and coordinate with said contractors to confirm power needs.

1. Sufficient power for this purpose shall be furnished as “spare” dedicated circuit capacity in Division 26’s panelboards. All wiring, conduit and electrical devices downstream of the panelboards are the responsibility of the Divisions 21 through 23 trades requiring the power.

    a. Such equipment is hereby defined as:

2. Electrical heat trace. Required heat trace locations, capacities and specification are shown on the plumbing drawings (Division 22 work).

3. Dry-pipe control panels and valves. Required connections are included in the Division 21 work, and will be shown by that contractor's engineered system design drawings.

    a. Such equipment is hereby defined as:

    b. Electrical heat trace. Required heat trace locations, capacities and specification are shown on the plumbing drawings (Division 22 work).

    c. Fire protection air compressors, dry-pipe control panels and valves. Required connections are included in the Division 21 work, and will be shown by that contractor's engineered system design drawings.

    d. Pre-action system alarm and trouble initiation signals (such as smoke detectors or general alarm conditions in a pre-action zone) shall be provided under Division 28 fire alarm work.

    e. Division 21 shall provide pre-action control panel and interconnection between pre-action panel and location of pre-action valve(s). See Specification 21-5000 for FM 200.

    f. Division 28 shall provide interconnection between fire command center alarm panel (provided under Division 28) and remote communication fire alarm panel (provided under Division 28).

4. Infrared plumbing fixtures. Fixtures requiring power are shown on the plumbing drawings and schedules. Provide junction box and or receptacle as required by manufacturer.

5. Temperature control panels, control air compressors and line voltage power for 24v control transformers. Required connections are included in Division 23 and will be shown by that contractor's control submittal drawings.

6. Condensate pumps. Provide power from associated unit or from nearby panelboard.

7. BAS or Control System Gateways. Provide power from nearest panelboard and single data cable from nearest telecommunications room.

1.5 GENERAL REQUIREMENTS

A. Special Requirements:

1. Motors, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.

B. Building Management System Controls:

1. Provide 120V circuit and single data cable to each building management control panel. Coordinate exact locations with controls contractor. See Specification 27-1500

2. Low voltage wiring and raceways from J-boxes to distributed control components, all low voltage connections, all control panels and all control transformers (not part of unitary equipment) shall be provided under Division 23.

3. Any additional power requirements shall be the responsibility of the Division 23 Contractor requiring same, and shall be provided at no additional cost to the owner.

1.6 CEILING AND CHASE CAVITY PRECEDENCE

A. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of precedence. A system with higher precedence may direct that systems of lower precedence be relocated from space, which is required for expedient routing of the precedent system.

1. Plumbing waste, cooling coil drain piping, and roof drain mains and leaders.
2. Condensate piping.
3. Hydronic main piping (8” and larger).
4. Plumbing vent piping.
5. Supply, return and exhaust ductwork.
6. Cable tray systems.
7. Electrical conduit 4” diameter or greater.
8. Hydronic branch and mains (greater than 2”, but less than 8”).
9. Domestic water piping.
10. Fire sprinkler mains and leaders.
11. Hydronic branch piping (2” and less).
12. Domestic hot and cold-water branches.
13. Electrical branch conduits.
14. Pneumatic control piping.
15. Fire sprinkler branch piping and sprinkler runouts.

B. Light fixtures have precedence in a zone, which is the same height above the ceiling as the depth of the fixture (plus 2”).

C. Examine the contract documents of all trades (e.g. all Divisions 21 through 23 and 26 through 28 drawings, the architectural floor plans, reflected ceiling plans, elevations and sections, structural plans and sections, etc.).

D. Coordinate necessary equipment, ductwork and piping locations so that the final installation is compatible with the materials and equipment of the other trades.

E. Prepare shop drawings for installation of all new work before installation to verify coordination of work between trades.

F. Provide access doors for all electrical and communications equipment which require access for adjustment or servicing and which are in otherwise inaccessible locations. All access door locations must be approved by the architect prior to installation and be in as inconspicuous location as possible.

1. For equipment located in “accessible locations” such as lay-in ceilings: Locate equipment to provide adequate service clearance for normal maintenance without removing architectural, mechanical, electrical or structural elements such as the ceiling support system, electrical fixtures, etc. “Normal maintenance” includes, but is not limited to: replacement of drivers, fuses, etc.

1.7 BLOCKOUT USAGE

A. Electrical and Mechanical Contractors shall review the contract documents and advise if additional blockouts are necessary for the execution of work. Electrical and Mechanical Contractors shall coordinate and hold meetings with other contractors who will occupy the blockouts to ensure sufficient space is allocated for their scope of work. It is not

acceptable to delay this meeting until conduit/piping/tray is being installed. Change orders are not acceptable due to a lack of contractor coordination prior to commencing rough in.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 26 0501

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SECTION 26 0502

ELECTRICAL SUBMITTALS AND O & M MANUALS

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 all Division 26, 27 and 28 sections.

B. Architectural, Structural, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.

C. Consult all other sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.

1.2 SUBMITTAL REQUIREMENTS:

A. GENERAL:

1. After the Contract is awarded but prior to ordering, manufacture, or installation of any equipment, prepare complete Submittals including shop drawings, product data, brochures, etc. for materials and equipment as required by each section of the specification.
2. Review of Submittals shall not relieve the Contractor of responsibility for dimensions and/or errors that may be contained therein, or deviations from the Contract Document's requirements. It shall be clearly understood that the noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings and Brochures, the requirements of the Contract Document's shall govern and are not waived, or superseded in any way by the review of the Shop Drawings and Brochures.
3. Submittals are reviewed, not approved. Comments made within submittals do not alter the contract documents in any way. The contractor is still responsible, regardless of comments (if any) made within submittals, for complying with drawings and specifications.
4. Notify engineer in writing if any of the comments noted in the submittals alter the contract cost. A comment within the submittal process which increases/decreases cost of product is not an authorization to the contractor under any circumstances to proceed.
5. Notify engineer of any modifications between contract documents and submittals. It is the responsibility of the contractor to ensure compliance.
6. ELECTRONIC SUBMITTAL REQUIREMENTS:
   a. Provide submittals in Portable Document Format (PDF).
   b. Documents must be electronically bookmarked and keyword searchable using Adobe Acrobat (http://www.adobe.com/acrobat) or Bluebeam Revu (http://www.bluebeam.com) for each relevant section. For example, include electronic bookmarks separating “Light Fixtures” from “Panelboards”.

c. Electronically highlight all options for light fixtures, electrical equipment, etc. Manual highlighting and scanning of the documents is NOT acceptable and will NOT be reviewed.

d. Provide only completed cutsheets for all fixture and equipment types. Blank cutsheets submitted with a schedule are NOT acceptable and will NOT be reviewed.

e. At the time of submission, the electrical contractor shall provide a complete and comprehensive submission of all required specification sections/shop drawings at the same time. Exceptions may be given, with prior approval, for time-sensitive equipment.

f. A maximum of one submittal per specification section is allowed. It is NOT acceptable to provide a product by product submittal. Single product by product submittals will NOT be reviewed.

B. **PASSWORD AND SECURITY SETTINGS**

a. All default passwords for installed equipment shall be reprogrammed with owner-approved passwords and settings. The contractor shall coordinate with the owner to confirm specific password requirements prior to final programming. Ensure that all security settings are configured per the owner's instructions and industry best practices. Document all programmed passwords and provide secure delivery to the owner upon project completion. Unauthorized retention or reuse of passwords is strictly prohibited.

C. **SCHEDULING**

1. GENERAL

a. A minimum period of two weeks, exclusive of transmittal time, will be required each time Submittals are submitted or resubmitted for review. This time period shall be considered by the Contractor when scheduling submittal data.

b. If the shop drawings are rejected twice, the contractor shall reimburse the engineer the sum of $1,200.00 for the third review and any additional reviews required prior to commencement of the third review.

D. **QUALITY ASSURANCE**

1. PRE-SUBMITTAL PREPARATION

a. Prior to submission of the Shop Drawings and Project Data, review and certify that they are in compliance with the Contract Documents. Verify all dimensional information to ensure proper clearance for installation of equipment.

b. Shop drawings requiring the use of electronic documents (floor plans, Lighting plans, fire alarm plans, etc.) shall be requested via a request for information (RFI) through the general contractor. Electronic documents will be provided to the Architect for distribution. No direct vendor requests will be accepted.

c. Contractor is completely responsible for the content of the submittal

2. SUBMITTAL REQUIREMENTS

a. Certifications shall be written or in the form of rubber stamp impressions as follows:

i. I hereby certify that this Shop Drawing and/or Brochure has been checked prior to submittal and that it complies in all respects with the requirements of the Contract Drawings and Specifications for this Project.

(Name of Electrical Subcontractor)

Name_____.

Position_____Date_____.

b. Brochures to be submitted shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information. Brochures submitted shall contain only information relevant to the particular equipment or materials to be furnished. The Contractor shall not submit catalogs that describe several different items in addition to those items to be used, unless all irrelevant information is marked out, or unless relevant information is clearly marked. Brochures from each manufacturer shall be identified and submitted separately.

c. Shop Drawings shall be done in an easily legible scale and shall contain sufficient plans, elevations, sections, and isometrics to clearly describe the equipment or apparatus, and its location. Drawings shall be prepared by an Engineer/Draftsmen skilled in this type of work. Shop Drawings shall be drawn to at least 1/4" = 1'0" scale.

d. Observe the following rules when submitting the Shop Drawings and Brochures.

i. Each Shop Drawing shall indicate in the lower right hand corner, and each Brochure shall indicate on the front cover the following: Title of the sheet or brochure, name and location of the building; names of the Architect and Electrical Engineer, Contractor, Subcontractors, Manufacturer, Supplier/Vendor, etc., date of submittal, and the date of correction and revision. Unless the above information is included the submittal will be returned for resubmittal.

1. Submittal Identification shall include the following:

a. A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted.

b. Original submittal numbers shall have the following format: “XXX-Y;” where “XXX” is the originally assigned submittal number and “Y” is a sequential letter assigned for resubmittals (for example, A, B, or C being the first, second, and third resubmittals, respectively). Submittal 25B, for example, is the second resubmittal of Submittal 25.

e. SPECIFICATION section and paragraph to which submittal applies.

E. POST-SUBMITTAL

1. Check all materials and equipment after arrival on the job site and verify compliance with the Contract Documents.

1.3 PROVIDE SUBMITTALS AS REQUESTED FOR EACH OF THE SECTIONS LISTED BELOW:

A. 26 0510 Elevator Electrical Requirements

1. Submit manufacturer’s data for all power module switches and other disconnects specified in this section.

B. 26 0519 Conductors and Cables

1. (600V and Below)

a. Submit megohmmeter test data for circuits under 600 volts.

2. Conductors and Cables (Medium and Low Voltage)

a. Submit manufacturer's data on electrical cable and connectors for use above 600 volts. Upon request of Architect/Engineer, submit certificate of compliance indicating that cable has been tested in accordance with ICEA S-68-516, AE16 #6 and UL Standard 1072, and meets or exceeds minimum requirements.

b. Submit test data in accordance with IEEE Standard 400-2001 showing ambient conditions, voltage levels, level durations, and conduction current for each step. Include effective insulation resistance in submittal.

c. Submit medium voltage cable Splicer/Terminator certification of competency and experience 20 days before splices or terminations are made in medium voltage cables. Splicer/Terminator experience during the immediate past 3 years shall include performance in splicing and terminating cables of the type and classification being provided under this contract.

C. 26 0526 Grounding

1. Submit the name of test agency to be used for testing specified in this section. Submit results of tests specified in this section. Also include test results in Operation and Maintenance Manuals as specified.

D. 26 0532 Conduit Raceway

1. Submit manufacturer’s data on MC-PCS Power & Control/Signal Cable.

E. 26 0533 Electrical Boxes and Fittings

1. Submit manufacturer’s data including specifications, installation instruction and general recommendations for each type of floor box used on project.

F. 26 0536 Raceway Systems

1. Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of raceway as follows: Surface Metal Raceways, Cable Tray Systems, Overhead metal raceways, Wire basket cable tray systems

2. Submit dimensioned drawings of raceway systems showing layout of raceways and fittings, spatial relationships to associated equipment, and adjoining raceways, for each type of raceway as follows: Surface metal Raceways, Cable Tray Systems, Overhead metal raceways, Wire basket cable tray systems

G. 26 0548 Electrical Seismic Control

1. A single submittal shall be provided for all seismic anchorage and restraints for all Division 26 equipment and systems provided as part of this project. Individual submittals for specific systems will not be accepted.

2. Submit shop drawings, calculations, and printed data for the following items under provisions of the General Conditions of the Contract:

a. Complete engineering calculations and shop drawings for all seismic requirements for all equipment to be restrained as outlined in Section 26 0548 Specification, and as detailed on drawings.

b. The professional seal of the engineer who is responsible for the design of the Seismic Restraint System.

c. Details for all seismic bracing.

d. Details for steel frames, concrete inertia bases, and housekeeping pads. Include dimensions, embed depths, dowelling details, and concrete reinforcing requirements.

e. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing anchors, snubbers, cables, and bolt connections.

f. Floor plan noting the locations, size, and type of anchorage and restraint to be used.

g. Include confirmation that all calculations are based on the design criteria listed in appropriate Section.

h. Certificate of Compliance.

i. Where equipment is exempt per this specification provide a written certificate of compliance for each of the systems noted with the professional seal of engineer who has reviewed the electrical system.

H. 26 0553 Electrical Identification

1. Submit manufacturer's data on each type of electrical identification products

a. Submit one sample of each component of the electrical identification system as follows: Wire/cable tape marker, Tags, Engraved, plastic laminate labels, Arc-flash hazard labels

I. 26 0573 Protective Device Study

1. Submit partial study that includes the calculated values for short circuit current availability and arc flash levels for each switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution panelboard, automatic transfer switch, and branch circuit panelboard. This data shall be submitted prior to, or at the same time as, submitting the entire electrical gear package. Contractor shall utilize construction drawings to estimate approximate feeder lengths for this preliminary submittal. Submitted data shall include equipment/panel designations, feeder conductor sizes, feeder lengths, and calculated short circuit values and arc flash levels. Include the utility transformer ratings and transformer impedances used for the preparation of the short circuit calculations.

2. Construction Period Submittal: During the construction period but prior to application of utility power to the electrical distribution system, submit an indexed copy of the complete protective device study based on actual field values. Include the following:

a. Introductory section with basic formulas, pertinent data, and rationale employed in the study.

b. One-line diagram for that portion of the system included in the study.

c. Calculations section showing tabulated calculations.

d. Results, recommendations, settings, etc.

3. Provide one revision to study based on engineering review comments for the completed study to allow for minor modifications to adjustable circuit breakers to minimize arc flash levels.

J. 26 0923 Occupancy Sensors

1. Submit manufacturer's data on occupancy sensors, control modules, wiring diagrams, interconnection diagrams and any related accessories.

2. Submit scaled drawings with lighting fixtures shown clearly marked by manufacturer showing proper product, location and orientation of each sensor.

K. 26 0943 Lighting Control Equipment

1. Submit manufacturer's data on lighting control equipment including, but not limited to published catalog data sheets, rough-in diagrams and instructions for installation, operating and maintenance, suitable for inclusion in maintenance manuals.

2. Meet with the electrical engineer at their office prior to preparation of shop drawings to discuss and verify specific programming and zoning requirements of system(s).

3. Meet with the lighting representative/manufacturer of the approved and accepted lighting control equipment to verify and understand specific installation requirements associated with that system.

4. Submit detailed drawings and documentation of lighting control components and interconnection including, but not necessarily limited to:

   a. Electronic controllers

   b. Control stations

   c. Photo sensors

   d. Occupancy sensors

   e. Network wiring details

   f. Input and output wiring details

   g. Lighting control panel load schedules

   h. Provide a complete sequencing and programming schedules for all devices, zones and scenes.

   i. Wallstations layouts

   j. Accurately scaled equipment layouts, wire/cable routing and connections to control wiring and electrical power feeders.

L. 26 1010 Energy & Power Metering System

1. Submit manufacturer's data on all components.

2. Submit riser diagrams and interconnection diagrams, wiring layouts etc. for advanced metering system including low voltage wiring interconnections; and communications and data line interconnections to system components and to the BAS/BMS (Building Automation System/Building Management System) equipment.

3. The external wiring interconnections required by the electrical contractor shall be clearly identified on the shop drawings.

M. 26 2200 Transformers

1. Submit manufacturer's data on transformers, including certification of transformer performance efficiency, percentage regulation at 100 percent and 80 percent power factor, no-load and full load losses in watts, percent impedance at 75 degrees C, hot-spot and average temperature rise above 40 degrees C ambient, sound level in decibels, and standard published data. Before submitting product data, verify that dimensions of units to be supplied allow proper code required clearances adjacent to unit.

2. Submit dimensioned drawings of transformer installations, showing layout, mountings and supports, and spatial relationship to proximate walls and equipment.

3. For types and ratings required, furnish additional fuses, amounting to one unit for every five installed units, but not less than three units of each (including ELSP fuses when specified).

N. 26 2413 Switchgear and Switchboards

1. Submit manufacturer's data on switchgear and switchboards.

2. Submit dimensioned drawings of switchgear and switchboards showing accurately scaled basic sections including, but not necessarily limited to, auxiliary compartments, section components, and combination sections. Show plan view of equipment with dimensioned clearances to proximate equipment. Failure to submit said plan view shall not relieve contractor of responsibility to verify required clearances before release of equipment for fabrication.

3. Submit manufacturer’s data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2413 submittals received prior to submission of the preliminary protective device study will be REJECTED.

4. For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than 3 units of each.

O. 26 2416 Panelboards

1. Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not necessarily limited to, circuit breakers, fusible switches, fuses, ground-fault circuit interrupters, and accessories.

2. Submit manufacturer data including specifications, installation instructions and general recommendations, for each type of panelboard required.

3. Submit manufacturer’s data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2416 submittals received prior to submission of the preliminary protective device study will be REJECTED.

P. 26 2713 Service Entrance

1. Submit manufacturer's data on service-entrance equipment and accessories.

2. Submit dimensioned layouts of service-entrance equipment and spatial relationships to proximate equipment. Failure to submit said layouts shall not relieve contractor of responsibility to verify required clearances before release of equipment to fabrication.

3. Submit manufacturer’s data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2713 submittals received prior to submission of the preliminary protective device study will be REJECTED.

4. For types and ratings required, furnish additional fuses, amounting to one unit for every 2 installed units, but not less than one unit of each.

Q. 26 2726 Wiring Devices

1. Submit manufacturer's data on electrical wiring devices.

R. 26 2815 Overcurrent Protective Devices

1. Submit manufacturer's data on overcurrent protective devices, including catalog cuts, time-current trip characteristic curves, and mounting requirements.

2. Submit layout drawings of overcurrent protective devices, with layouts of circuit breakers, including spatial relationships to proximate equipment. Failure to submit said spatial layouts does not relieve contractor of responsibility to verify all required

clearances before release of equipment for fabrication.

3. Submit manufacturer's data and shop drawings only after completion of the preliminary protective device study (see Section 26 0573 as applicable). Any Section 26 2815 submittals received prior to submission of the preliminary protective device study will be REJECTED.

4. For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than two units of each size and type, unless specified otherwise in another section of these specifications.

5. Submit time-current trip curves (in log-log format) and trip setting parameter/range information (for each trip function) for all solid-state circuit breakers.

6. Manufacturer shall also provide recommended trip settings with the shop drawing submittal (including ground fault settings) for coordination with downstream overcurrent devices. Manufacturer shall base recommendations on the AIC rating of the electrical equipment.

7. Where the Protective Device Study specification section 260573 is included in the project, the time-current curves and recommended trip settings for all solid-state circuit breakers shall be submitted as part of the protective device study.

S. 26 2816 Motor and Circuit Disconnects

1. Submit manufacturer's data including specifications, installation and general recommendations, for each type of motor and circuit disconnect switch required.

2. Submit dimensioned drawings of electrical motor and circuit disconnect switches that have rating of 100 amperes and larger.

T. 26 2913 Motor Starters

1. Submit manufacturer's data on motor starters.

2. Submit dimensioned drawings of motor starters showing accurately scaled equipment layouts.

3. After installation is complete, including water and air balancing, measure voltage (L-L and L-N) and full load current of each phase of each motor. Submit report showing field readings of voltage, amperage, service factor, and thermal heater size installed for each motor.

U. 26 3213 Emergency Electrical Systems

1. Dimensioned drawings of emergency electrical system components and accessories including, but not necessarily limited to generator sets, isolation/by-pass switches, day tanks, transfer switches, instruments and accessories, (and) annunciator panels, (and fuel line and exhaust piping). Show accurately scaled layouts of system components; indicate their spatial relationship to associated equipment; show connections to normal and emergency power feeders. Failure to submit said scaled lay-outs does not relieve contractor of responsibility to verify all required clearances before release of equipment for fabrication.

2. Manufacturer's standard catalog data describing and depicting each engine-generator set, batteries, charger, tanks, and all ancillary equipment in sufficient detail to demonstrate complete specification compliance.

3. Drawings depicting each of the following:

   a. Base mounted equipment, with base and all attachments including anchor bolt template and recommended clearances for maintenance and operation.

   b. Complete starting system, fuel system, cooling system, and exhaust system.

c. Electric wiring of relays, breakers, and switches with applicable single line and wiring diagrams and written description of operation and the instrumentation provided.

d. Enclosure (if applicable).

4. Manufacturer's standard catalog data describing and depicting each transfer and by-pass isolation switch along with all ancillary equipment in sufficient detail to demonstrate complete specification compliance. In addition provide the following:

a. One-line diagram of each switch assembly and wiring diagram of each unit.

b. A complete list of equipment and material to be provided, containing an adequate description of each separate item of equipment.

5. Submit four complete sets of operating manuals for each item of equipment and/or component outlining the step-by-step procedure required for system start up, operation, and shutdown. Include the manufacturer's name, model number, and a description of all equipment, complete with basic operating features. Describe in detail all maintenance procedures and a troubleshooting guide listing possible breakdowns and repairs for each piece of equipment. Include all factory service manuals, complete parts lists, simplified schematic diagrams of each system as installed, and the original. Include complete rest reports specified in Part 3-Execution herein.

V. 26 4313 Surge Protective Devices (SPD)

1. Submit manufacturer's data on SPD's listing all performance ratings specified or required herein.

2. Submit dimensioned drawings of SPD's including, but not necessarily limited to, the following.

a. Complete data sheet.

b. Set of outline drawings giving complete mounting information, conduit entry and exit locations and dimensions, overall unit dimensions, weights, physical characteristics, etc.

c. Set of complete electrical drawings for power and control wiring.

d. Manufacturer's literature giving detailed information of equipment including parts numbers, model numbers and ratings.

e. UL 1449 suppressed voltage rating documentation.

W. 26 5100 Interior and Exterior Building Lighting

1. Submit manufacturer's data on interior and exterior building lighting fixtures.

2. Submit dimensioned drawings of lighting fixtures. Submit fixture shop drawings in PDF format with separate sheet for each fixture, assembled in luminaire "type" alphabetical order, with proposed fixture catalog number and accessories clearly indicated on each sheet.

3. When applicable submit standard color samples with the shop drawings. If standard colors are not acceptable, a color sample will be provided to the fixture manufacturer. Return of the shop drawings will be delayed until color samples are provided.

4. Submit driver manufacturer cut sheets.

5. Submit a list of all lamps used on projects.

a. Stock of all spare items shall be delivered as directed to Owner's storage space. All components shall be labeled to match construction document

nomenclature,

X. 26 5600 Exterior Area Lighting

1. Submit manufacturer's data on lighting units, including certified dimension drawings of components including, but not necessarily limited to, poles and standards, mast arms, brackets, hardware and fixtures.

Y. 27 1500 Telephone Data Systems

1. Provide proof of RCDD certification and connectivity manufacturer certification.
2. Provide submittals for all racks/cabinets; patch panels, devices, cabling, firestopping solutions, tray, non-continuous cable support devices, grounding equipment, and miscellaneous equipment to be used on project. Where multiple part numbers are listed on a datasheet/cutsheet, highlight or circle applicable part.
3. Provide submittals showing complete racking layout in plan and elevation view to scale. Coordinate exact rack layout with Owner Information Technology Representative prior to submittal.
4. Provide color samples of all available standard color faceplates to architect.
5. Provide proposed labeling scheme for approval by owner/engineer.
6. Provide catalog cutsheets of all test equipment that will be used.

Z. 27 3244 Two-Way Communication

1. Data sheets on all equipment being provided as well as recommended cable types. Internal control cabinet drawings showing internal block diagram connections shall be provided. Wiring diagrams showing typical field wiring connections as well as single line floor plan indicating equipment locations as well as cable routings and quantities.
2. Submit product data, including manufacturer's (Specifications Data) product sheet, for specified products.
3. Submit shop drawings showing layout, profiles, and product components, including anchorage and accessories. Include cabling diagrams, wiring diagrams, station installation details, and equipment cabinet details.

AA. 27 4100 Audiovisual Systems

1. Provide a list of finish options for selection. Do not order any equipment if finishes have not been selected on the shop drawings.
2. Provide shop drawings for 27 4100 at the time of original shop drawing submission. Do not order AV equipment from the first submission. One hundred and twenty (120) days prior to the time of AV equipment installation, provide a second submission of AV equipment only. Provide current equivalent if specified model has been discontinued.
3. The following items shall be included in the shop drawings submittal:
    a. Project manager’s written proof, with signature and date, that shop drawings and/or brochure has been checked for accuracy prior to submittal. Shop drawings to comply in all respects with the requirements of the contract drawings and specifications for this project.
    b. A complete bill of materials, broken out per system type, for all components, accessories and hardware to be provided in order to assemble a complete and working system as described within the contract documents.
        i. The bill of material is intended to be used to verify equipment within each system. Only one cut sheet per

unique product type is required.

ii. Example several systems may require the same flat panel display mount, that mount should be listed in each system type with only one (1) cut sheet provided for that product.

c. Manufacturer's data sheets and installation details for all devices, plates, cables and similar equipment. Product data showing multiple options, products and/or models shall be clearly marked identifying the specific options, products and/or models being provided.

d. Signal flow drawings showing all audio, video, control, network and power connections required between all pieces of equipment within each system.

i. Unique cable/wire identifier for each connection that correspond to field cabling labelling scheme.

ii. All connections require connector type and male/female termination to be identified. Type shall correspond to a connector legend or shall be clearly identified per instance.

iii. Wiring pinouts for all multipin connectors used

iv. Detailed panel drawings showing wall, floor, rack, etc. input/output panel dimensions, connector types and text labeling for each connection shown

v. Physical location information for each device.

vi. Upon request AV Consult's signal flow drawings may be utilized for signal flow documentation within the shop drawings, provided, the items above are included. Contractor shall make request for electronic files as indicated in section 1.2.C.

e. Equipment rack elevations.

f. Matrix routing and preset configuration tables, and digital signal processing configuration details.

g. Wireless microphone transmission frequencies.

h. Submit all manufacturer training, 3rd party and/or organization certificates for each equipment and/or systems required for the implementation of this specification.

4. All touch panel layouts, page logic functions and control system functionality, shall be submitted and approved by the Owner and AV Consultant prior to installation and programming of the control systems. Contractor shall submit the following information at the following stages during the construction of the GUI.

a. Draft Stage: Draft drawings and/or sketches of; basic layouts, button details, text details and page flip progression. Include control schemes for all applicable devices in system.

b. Intermediate Stage: Intermediate Touch Panel Menus designed with manufacturer's software. Submit printouts and/or software files for review. Include detailed layouts, extensive control schemes for all controlled components, comprehensive button and text configurations, page flips and pop-up progression. Incorporate any changes or comments from previous stage mentioned above.

c. Demo Stage: Provide an active Touch Panel and controller to extensively demonstrate the operation of the control system. Demo of system shall be subject for review and considered as a deliverable. Include all revised

detailed layouts, extensive control schemes for all controlled components, comprehensive button and text configurations, page flips and pop-up progression. Incorporate any changes or comments from the previous stage mentioned above.

d. Final Stage: Submit Final Touch Panel Menus designed with manufacturer's software. Submit printouts and software files for review. Include all detailed layouts, all revised control schemes for all controlled components, revised button and text configurations, page flips and pop-up progression. Include final page configurations for control of system from the touch panel. Incorporate any and all changes or comments from the previous stage mentioned above.

BB. 27 5123 Intercommunication Systems

1. Provide a complete bill of materials for all components, accessories and hardware to be provided in order to assemble a complete and working system as described within the contract documents.
2. Provide wiring layouts for Audio, Video, Control, and power.

CC. 28 1600 Intrusion Detection System

1. Submit manufacturer's data and installation details for all devices, panels, cables, and head-end equipment. Product data showing multiple options, products and/or models shall be clearly marked identifying the specific options, products and/or models being provided.
2. Submit dimensioned drawings and schematics for design of system, which include coverage patterns and areas of all motion detectors. Submit actual riser diagrams of complete system and elevations of required equipment. Typical risers are not acceptable.
3. Provide a complete bill of materials for all components, accessories, and hardware to be provided in order to assemble a complete and working system as described within the contract documents.
4. Submit dimensioned drawings and device wiring layouts for all equipment.
5. Submit equipment rack elevation diagrams (if applicable).
6. Submit network switch port count and power requirements. Port count and POE switch requirements should be broken out per EF/ER/TR closet.
7. Submit manufacturer certifications for all systems provided. Certifications must be from local office providing the install.
8. Provide battery calculations to verify system standby time are required.
9. Provide a detailed scope of work document for all services provided.

DD. 28 2205 Access Control System

1. Submit manufacturer's data sheets including specifications, installation instructions, and general recommendation for each type of equipment specified.
2. Submit dimensioned drawings and schematics for design of system. Submit actual riser diagrams of complete system and elevations of required equipment. Typical risers are not acceptable.
3. Provide a complete bill of materials for all components, accessories, and hardware to be provided in order to assemble a complete and working system as described within the contract documents.
4. Submit dimensioned drawings and device wiring layouts for all equipment.
5. Submit equipment rack elevation diagrams (if applicable).
6. Submit network switch port count and power requirements. Port count and POE

switch requirements should be broken out per EF/ER/TR closet.

7. Submit manufacturer certifications for all systems provided. Certifications must be from local office providing the install.
8. Provide battery calculations to verify system standby time are required.
9. Provide a detailed scope of work document for all services provided.

EE. 28 2300 Video Surveillance Systems

1. Provide a detailed scope of work document for all services provided.
2. Submit manufacturer certifications for all systems provided. Certifications must be from local office providing the install.
3. Product Data: Submit manufacturer's data on closed circuit television and recording systems equipment including, but not limited to, cameras, lens selections, recording server, mid-span unit, roughing-in diagrams and instructions for installation, operating and maintenance, suitable for inclusion in maintenance manuals.
4. Shop Drawings: Provide shop drawings showing:
   a. Equipment/device locations and connecting wiring of entire CCTV system. Locations of all cameras with custom painted enclosures due to wood ceilings.
   b. Include wiring diagrams and riser diagrams. Locations of all cameras, power supplies and controllers; point-to-point wiring diagrams for all devices. Include wiring diagrams for: cameras, environmental enclosures, pan-tilt-zoom mounts (if applicable); controllers; auxiliary devices.
   c. Submit equipment rack elevation diagrams (if applicable).
   d. Provide server calculations from Video Management System provider and camera manufacturer to validate proper server configuration and hard drive storage in submittals.
   e. Mid-span power budget calculations showing power requirements for all cameras.
   f. Submit network switch port count and power requirements. Port count and POE switch requirements should be broken out per IDF/MDF closet.
   g. Dimensioned drawings shall show design intent for this specific job. Typical riser diagrams are not acceptable.
5. Provide a complete bill of materials for all components, accessories, and hardware to be provided in order to assemble a complete and working system as described within the contract documents.

FF. 28 3111 Fire Alarm and Detection System

1. Submit manufacturer's data on fire alarm and detection systems including, but not limited to, roughing-in diagrams and instructions for installation, operating and maintenance, suitable for inclusion in maintenance manuals.
2. Provide shop drawings showing equipment/device locations and connecting wiring of entire fire alarm and detection system. Include wiring diagrams and riser diagrams of panel. Provide dimensioned drawing of Fire Alarm Control Panel and Building Graphic. Shop drawings shall be prepared by an individual with a minimum NICET Level IV (Fire Protection Engineering/Fire Alarm Systems) certification. The individuals name and certification number shall be indicated on submittal design drawings.
3. Submit a written statement to the Architect and the state and local Fire Marshal's Office that each device of the fire alarm system will be installed, inspected and

tested in accordance with applicable requirements of NFPA Standard 72.

4. Submit a complete set of documents to the Office of the State Fire Marshal containing the following information:
   a. A complete set of shop drawings indicating:
      i. Location of all alarm-initiating and alarm-signaling devices.
      ii. Point-to-point wiring diagrams for all alarm-initiating and alarm-signaling devices.
   b. Wiring diagrams for:
      i. Alarm control panels.
      ii. Auxiliary function relays and solenoids.
      iii. Remote signaling equipment.
      iv. Standby battery calculations, including voltage drop calculation.
   c. A complete equipment list identifying:
      i. Type
      ii. Model
      iii. Manufacturer
      iv. Manufacturer catalog data sheets
      v. UL Listing and/or FM approval showing compatibility of device with Fire Alarm Control Panel (FACP)
   d. A complete zone list identifying all:
      i. Alarm-initiating and alarm-signaling devices.
      ii. Remote signaling and auxiliary function zones.
      iii. Specific devices associated with each zone.
   e. Sample “System Record Document”.
   f. Fire Alarm Key Plan Drawing showing the location of all device addresses and/or zones.
5. Address all comments from the Fire Marshal and instigate changes to the systems as applicable. Re-submit documents indicating changes instigated for final approval.

1.4 OPERATION & MAINTENANCE MANUALS

A. Provide operating instruction and maintenance data books for all equipment and materials furnished under this Division.

B. Submit four copies of operating and maintenance data books for review at least four weeks before final review of the project. Assemble all data in a completely indexed volume or volumes and identify the size, model, and features indicated for each item. The binder (sized to the material) shall be a 2" slide lock unit (Wilson-Jones WLJ36544B). The cover shall be engraved with the job title in 1/2" high letters and the name and address of the Contractor in 1/4" high letters. Provide the same information in 1/8" letters on the spine.

C. Include complete cleaning and servicing data compiled in clearly and easily understandable form. Show serial numbers of each piece of equipment, complete lists of replacement parts, motor ratings, etc. Each unit shall have its own individual sheet. (Example: If two items of equipment A and D appear on the same sheet, an individual sheet

shall be provided for each unit specified).

D. Include the following information where applicable.

1. Identifying name and mark number.
2. Certified outline Drawings and Shop Drawings.
3. Parts lists.
4. Performance curves and data.
5. Wiring diagrams.
6. Light fixture schedule with the lamps and ballast data used on the project for all fixtures
7. Manufacturer's recommended operating and maintenance instructions.
8. Vendor's name and address for each item.

E. The engineer will review the manuals and when approved, will forward the manuals on to the architect. If the manuals are rejected twice, the contractor shall reimburse the engineer the sum of $1,200.00 for each review afterwards.

F. Provide high quality video and audio recording for all training sessions. All trainings shall be recorded by utilizing a pro-grade digital camera system. Utilize camera tripod and record audio directly at the presenter. Smartphone recordings are not allowed.

G. Provide Operation and Maintenance Manual information for each section listed below in addition to the general requirements listed above.

1. 26 0526 Grounding
   a. Test Results of measured resistance values
2. 26 0548 Electrical Seismic Control
   a. Certificate of Compliance from Final Inspection
3. 26 0923 Occupancy Sensors
   a. Record Drawings
      i. A complete set of ‘as-builts’ drawings showing installed wiring, specific interconnections between all equipment, and internal wiring of this equipment shall be included in the operating and maintenance manuals upon complete of the system.
      ii. Provide a DIGITAL COPY to the owner containing the information specified below. The DIGITAL COPY shall include all information required to allow the Owner to change the schedules themselves. The DIGITAL COPY shall contain a minimum of following:
         1. CAD drawing files of ‘as-built’ lighting control components and point to point connections.
         2. General configuration programming.
         3. Job specific configuration programming to include schedule.
         4. Tutorial file on complete programming of lighting control system.
4. 26 0943 Lighting Control Equipment
   a. Record Drawings
      i. A complete set of ‘as-builts’ drawings showing installed

wiring, specific interconnections between all equipment, and internal wiring of this equipment shall be included in the operating and maintenance manuals upon complete of the system.

ii. Provide a DIGITAL COPY to the owner containing the information specified below. The DIGITAL COPY shall include all information required to allow the Owner to change the schedules themselves. The DIGITAL COPY shall contain a minimum of following:

1. CAD drawing files of 'as-built' lighting control components and point to point connections.
2. General configuration programming.
3. Job specific configuration programming to include schedule.
4. Tutorial file on complete programming of lighting control system.

5. 26 2913 Motor Starters

a. After installation is complete, including water and air balancing, measure voltage (L-L and L-N) and full load current of each phase of each motor. Submit report showing field readings of voltage, amperage, service factor, and thermal heater size installed for each motor.

6. 26 3213 Emergency Electrical System

a. Manual Requirements

i. Submit four complete sets of operating manuals for each item of equipment and/or component outlining the step-by-step procedure required for system start up, operation, and shutdown. Include the manufacturer's name, model number, and a description of all equipment, complete with basic operating features. Describe in detail all maintenance procedures and a troubleshooting guide listing possible breakdowns and repairs for each piece of equipment. Include all factory service manuals, complete parts lists, simplified schematic diagrams of each system as installed, and the original. Include complete rest reports specified in Section 26 3213.

b. Test Results as outlines in Section 26 3213

7. 26 0943 Lighting Control Equipment

a. Record Drawings

i. A complete set of 'as-builts' drawings showing installed wiring, specific interconnections between all equipment, and internal wiring of this equipment shall be included in the operating and maintenance manuals upon complete of the system.

ii. Provide a DIGITAL COPY to the owner containing the information specified below. The DIGITAL COPY shall include all information required to allow the Owner to change the schedules themselves. The DIGITAL COPY shall contain a minimum of following:

1. CAD drawing files of 'as-built' lighting control

components and point to point connections.

2. General configuration programming.
3. Job specific configuration programming to include schedule.
4. Tutorial file on complete programming of lighting control system.

8. 26 5100 Interior and Exterior Building Lighting

   a. The supply two complete manuals consisting of, as a minimum, general system arrangement, lighting cutsheets, schematic of System components and options, factory test reports, trouble-shooting data, parts lists, preventative maintenance information, and warranty contact information.

9. 27 1010 Structured Cabling Systems

   a. Test Results and requirements as outlined in Section 27 1500

   b. Manual shall include all service, installation, programming and warranty, including test results for each cable.

   c. Provide laminated plans (minimum size 11 x 17) of all telecommunications record drawings (including riser diagrams) in each and every EF, ER and TR.

   d. Record Drawings

      i. The Owner shall provide electronic (DWG) format of telephone/data system drawings that as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner.

      ii. Provide a complete set of “as built” drawings in paper and electronic (DWG and PDF) formats showing cabinets, racks, patch panels, wiring, specific interconnections between all equipment and internal wiring of equipment within 30 working days of completion. Drawings are to include all labeling information used in denoting equipment used in the installation. Labeling, icons, and drawing conventions used shall be consistent throughout all documentation provided.

10. 275123 Intercommunications Systems

    a. Manual Requirements

       i. Operating and maintenance manuals shall be submitted prior to testing of system. Manuals shall include all model numbers, service, installation, and programming information.

       ii. Include all the following information:

           1. Warranty
           2. Network settings
           3. Riser diagrams from Shop drawings
           4. Training videos
           5. Flash drive with programing source code and software editing programs

b. Record Drawings

i. The Owner shall provide electronic (DWG) format of intercom System system drawings that as-built construction information can be added to. These documents will be modified by the intercom contractor to denote as-built information as defined above and returned to the Owner.

ii. Provide a complete set of "as built" drawings in paper and electronic (DWG and PDF) formats showing cabinets, racks, patch panels, wiring, specific interconnections between all equipment and internal wiring of equipment. Drawings are to include all labeling information used in denoting equipment used in the installation. Labeling, icons, and drawing conventions used shall be consistent throughout all documentation provided.

11. 27 3244 Two-Way Communication system

a. Record Drawings

i. Provide As-Built drawings that include changes to wiring, wiring designations, junction box labeling, and other pertinent information.

12. 27 4110 Audiovisual Systems

a. Manual Requirements

i. Operating and maintenance manuals shall be submitted prior to testing of system. Total of two (2) manuals, shall be delivered to the Company. Manuals shall include all model numbers, service, installation, and programming information.

ii. Include all the following information:

1. Warranty
2. Network settings
3. Riser diagrams from Shop drawings
4. Training videos
5. USB Flash drive with programing source code and software editing programs

b. Record Drawings

i. The Owner shall provide electronic (DWG) format of AV System system drawings that as-built construction information can be added to. These documents will be modified by the AV contractor to denote as-built information as defined above and returned to the Owner.

ii. Provide a complete set of "as built" drawings in paper and electronic (DWG and PDF) formats showing cabinets, racks, patch panels, wiring, specific interconnections between all equipment and internal wiring of equipment. Drawings are to include all labeling information used in denoting equipment used in the installation. Labeling, icons, and drawing conventions used shall be consistent throughout all documentation provided.

13. 28 1600 Intrusion Detection System

a. Record Drawings

i. A complete set of CAD “AS-BUILT” Drawings showing installed wiring, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of the system.

ii. A building map (2 copies) shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building security map adjacent to the security control panel. Provide high quality plastic sign (map holder) with two layers. The back layer shall be painted black. The front layer shall be a clear center for viewing the CAD security drawing. Edges of the sign shall be colored to match the building interior. The building map shall indicate the various by the use of different colors (minimum of five colors).

iii. The USB flash drive containing the files shall be supplied to the owner. These shall include all information required to allow the district to change the security program themselves. The flash drive shall contain a minimum of the following:

1. CAD drawing files of building security map.
2. CAD drawing files of AS BUILT security components and point to point connections.
3. General configuration programming.
4. Job specific configuration programming.
5. Tutorial file on complete programming of security system.

14. 28 1600 Intrusion Detection Systems

a. Manual Requirements

i. Provide (2) copies and a USB drive with the following:

1. All service, installation and programming information.
2. All model numbers, service, installation, and programming information.
3. Provide usernames and passwords within the O&M manual.
4. Locations of all panels, power supplies and controllers; point-to-point wiring diagrams for all devices.
5. Complete equipment list identifying: Type; model; manufacturer; manufacturer’s data sheets.
6. Network settings, including a list of IP and MAC addresses, username and passwords for network devices coordinated with door name and/or location.
7. Serial and model numbers for all major

components.

8. Installation manuals and user manuals for all systems listed in these specifications.
9. USB drive with any programming source code, drawing DWGs and PDFs, training videos
10. Installers and Manufacturer's Contact Information

b. Record Drawings

i. Locations of all panels, power supplies and controllers; point-to-point wiring diagrams for all devices.

ii. Complete equipment list identifying: Type; model; manufacturer; manufacturer's data sheets.

iii. Provide a complete set of CAD "AS-BUILT" Drawings showing installed wiring, wire paths, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of the system.

iv. A building map (2 copies) shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building security map adjacent to the security control panel. Provide high quality plastic sign (map holder) with two layers. The back layer shall be painted black. The front layer shall be a clear center for viewing the CAD ~~security~~ Intrusion Detection drawing. Edges of the sign shall be colored to match the building interior. The building map shall indicate the various by the use of different colors (minimum of five colors).

15. 28 2205 Access Control Systems

a. Manual Requirements

i. Manuals shall include all service, installation and programming information.

b. Record Drawings

i. A complete set of CAD "AS-BUILT" Drawings showing installed wiring, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of the system.

ii. A building map (2 copies) shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building security map adjacent to the security control panel. Provide high quality plastic sign (map holder) with two layers. The back layer shall be painted black. The front layer shall be a clear center for viewing the CAD security drawing. Edges of the sign shall be colored to match the building interior.

iii. The USB flash drive containing the files shall be supplied to the owner. The flash drive shall include all information required to allow the district to change the security program themselves. The flash drive shall contain a minimum of the following:

1. CAD drawing files of building security map.
2. CAD drawing files of AS BUILT security components and point to point connections.
3. General configuration programming.
4. Job specific configuration programming.
5. Tutorial file on complete programming of security system.

16. 28 2300 Video Surveillance System

a. Manual Requirements

i. Provide (2) copies and a USB drive with the following:

1. All service, installation and programming information.
2. All model numbers, service, installation, and programming information.
3. Provide usernames and passwords within the O&M manual.
4. Locations of all panels, power supplies and controllers; point-to-point wiring diagrams for all devices.
5. Complete equipment list identifying: Type; model; manufacturer; manufacturer's data sheets.
6. Network settings, including a list of IP and MAC addresses, username and passwords for network devices coordinated with door name and/or location.
7. Serial and model numbers for all major components.
8. Installation manuals and user manuals for all systems listed in these specifications.
9. USB drive with any programming source code, drawing DWGs and PDFs, training videos
10. Installers and Manufacturer's Contact Information

b. Record Drawings

i. Locations of all panels, power supplies and controllers; point-to-point wiring diagrams for all devices.

ii. Complete equipment list identifying: Type; model; manufacturer; manufacturer's data sheets.

iii. Provide a complete set of CAD "AS-BUILT" Drawings showing installed wiring, wire paths, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of the system.

c. A building map (2 copies) shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building security map adjacent to the security control panel. Provide high quality plastic sign (map holder) with two layers. The back

layer shall be painted black. The front layer shall be a clear center for viewing the CAD ~~security~~ Video Surveillance drawing. Edges of the sign shall be colored to match the building interior. The building map shall indicate the various by the use of different colors (minimum of five colors).28 3113 Fire Alarm and Detection System

d. Manual Requirements

i. Operating and maintenance manuals shall be submitted prior to testing of the system. Manuals shall include all service, installation, and programming information.

e. Record Drawings

i. A complete set of CAD "as-built" drawings showing installed wiring, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon completion of the system. Vendor shall not request drawings from the Engineer. Vendor shall request current architectural drawings from the Architect and include all cost with bid.

ii. A building map shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building fire alarm map adjacent to the fire alarm panel and all remote operating panels. Provide high quality plastic sign (map holder) with two layers. The back layer shall be painted black. The front layer shall be a clear center for viewing the CAD fire alarm drawing. Edges of the sign shall be colored to match the building interior. The building map shall indicate the various devices and wiring by the use of different colors (minimum of five colors).

iii. Provide a USB Drive to the Owner containing the information specified below. The USB Drive shall include all information required to allow the Owner to change the fire alarm program themselves. The USB Drive shall contain a minimum of the following:

1. CAD drawing files of building fire alarm map.
2. CAD drawing files of as-built fire alarm components and point to point connections.
3. General configuration programming.
4. Job specific configuration programming.
5. Tutorial file on complete programming of fire alarm system

17. 28 3113 Fire Alarm and Detection System

a. Manual Requirements

i. Operating and maintenance manuals shall be submitted prior to testing of the system. Manuals shall include all service, installation, and programming information.

b. Record Drawings

i. A complete set of CAD "as-built" drawings showing installed wiring, color coding, specific interconnections between all equipment, and internal wiring of the equipment shall be delivered to the owner upon

completion of the system. Vendor shall not request drawings from the Engineer. Vendor shall request current architectural drawings from the Architect and include all cost with bid.

ii. A building map shall be supplied to the owner indicating the exact location of all devices along with the addresses of the individual devices. Install building fire alarm map adjacent to the fire alarm panel and all remote operating panels. Provide high quality plastic sign (map holder) with two layers. The back layer shall be painted black. The front layer shall be a clear center for viewing the CAD fire alarm drawing. Edges of the sign shall be colored to match the building interior. The building map shall indicate the various devices and wiring by the use of different colors (minimum of five colors).

iii. Provide a DIGITAL COPY to the Owner containing the information specified below. The DIGITAL COPY shall include all information required to allow the Owner to change the fire alarm program themselves. The DIGITAL COPY shall contain a minimum of the following:

1. CAD drawing files of building fire alarm map.
2. CAD drawing files of as-built fire alarm components and point to point connections.
3. General configuration programming.
4. Job specific configuration programming.

c. Final Submittal to the Office of the Fire Marshal

i. Record of Completion: Provide a completed System Record of Completion (NFPA 72-Figure 4.5.2.1) in accordance with Section 4.5.3.

ii. Operation Instructions and A-Built Drawings: Provide one set of instructions on operation of the Fire Alarm System and one set of As-Built drawings. Demonstrate compliance of installation of the System Record Documents at or near the fire alarm control unit.

iii. Fire Alarm Key Plan Drawing: Demonstrate compliance of installation of the fire alarm key plan drawing at the FACP.

b. TUTORIAL FILE ON COMPLETE PROGRAMMING OF FIRE ALARM SYSTEM

1.5 SPARE PARTS:

A. Provide spare parts (fuses, diffusers, lamps, etc.) as specified. Transmit all spare parts to Owner's Representative prior to substantial completion. Any unused material/labor not utilized during construction shall be a credit back to the owner. Utilize Project Tracking Document to keep record of the following items.

Section	Section Name	Description	Qty. Rqrd.	Qty Rcvd	Fulfilled?
26 0532	Conduit Raceway	Provide 1000 feet of 3/4” conduit with 4 #12 conductors, 1500 feet of 3/4” conduit with 4 #10 conductors, and 1000 feet of 1” conduit with 4 #10 conductor in PVC Provide all supports, fittings,	Per description		

		boxes, terminations, etc. as required for installation. Install only as directed by engineer.			
26 0923/26 0943	Lighting Controls/Occupancy Sensors	Spare sensors for each type used on project.	7		
		Spare wallstations for each type used on project. (RC1, RC2)	7		
26 2200	Transformers	Maintenance Stock Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every five installed units, but not less that three units of each (including ELSP fuses when specified).	Per description		
26 2413	Switchgear and Switchboards	Maintenance Stock Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every 5 installed units, but not less than 3 units of each. (Attic Stock)	Per description		
26 2713	Service Entrance	Maintenance Stock Fuses: for types and ratings required, furnish additional fuses, amounting to one for every 2 installed units, but not less than one unit of each. (Attic Stock)	Per description		
26 2726	Wiring Devices	Provide (2) switches, and (10) duplex receptacles as directed by the Engineer. Include 25' of 3/4" EMT conduit with 4 #12 THHN for each device. Provide a total of (5) spare floor boxes covers for each box type used (Attic Stock).			
26 2816	Motor and Circuit Disconnects	Spare fuses amounting to one spare fuse for each 10 installed but not less than three of any one type and size. (Attic Stock)	Per description		
26 2913	Motor Starters	Maintenance Stock Fuses: For types and ratings required, furnish additional fuses, amounting to one unit for every 10 installed, but not less than 5 units of each, for both power and control circuit fuses. (Attic Stock)	Per description		
26 5100	Interior and Exterior Building Lighting	Provide the following attic Stock Fixtures: A4H: 10 A4M: 10 L4HD: 4 L8HD: 4 SL4C: 4			
		Provide (10) extra type X1 and (5) X2 exit signs for discretionary placement by fire marshal or code official. Include 150' of 3/4" EMT conduit with 3 #12 THHN for each exit sign. Provide all supports, fittings, boxes, terminations, etc. as required for installation. Install only as directed by engineer.	Per description		
27 1010	Structured Cabling System	Provide (10) type 2 drop data outlets, (2) WAPs. Include 30 meters of 1" EMT. Provide all supports, fittings, boxes, terminations, etc. as required for installation. Install only as directed by engineer. Credit back all unused material and labor to the Owner.	Per description		
27 5123	Intercommunication System	Type Speaker	5		
		Type IW1 speakers (Exterior Type)	5		
		Back boxes	5		
		Call switches	5		
		150 feet of conduit and cable per each spare device	Per description		
28 2205	Access Control System & Burlgar Alarm	Card Readers (Standard)	4		
		Card Readers (Mullion)	2		

		150 feet of conduit with wiring (completely installed and wired) for each spare device	Per description		
28 3111	Fire Alarm and Detection	Thermal detectors with base	10		
		Smoke detectors with base	10		
		Strobe/horns	10		
		Manual pull stations with addressable modules	2		
		Duct smoke detectors	4		
		Carbon Monoxide Detector and Monitor Module	6		
		150 feet of conduit with wiring (completely installed and wired) for each spare device	Per description		

END OF SECTION 26 0502

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MURRAY CITY POWER

MURRAY CITY
GENERAL REQUIREMENTS
AND
SPECIFICATIONS
FOR
ELECTRICAL INSTALLATIONS

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MURRAY CITY POWER
RESIDENTIAL ELECTRIC POWER SERVICE REQUEST

STEPS FOR UNDERGROUND/OVERHEAD SERVICE INSTALLATION AND HOOK-UP

Complete the following steps in the order listed below:

1. Builder must fill out the Load Data Sheet, page 2 below, and return it to Murray City Power. We use the sheet to document inspections and size the service wire/conduit. We will not perform the required trench inspections without a Load Data Sheet. The builder and Murray City Power will meet to determine if the service will be underground or overhead.

2. Do not begin work on the service installation before receiving the service design from Murray City Power. Any work done that does not meet the Murray City Power design is at risk of having to be re-done at the cost of the builder/customer.

3. The building site requiring service must have its address marked and clearly visible from the street.

4. The meter riser must be rigid conduit (RMC) and strapped to the foundation. The customer installs the meter base and meter riser, including the elbow/sweep for underground service.

5. Contact Murray City Building Inspection Division to schedule an inspection: (801) 270-2431 for a power to panel inspection. When you pass the power to panel inspection . . ..

6. At this point, you MUST have passed the Building Dept. power to panel inspection.
   For underground service--Murray City will dig the trench, install the conduit, and provide the wire for underground service. A Murray City crew will come to the building site and install the wire in the conduit, make the connections and set the meter.
   For overhead service--The customer will provide the wire from the weatherhead to the meter. Murray City will provide the wire for the overhead service from the source up to the weatherhead, make connections and set the meter.
   For service changes--The customer is responsible to pay for the wire and installation, and if the customer is converting from overhead service to underground service the customer is also responsible to pay for trenching and conduit. Murray City will inspect before the customer backfills the trench. Murray City will install the wire in the conduit, make the connections and set the meter, at the customer's expense.

LOAD DATA SHEET
SINGLE FAMILY RESIDENTIAL STRUCTURE
Underground/Overhead Electric Service Feed

Architect/Engineer/Builder/Contractor:
Please submit this form for each single-family residential structure to be served by Murray City Power by means of an underground or overhead service wire. Using the NEC code to size the service wire is acceptable. Submit the form by email: murraycitypower@murray.utah.gov , or by delivery to the address 153 West 4800 South, Murray, UT 84107. By signing this document, you are hereby acknowledging that the information provided is accurate and that you take responsibility for this information up to and including financial cost for the replacement of Murray City equipment due to any inaccuracies contained herein.

Contractor Contact Information:
Contractor/consultant name _____
Contact person _____Day phone # _____
Cell phone # _____ Fax # _____ Best contact time ☐ a.m. ☐ p.m.
E-mail address:_____
Customer (Owner) Contact Information *Complete this section if owner and contractor are separate individuals*
Name_____
Mailing address _____City, State Zip _____
Day phone # _____ Cell phone # _____ Best contact time ☐ a.m. ☐ p.m.
E-mail address:_____
Service Information *This section is required*
New service address _____ City, State Zip _____
New service address coordinates *(if applicable)*
_____
Subdivision name _____ Phase _____ Lot # _____ Block #_____
If known, nearest pole or padmount # *(pole/equipment tag, 10 or 12 digits)* _____

Service panel size: ☐ *150 Amp* ☐ *200 Amp* Size of building:_____ total sq. ft.

Distance between service hookup (power source) and meter equipment:_____ ft.

Special conditions and/or requests _____

Main source of heat: ☐ *gas* ☐ *propane* ☐ *electric* If electric: ☐ *heat pump (___ tons)* ☐ *furnace*
If air conditioning: ☐ *evaporative cooler* ☐ *central air (___ tons)* ☐ *heat pump (___tons)* ☐ *other*

Expected building completion date *(mm/dd/yyyy)* _____

MURRAY CITY POWER
RESIDENTIAL ELECTRIC POWER SERVICE REQUEST

It is important to provide the most accurate information available as it is used to design the facilities to serve your requested load. You may want to consult a licensed electrician or engineer prior to providing the information. Changes to load after submitting this information may delay design and potentially impact cost.

Please sign and date this form

_____

Applicant or representative signature Date

Please completed form to: murraycitypower@murray.utah.gov ,

or delivery to 153 West 4800 South, Murray, UT 84107.

MURRAY CITY POWER
COMMERCIAL ELECTRIC POWER SERVICE REQUEST

STEPS FOR UNDERGROUND/OVERHEAD SERVICE INSTALLATION AND HOOK-UP

Complete the following steps in the order listed below:

1. Builder must fill out the Load Data Sheet, page 2 below, and return it to Murray City Power. We use the sheet to document inspections and size the transformer. We will not perform the required trench inspections without a Load Data Sheet. The builder and Murray City Power will meet to determine if the service will be underground or overhead.

2. Do not begin work on the service installation before receiving the service design from Murray City Power. Any work done that does not meet the Murray City Power design is at risk of having to be re-done at the cost of the builder/customer.

3. The building site requiring service must have its address marked and visible from the street.

4. For underground service--Dig a trench (30" minimum depth) between the power source and meter equipment.
   For overhead service—Skip to step 8.

5. Install the conduit specified by Murray City Power (4" minimum for 3 phase service) to the power source, connect to existing conduit. The meter riser must be rigid (RMC) and strapped to the foundation. Call Murray City (24 hours in advance) at 801-264-2730 to schedule a required inspection of the trench and conduit prior to backfilling.

6. Murray City will meet contractor/customer to inspect and GPS the trench and conduit.

7. After you have passed the conduit and trench inspection, cover the conduit with approved backfill. Approximately 1 foot directly above conduit, tamp soil and place red plastic electrical warning tape--3" to 6" wide that reads, "Caution—Buried Electric Cable Below". Leave a tail of warning tape sticking out of the ground at the meter riser and power source. Backfill the trench to final grade, compact, and fill as necessary.

8. Contact Murray City Building Inspection Division to schedule an inspection: (801) 270-2431 for a power to panel inspection. When you pass the power to panel inspection . . ..

9. At this point, you MUST have passed the Murray City Building Inspection Division power to panel inspection.
   For underground service—The customer shall provide and pull the secondary service wire. Murray City Power will make the connections in the transformer and Customer will make connections in the meter/CT cabinet. Murray City will set the meter.

For overhead service--The builder/customer will provide the wire from the weatherhead to the meter. Murray City will provide the wire for the overhead service from the source up to the weatherhead, make connections and set the meter.

For service changes--The customer is responsible to provide the wire and installation, and if the customer is converting from overhead service to underground service the customer is also responsible to pay for trenching and conduit. Murray City will inspect before the customer backfills the trench. The customer will install the wire in the conduit. Murray City Power will make the connections in the transformer and Customer will make connections in the meter/CT cabinet. Murray City will set the meter.

LOAD DATA SHEET
COMMERCIAL STRUCTURE
Underground/Overhead Electric Service Feed

Architect/Engineer/Builder/Contractor:
Please submit this form for each commercial structure to be served by Murray City Power by means of an underground or overhead service wire. Using the NEC code to size the service wire is acceptable. Submit the form by email: murraycitypower@murray.utah.gov , or by delivery to the address 153 West 4800 South, Murray, UT 84107. By signing this document, you are hereby acknowledging that the information provided is accurate and that you take responsibility for this information up to and including financial cost for the replacement of Murray City equipment due to any inaccuracies contained herein.

Contractor Contact Information:
Contractor/consultant name _____
Contact person _____Day phone # _____
Cell phone # _____ Fax # _____ Best contact time ☐ a.m. ☐ p.m.
E-mail address:_____
Customer (Owner) Contact Information *Complete this section if owner and contractor are separate individuals*
Name_____
Mailing address _____City, State Zip _____
Day phone # _____ Cell phone # _____ Best contact time ☐ a.m. ☐ p.m.
E-mail address:_____
Service Information *This section is required*
New service address _____ City, State Zip _____
New service address coordinates *(if applicable)*
_____
Subdivision name _____ Phase _____ Lot # _____ Block #_____
If known, nearest pole or padmount # *(pole/equipment tag, 10 or 12 digits)* _____

☐ Submit electrical system one-line diagram showing main disconnect size and service panel size.
Service panel size: _____ amps Size of building:_____ total sq. ft.
Main disconnect size: _____ amps

Load List			
Type	Description	Added Load	Units
HVAC/Refrigeration Equip.			Tons
Largest Motor (code:_____)			HP
Fans/small motors/pumps/compressors			HP
Electric Heating (space/water)			kW
Equipment with large power requirement			kW

MURRAY CITY POWER
COMMERCIAL ELECTRIC POWER SERVICE REQUEST

Distance between service hookup (power source) and meter equipment:_____ ft.

Special conditions and/or requests _____

Main source of heat: ☐ *gas* ☐ *propane* ☐ *electric* If electric: ☐ *heat pump (___ tons)* ☐ *furnace*
If air conditioning: ☐ *evaporative cooler* ☐ *central air (___ tons)* ☐ *heat pump (___tons)* ☐ *other*

Expected building completion date *(mm/dd/yyyy)* _____

It is important to provide the most accurate information available as it is used to design the facilities to serve your requested load. You may want to consult a licensed electrician or engineer prior to providing the information. Changes to load after submitting this information may delay design and potentially impact cost.

Please sign and date this form

_____
Applicant or representative signature Date

Please email completed form to: murraycitypower@murray.utah.gov ,

or delivery to 153 West 4800 South, Murray, UT 84107.

MURRAY CITY POWER
NET METERING CHECKLIST

□ **Interconnection Agreement**

Complete the Murray City Power Interconnection Agreement and email to:
murraycitypower@murray.utah.gov

Once the Interconnection Agreement has been reviewed and approved by Murray City Power, a signed copy will be sent back to the customer/contractor via email.

□ **Building Permit**

Obtain building permit and complete plan submittal checklist with Murray City Building Inspection Division, 4646 S. 500 W. Murray, UT 84123, (801) 270-2431

□ **Purchase Net Meter**

Please make checks payable to Murray City Power. Payment may be mailed or hand-delivered to the Murray City Power office building: 153 West 4800 South, Murray, UT 84107.

- Residential Customer Net Meter - $250
- Commercial Customer Net Meter - $350

□ **Installation of Solar System**

Please note the following Murray City requirements:

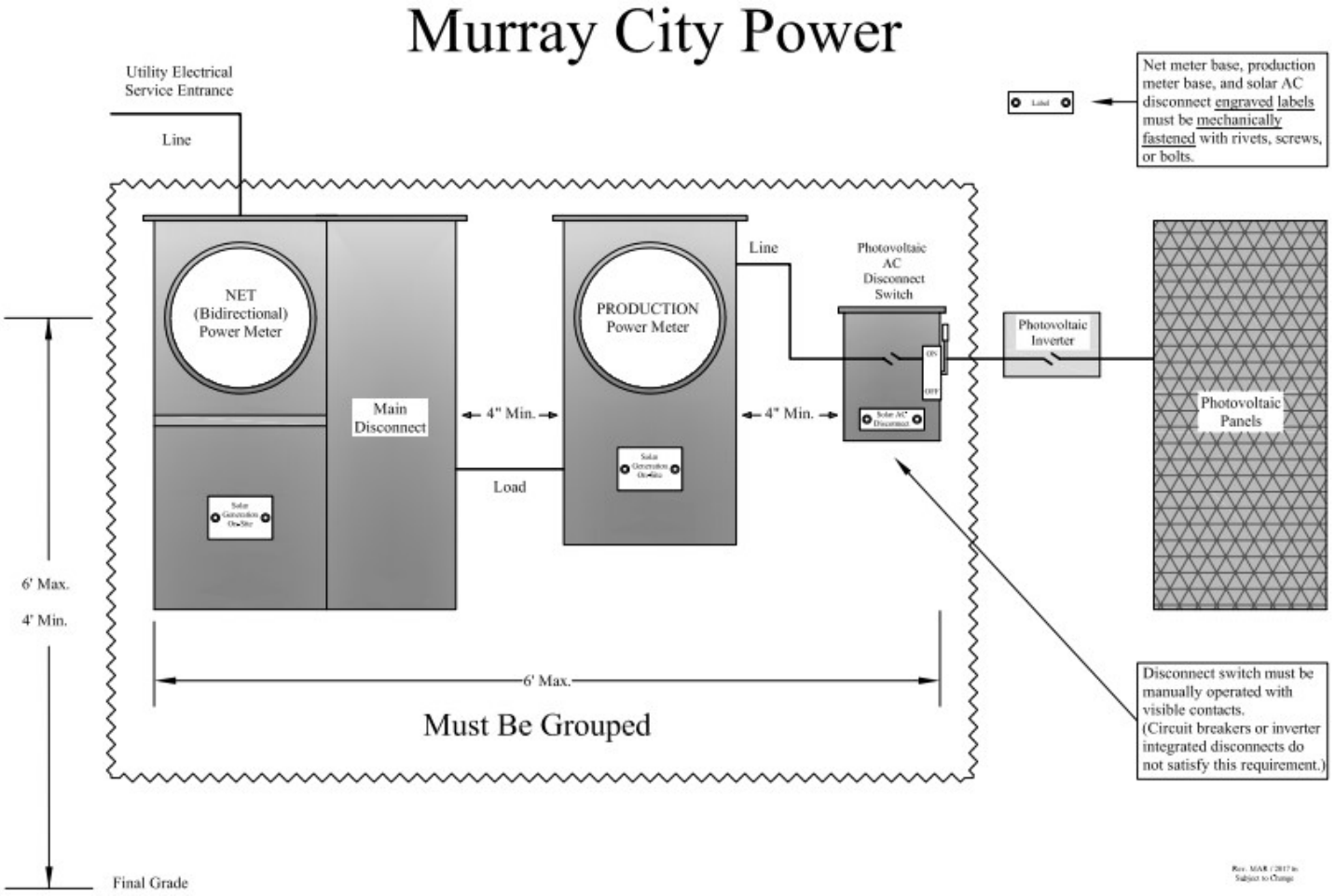
- Solar system must include a production/generation meter, in addition to the net meter; Murray City Power covers the cost of this meter
- Meter-base must be labeled with a permanent, engraved label; mechanically fastened with rivets, screws, or bolts (no double-sided tape) which states "Solar Generation On Site" or equivalent.
- A separate safety disconnect must be installed between the solar system inverter and the production meter base, and located within several feet of the net meter base. This switch must be manually operated and designed such that the actual contacts of the switch are visible to determine whether they are open or closed. Meter base circuit breakers do not satisfy this requirement, nor does a solar system's integrated inverter disconnect. The safety disconnect must be labeled as per requirements above, stating "Solar Power Disconnect" or equivalent.
- Customer/Contractor is not permitted to connect panels to Murray's system until the new net meter is installed. If the system is connected before the new meter is installed, all excess kWh produced by the system will be seen by the existing meter as kWh consumed, not generated, resulting in an extra cost to the customer instead of a credit.

□ **Final Inspection**

Once installation of the solar system is complete, please contact the Murray City Building Inspection Division to schedule an inspection: (801) 270-2431

□ **Net Meter Installation**

Once the final inspection is complete, please contact the Metering Supervisor at 801-264- 2730 to schedule a time to meet with customer/contractor to test the new system and install the net and production meters. Murray City Power will notify the Murray Utility Billing Division to activate customer's net meter account.



GENERAL REQUIREMENTS AND SPECIFICATIONS FOR ELECTRICAL INSTALLATIONS

1 GENERAL REQUIREMENTS

1.1 GENERAL

The purpose of this document is to assist Murray City Power customers in obtaining electric service. This document provides the requirements and shows the specifications for customer installations that must be met for electric service to be connected.

It is the customer's responsibility to ensure compliance with these requirements and specifications. These requirements and specifications apply to new services, relocated services, house relocations, rewired services, and upgraded services.

Any work done before receiving the electric service design and signed contract from Murray City Power that does not meet the Murray City Power design is at risk of having to be removed and re-installed at the cost of the builder/customer.

1.2 COMPLIANCE AND CONFLICT WITH REQUIREMENTS

All electrical work shall be in compliance with the latest edition of the National Electric Code (NEC), International Building Code, ICC Electrical Code, and the National Electrical Safety Code (NESC) except where these specifications are more stringent. If there is a conflict between standards, the most stringent shall rule.

1.3 SERVICE DENIAL FOR UNSAFE CONDITIONS OR TAMPERING

A service may be denied when unsafe conditions exist, or when the customer has tampered with utility-owned equipment, such as meters and lines. (Utah Administrative Code, Rule746-200.) Tampering with a service meter or meter seal will result in fines, penalties, and extra fees for the customer.

A residential service can be disconnected without notice when a clear emergency or serious safety hazard exists for so long as the conditions exist. The Murray City Power will immediately try to notify the customer of the disconnection and the reasons for it.

1.4 UNDERGROUND UTILITY LOCATION -- CALL BEFORE YOU DIG

State law requires the customer/excavator to call 8-1-1 to mark underground utility locations at least 48 hours prior to any excavation. Do not start excavation until utilities have been marked

by an underground locator service, or until the service confirms that no utilities exist in the area.

NOTE: Murray City does not locate/mark commercial services from the transformer to the customer's building. These are the responsibility of the commercial customer.

1.5 CUSTOMER GENERATION

Interconnection of customer distributed generation will be evaluated on a case-by-case basis. Contact Murray City Power before acquiring generation equipment or making any type of interconnection with any type of generating device to determine the requirements that must be met.

1.6 GROUNDING AND BONDING

The customer is responsible for ensuring that electrical wiring and service equipment are grounded and bonded in accordance with applicable NEC requirements. The grounding system shall have sufficient grounding electrodes, effectively bonded together, to prevent maximum resistance to ground exceeding 25 ohms. All grounding is to be in accordance with NEC Article 250.

Two ground rods 5/8" diameter x 8' long shall be driven at each three-phase transformer and three phase junction point, at 5' center to center (spacing). One ground rod shall be driven at each single-phase transformer and single-phase primary junction point. All concentric neutrals shall be connected and commonly grounded to the driven ground rod.

Metallic equipment less than 6 feet from Murray City Power equipment requires bonding to the Murray City Power equipment.

1.7 INSPECTION

All work shall be inspected, location recorded with GPS, and approved by Murray City Power personnel before underground systems are backfilled. Murray City Building Inspection Division will perform "power to the panel" inspections. Final inspection and energizing the system will be performed by Murray City Power personnel.

1.8 POWER FACTOR

The customer is responsible for maintaining power factor between 90% lagging and 90% leading, or higher. Murray City Power recommends that customers provide and maintain code-approved power factor correction devices to maintain power factor between 90% lagging and 90% leading.

A power factor rate adjustment applies to commercial customers. This rate adjustment has the effect of increasing the power demand charges to customers who do not maintain a power factor of 90% or higher.

1.9 EQUIPMENT PERFORMANCE, PROTECTION, AND HARMONICS

The customer shall provide any power-conditioning devices necessary for the proper performance and protection of voltage-sensitive equipment. The customer is responsible for providing and maintaining code-approved protective devices to protect equipment against overloading, short circuits, ground faults, high or low voltage, and single-phasing of three-phase motors.

Customers shall not generate harmonic distortion that create disturbances on the electrical system that interfere with any other customer's equipment. Customers shall provide harmonic filtering on equipment that can produce harmonic distortion (such as adjustable speed drives, power supplies, and electronic ballasts for lighting) such that harmonic distortion is kept within the limits specified in IEEE Standard 519, Section 10.

2 PERMITS AND APPLICATIONS

2.1 SERVICE APPLICATION

The customer shall complete an Electric Power Service Request Load Data Sheet to apply for electric service. The customer shall provide accurate load information on the request. The steps for service installation and hook-up are detailed on this request form. Refer to the request forms "Residential Electric Power Service Request" or "Commercial Electric Power Service Request" at the front of this standard.

2.2 PERMIT

City ordinances require applicants to obtain appropriate permits as per Murray City code before electric service is provided.

2.3 EASEMENTS

The customer (developer) shall provide, without cost to Murray City, all permits, rights-of-way, and easements required for the installation and maintenance of the public facilities that serve the customer (development). A Public Utility Easement (PUE) will be required in all subdivisions adjacent to the road right-of-way. A ten (10) foot easement is required along all frontages. Ten (10) foot easement is required at rear of lot. Five (5) foot easement is required on each side of side lot lines. No permanent structure or obstruction can be placed within the PUE without prior written approval of all Murray City owned utilities.

3 SERVICES

3.1 TYPES OF SERVICE

Electric service is provided as 60-hertz, alternating current, single-phase or three-phase. Nominal provided secondary voltages and types of service are shown in Table 1.

Table 1-Type and Voltage of Secondary Service

Phases	Voltage	Wiring	Limits
Single-phase	120 volts	Two-wire, grounded	200 amps or less
Single-phase	120/240 volts	Three-wire, grounded	400 amps or less
Three-phase	120/208 volts	Four-wire, grounded wye	750 kVA or less
Three-phase	277/480 volts	Four-wire, grounded wye	n/a

Contact Murray City Power to determine the requirements that must be met for primary voltage service at 7,200/12,470 volts.

3.2 STANDARD TRANSFORMER SIZES

Standard transformer sizes that are allowed are given in Table 2.

Table 2-Standard Transformer Sizes

Overhead Transformers	Secondary Voltage	Sizes in kVA
Single-phase	120/240 volts	10, 15, 25, 37.5, 50, 75, 100, 112.5, 167
Three-phase (bank of 3 single-phase transformers)	120/208 volts	75, 150, 225, 300
	277/480 volts	75, 150, 225, 300
Pad-mounted Transformers		
Single-phase	120/240 volts	25, 50, 75, 100, 167
Three-phase	120/208 volts	75, 112.5, 150, 225, 300, 500, 750
	277/480 volts	75, 112.5, 150, 225, 300, 500, 750, 1000, 1500, 2000, 2500

4 METER REQUIREMENTS

4.1 GENERAL

1. The customer is responsible for providing, installing, and maintaining all service equipment.
2. Meters shall be located where approved by Murray City Power.
3. Meters shall be accessible at all times for reading, maintenance, and emergencies.
4. Meters located within a gated area or enclosed space shall be approved prior to installation on a case-by-case basis.
5. Customers must contact Murray City Power before doing any work that involves the meter.
6. The minimum size meter base is 150 amps.
7. Three-phase 200 amp meter bases shall have a link by-pass.

4.2 METER BASE MOUNTING

1. Meter bases must be mounted to be plumb in all directions and securely mounted to a rigid surface.
2. Prior approval is required for installing meters in any type of enclosure.
3. Adequate protection for meters subject to physical damage must be provided.

4.3 METER LOCATION

The customer must provide a suitable meter location, with adequate clear working space. Metering equipment **shall not be installed** in the following locations unless prior approval is obtained from Murray City Power:

1. Any unsafe location, as determined by Murray City Power
2. Any hazardous location for electrical equipment as defined by the NEC
3. Within a 36 inches radius of the gas meter, gas valves, regulators, fittings, unions, or the gas line entrance into a building.
4. Directly over any window well, stairway, ramp or steps
5. In any entryway
6. Within 36 inches horizontally of a window that has a view of a living space or restrooms, or within 36 inches horizontally of a door.
7. In any place where moisture, fumes, or dust may interfere with the meter's operation or may damage the meter, as determined by Murray City Power
8. On any surface subject to excessive vibration, as determined by Murray City Power
9. In an area where metering is likely to be fenced in
10. Where the metering equipment is obstructed by anything including landscaping or other vegetation
11. Areas adjacent to fuel storage units

12. Any location where a vehicle could strike the meter, such as a driveway, unless bollards are installed.

Residential meters shall be installed:

1. Outdoors within 10 feet* of the front (street side) corner of the dwelling. (*This distance is for new construction.)
2. On the side of the dwelling closest to the power source
3. At a location acceptable to Murray City Power, and in accordance with the standards drawings in this document.

Where there is no suitable location on the structure, a free-standing metering installation may be used, at a location approved in advance by Murray City Power.

NOTE: For remodel of existing services the meter location must be permitted by the inspector and approved before installation by Murray City Power.

4.4 DIRECT METERING

Direct-connect metering is required for residential services, and for single-phase services 400 amps or less, or three-phase services 200 amps or less. There are additional requirements for direct-connect metering installations with more than one meter.

See sections 9.2 and 9.3 for requirements for non-residential direct metering installations.

4.5 CURRENT TRANSFORMER METERING

Current transformer (CT) metering is required for single-phase services greater than 400 amps and three-phase services greater than 200 amps. Murray City Power will provide and install, at customer's expense: the meter, a meter test switch, and secondary metering wiring. Murray City will provide the CTs, at the customer's expense, and the customer shall install CTs and torque to specifications. The customer will provide the CT cabinet and CT mounting base. The customer shall provide conduit, connectors/terminations, a disconnect after the CT cabinet rated for the load, and bonding for meter and CT enclosures. The customer shall make connections of service wire in the CT cabinet.

Meters shall not be installed on CT cabinets. CT cabinet doors shall open away from the meter.

A CT meter cabinet for 800 amp service shall be the 48" x 48" size.

See section 9.4 for detailed CT metering installation requirements.

4.6 SWITCHBOARD METERING (ABOVE 800 AMPS)

Switchboard metering is required for services greater than 800 amps. The customer shall provide a drawing of the proposed switchboard metering equipment and a mounting pad with

dimensions, to Murray City Power for review and approval. Approval must be obtained prior to fabrication.

The customer shall provide and install:

a. Switchboard enclosure with CT compartment, and CT mounting bases

b. Meter base

c. Locking equipment for the meter enclosure

d. Concrete mounting pad for the switchboard enclosure

e. A flat permanent surface (such as a concrete pad) extending a minimum of 36 inches (36") out from the switchboard in front of the CT compartment

Metering shall be installed inside switchboard in the meter compartment(s).

See section 9.5 for the requirements for switchboard metered installations.

5 CLEARANCES

5.1 OVERHEAD SERVICES

The customer shall provide a point of attachment for overhead service that allows minimum clearances listed in the NESC for service drops and drip loops to be met in all conditions. Contact Murray City Power if the service length may be greater than 45', or the service will cross over uneven or sloped ground that may impact clearance height.

The lowest point of the overhead service cable and drip loop shall be at least 18" above the roof. No more than 72" of the service cable can run across the roof of the structure being served. Refer to the overhead service standard drawings in this document.

If the point of attachment of the service cable is more than 36" above a point of support of the mast, two independent guys are required.

5.2 UNDERGROUND SERVICES

Clear workspace and fire code clearances must be maintained around pad-mounted equipment for underground services. Refer to the underground service standard drawings in this document.

At least 3 feet clear workspace measured from the edge of the equipment pad shall be available on the non-access side of pad mounted equipment.

At least 10' clear workspace measured from the edge of the equipment pad shall be available on the access (working) side of pad mounted equipment.

5.3 BETWEEN EQUIPMENT PADS AND BUILDINGS

The front of the equipment pad should always face away from adjacent structures and be free of obstructions. At least 8 feet, must separate the edges of the pad from any adjacent structure. The edges of the pad must be at least 10 feet from any combustible structures. See drawing A.4.

5.4 CLEARANCE FOR CONDUCTORS NEAR POOLS, SPAS, OR HOT TUBS

5.4.1 Overhead

Murray City Power recommends that pools, spas, or hot tubs not be placed below or near overhead conductors. Consult with Murray City Power before placing pools, spas, or hot tubs below or near overhead conductors.

5.4.2 Underground

Never locate underground conductors under or within 60” horizontally from the inside wall of a pool or spa. Likewise, pools or spas shall not be installed over or within 60” horizontally from an existing underground conductor.

6 UNDERGROUND SERVICE REQUIREMENTS

All underground service shall be installed in conduit. The customer shall provide conduit in place from the point of connection to the meter base with pulling tape provided in the conduit. For residential service Murray City Power will dig the trench, install the conduit, provide and pull the secondary service wire, make the connections and set the meter. In the case of a service change the customer is responsible to pay for trenching, conduit, wire and installation. For commercial service the customer shall provide conduit and provide and pull the secondary service wire. Murray City Power will make the connections in the transformer and the customer will make connections in the meter/CT cabinet. Murry City will set the meter.

The customer shall be sure that conduit is located where it will not be next to (or underneath) buildings, building foundations, or other structures (including retaining walls.)

Murray City Power will allow only one overhead-to-underground conduit (or underground-to-overhead conduit—a “riser” or “dip”) on an overhead power distribution pole, whether it is primary voltage or secondary.

6.1 SERVICE CONDUCTOR

For residential service Murray City will provide the wire for underground service.

For commercial service the builder/customer must provide the wire for underground service. Cable shall be tri-plexed aluminum “EC”. Individual conductors shall be covered with XLP insulation rated to 600 volts and shall have color coded jacket.

6.2 SERVICE CONDUIT

All conduit in the ground shall be not less than Schedule 40 PVC electrical grade gray conduit, 3" in diameter—for residential and single-phase commercial—or larger, depending on the cable size and distance. For commercial three-phase service the minimum conduit size is 4" in diameter, or greater according to the wire and secondary service size. The customer shall provide and install the conduit. The first ten (10) feet of any conduit above ground shall be rigid (RMC).

6.3 BACKFILL

Trench and conduit shall be inspected by Murray City Power prior to backfilling. The contractor is responsible to prevent the possibility of the conduit being damaged by backfilling with local soil. Backfill material shall be compacted. Install marking tape as required in section 6.4.

In areas of the trench where there is no equipment, no paving, or other structural requirement, the local soil may be used as backfill as long as it has no cobbles, construction waste or other refuse or deleterious materials.

A minimum of 30" of backfill above underground secondary/service conduit is required. Contractor is responsible for backfill and compaction for commercial services.

Excavated areas that support electrical equipment (transformers, junction boxes, switchgear, etc.), pavement, walks, etc., shall be backfilled with compacted like-kind structural backfill. Backfill shall be compacted in lifts no more than 2 feet. The final compaction beneath areas supporting electrical equipment shall be 95% of the maximum dry density as determined by ASHTO T-99.

6.4 MARKING TAPE

Marking tape shall be installed 12" above all buried conduits. It shall be red in color, 3" to 6" wide and state, "Caution—Buried Electric Cable Below"

6.5 JUNCTION BOXES

Primary and secondary junction boxes shall be placed on well compacted and level ground, meeting the backfill requirements in Section 6.3 and also placed so as to avoid being filled with drainage water. The secondary junction box shall be the type approved by Murray City Power.

6.6 BOXPADS

Box pads shall be placed on compacted and level ground meeting the backfill requirements in Section 6.3.

6.7 TRANSFORMER PADS

The transformer pads for transformers less than 100 kVA single phase will be provided by Murray City Power. Murray City Power will install all transformer pads for residential services. The top of the transformer pad shall be at least 2 inches above the sidewalk. Concrete pads must meet the following requirements and shall be approved by Murray City Power:

6.7.1 Site Preparation

All dirt beneath the pad site must be compacted meeting the backfill requirements in Section 6.3, and level prior to setting or pouring the pad to prevent settling.

6.7.2 Concrete

Concrete shall be made using 6 bags of standard brand of Portland cement per cubic yard. Steel reinforcement shall be No. 4 bars placed on 12” centers and in accordance with the concrete transformer pad drawing. The pad must be poured at least three full days prior to setting the transformer. Concrete shall be kept above freezing at least 72 hours after pouring. The finished surface must be completely flat and level.

Precast transformer pads may be used for transformers up to 500 kVA.

6.7.3 Conduit Window Layout

Low voltage conduits shall be formed as tightly as possible against the right side of the opening and shall in no case extend further than 20” from the right side of the conduit window on a small pad (96” x 78”) or 30” on a large pad (100” x 103”). Do not put any concrete in or under the conduit window. Use dirt to separate conduits. All construction shall be in accordance with the latest International Electric Code and approved by Murray City Power.

6.8 CLEARANCES

The front of the pad should always face away from adjacent structures and be free of obstructions. At least 8 feet must separate the edges of the pad from any adjacent structure. The edges of the pad must be at least 10 feet from any combustible structures.

6.9 GROUNDING METHODS

Driven ground rods are required at services, transformers, primary junction boxes and switches.

7 OVERHEAD SERVICE REQUIREMENTS

Murray City Power provides (at customer's expense) service wire to the meter mast (weatherhead) on overhead connections.

All residential overhead services will be sized on a case-by-case basis. Customers shall provide all service secondary conductor from the point of connection (weatherhead) to the meter base on overhead services.

The customer shall provide a point of attachment for overhead service that allows minimum clearances to be met in all conditions. Contact Murray City Power if the service length may be greater than 45', or the service will cross over uneven or sloped ground that may impact clearance height.

Mast shall be 2" or 3" rigid conduit, depending on the size of the service (see Table 3). The meter mast shall be securely connected to the structure with at least 2 points of attachment using Unistrut and 3/8" minimum lags.

Table 3-Meter Mast Conduit Size

Service Size	**Conduit Size for Meter Mast**
200 amp or less	2" min.
201 – 400 amp	3" min.
Above 400 amp	Contact Murray City Power

Mast weatherhead shall pass through the building eve and extend at least 24" above the roof, unless the weatherhead is mounted on the gable end of the building. The lowest point of the overhead service cable and drip loop shall be at least 18" above the roof. No more than 72" of the service cable can run across the roof of the structure being served.

If the point of attachment is more than 36" above a point of support on the mast, two independent guys are required. Guy wires shall be ¼" galvanized stranded steel, attached 16" or 24" apart with ¼" lag bolts to rafters plate between shingles. See drawing A.9.

8 MULTI-FAMILY RESIDENTIAL BUILDINGS

8.1 GENERAL

This section describes services with separate meters for multi-family residential buildings with three or more units. Murray City Power requires grouping of service entrance conductors at a common location.

Requirements:

1. All meters shall be in a common location.
2. Meter banks shall be installed on the side of the building closest to the power source.
3. The service entrance and meter shall be installed in locations meeting the requirements of Section 4.
4. The service entrance shall be sealed.

8.2 MULTIPLE-METERS

All multiple meter installations shall meet the following requirements.

Requirements:

1. Meter bases shall not be used as junction boxes.
2. A main disconnect is required when more than six services are connected. If an existing installation expands beyond six services, a main disconnect shall be installed.
3. NEC-approved load calculations are required when the sum of distribution section ampacities exceeds the pulling section ampacities. (See NEC Article 220, Branch-Circuit, Feeder, and Service Calculations.)
4. The cable pulling section must be appropriately sized for service termination.
5. Each service shall have a lockable and easily accessible disconnect in sight of the meter base location.
6. All required labels shall be correctly installed before the service is energized. Labels shall:
    a. be permanently affixed to the equipment by rivets or screws
    b. be of sufficient durability to withstand the local environment. Engraved metal or hard plastic labels are required.
    c. not be attached to removeable covers
7. Each metered service and associated breaker shall be labeled to identify the dwelling unit address. **Service will not be connected until permanent labels are attached.**
8. It is the responsibility of the customer to ensure the meter bases are correctly labeled. These labels shall be kept current for the life of the facility.
9. A minimum vertical clearance of at least 48” from the center of the lowest meter to the final grade is required. However, a minimum vertical clearance of 36” to the center of

the lowest meter is acceptable if a minimum 36" wide, flat, permanent surface (such as a concrete pad or walkway) below the meter is provided at the final grade and extends at least 18" on either side of the meter cabinet.

10. All unused openings shall be covered and secured by the customer.
11. Meters and metering equipment shall be located outdoors.
12. Panel covers must be secured in place prior to service equipment being energized.

9 COMMERCIAL, INDUSTRIAL, AGRICULTURAL SERVICES (ALL NON-RESIDENTIAL SERVICES)

This section provides the Murray City Power requirements for non-residential services. These services may be single-phase or three-phase, direct-connect or current transformer (CT) metered. Single-phase service up to 400 amps (A) and three-phase services up to 200 A can use direct-connect metering. CT metering equipment is required for single-phase service greater than 400 A and three-phase services greater than 200 A.

Non-residential customers should be sure to communicate with Murray City Power before purchasing and installing equipment.

The "General Requirements" in section 9.1 apply to all single-phase, three-phase, direct-connect, and CT metered commercial, industrial, and agricultural services. The subsequent sections provide additional requirements for direct-connect metering and CT metering, including multiple direct-connect meters, combination direct-connect and CT metering, and CT metering using switchboard (switchgear) equipment.

9.1 GENERAL REQUIREMENTS

1. There shall be only one meter per address.
2. All meter base enclosures shall be ring-type.
3. Acceptable meter bases are those manufactured in accordance with current EUSERC, ANSI-C12, and UL/ANS 1-414 requirements.
4. A main disconnect is required when more than six services are connected. If an existing installation expands beyond six services, a main disconnect shall be installed.
5. NEC-approved load calculations are required when the sum of distribution section ampacities exceeds the pulling section ampacities. (See NEC Article 220, Branch-Circuit, Feeder, and Service Calculations.)
6. Each service shall have a lockable and easily accessible disconnect in sight of the meter base location.

7. All required labels shall be correctly installed before the service is energized. Labels shall:
   a. be permanently affixed to the equipment by rivets or screws
   b. be of sufficient durability to withstand the local environment. Engraved metal or hard plastic labels are required.
   c. not be attached to removeable covers.
   d. be kept current for the life of the facility.
8. Each metered service and associated breaker shall be labeled to identify the unit address. Service will not be connected until permanent labels are attached.
9. A minimum vertical clearance of at least 48 inches (48") from the center of the lowest meter to the final grade is required. Maximum vertical clearance is 72 inches (72”) from the center of a meter to the final grade. However, in installations of three or more ganged meters, a minimum vertical clearance of 36 inches (36") to the center of the lowest meter is acceptable if a minimum 36 inches (36") wide, flat, permanent surface (such as a concrete pad or walkway) below the meter is provided at the final grade and extends at least 18 inches (18") on either side of the meter cabinet.
10. On overhead services, the customer must furnish all lugs and connect conductors to the line- side terminals. The customer is responsible for bringing the service entrance conductor to the connection of the utility service drop.
11. Cable termination connectors should have two bolts per connector. When mechanical lugs are used, two setscrews per conductor should be used where feasible.
12. All unused openings shall be covered and secured by the customer.
13. Meters and metering equipment shall be located outdoors.

9.2 DIRECT-CONNECT METERING, SINGLE INSTALLATIONS

The required types of direct-connect meter bases are listed in Table 4. Typical direct connect meter bases and typical service connections are illustrated in the figures in this section.

Direct-connect meter bases serving continuous duty motors are limited to 60 hp or less at 120 V/ 208 Y or 120 V/240 V, three-phase, and 125 hp or less at 277 V/480 Y, three-phase.

Table 4. Direct-connect Meter Base Requirements

Direct-connect Service Type	Amperage	Meter Base Requirement	Figure
Single-phase	200 A max.	EUSERC 305	Figure 1
Single-phase, Overhead Only	201-400 A	EUSERC 302B	Figure 3
Single-phase, Overhead and Underground	201-400 A	na	Figure 3
Network	200 A max.	EUSERC 305	Figure 2
Three-phase	200 A max.	EUSERC 305	Figure 2

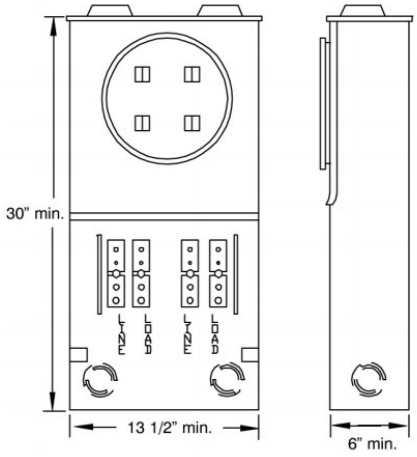


Figure 1 EUSERC 305 Single Phase

Figure 2 EUSERC 305 Three-phase

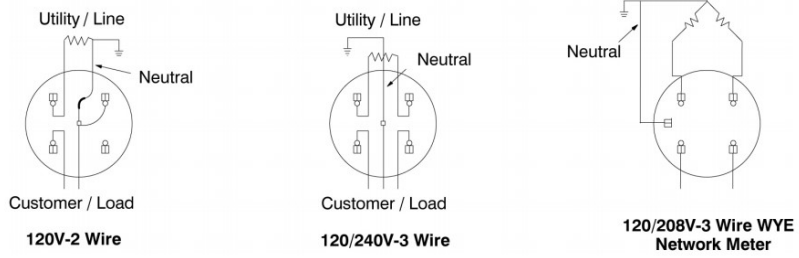


Figure 3 Typical Single-phase Service Connections (Meter Base Front View)

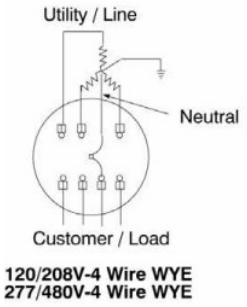


Figure 4 Typical Three-phase Service Connection (Meter Base Front View)

9.2.1 UNDERGROUND SERVICE METER PEDESTALS

Service meter pedestals meeting EUSERC 308 requirements can be used for non-residential underground service installations.

9.2.2 FREE-STANDING SERVICE METER INSTALLATIONS

Free-standing installations may be used for non-residential underground service or overhead service.

9.2.2.1 Underground Service

The installation requirements for direct connection, underground service, free-standing meters are listed below. These requirements are in addition to the general requirements in this section.

Requirements:

1. The customer shall consult Murray City Power to determine the location of the freestanding meter base.
2. The free-standing meter base shall meet all local ordinance requirements.
3. The meter base shall be protected from damage by use of barrier posts or other suitable protection approved by Murray City Power.
4. The customer shall furnish, install and maintain the meter installation on approved steel post(s).

The typical meter installations for a free-standing installation using steel posts is shown on drawing A.11

9.2.2.2 Overhead Service

Free-standing installations may be used for non-residential overhead service. The installation requirements for direct connection, overhead service, free-standing meters are listed below. These requirements are in addition to the general requirements in this section.

Requirements:

1. Wood poles shall be of sound timber. The pole or timber must be free of any defects that may weaken the wood, such as sucker knots and spike knots larger than 1/2 of any face. Cracks greater than 1/2 -inch wide are not permitted. No visible wood decay is allowed.
2. The pole height must provide required clearance for the Murray City Power's service drop and any other attachments. The customer shall install the meter base and service equipment on a wood pole no less than 25 feet long and 5-1/2 inches in diameter at the top, or a (nominal) 6"x 6" x 25' timber, set no less than 60 inches below ground level, with suitable backfill. The pole or timber shall be pressure- or thermally- treated with an approved preservative.
3. The pole or timber shall be easily accessible by Murray City Power power-lift aerial equipment.
4. In unstable soil, conductor lengths may be reduced; guying or bracing shall be required.
5. The conductor must be at least 24 inches (24") in length outside the weatherhead.

9.3 DIRECT-CONNECT METERING, MULTIPLE INSTALLATIONS

This section lists the requirements in addition to the general requirements for direct-connect, non-residential, single-phase and three-phase installations with more than one metered service.

Before being energized, the meter base shall be properly wired and grounded, and all necessary permits shall be in place. Ganged, modular, and switchboard styles of metering base equipment are approved for use.

Consult with Murray City Power regarding the design of the multiple metering services before purchasing and installing equipment.

Requirements:

1. Metering conductors shall not pass through adjacent metering compartments except in enclosed wireways.
2. A test bypass facility (TBF) with rigid insulating barriers shall be furnished, installed, and wired or bussed to the meter bases. TBF cover panels shall be sealable and fitted with a lifting handle.
3. A pull box section is required for two or more services and must meet EUSERC 343 and 343A requirements for the type and size of service. In addition:

a. Only Murray City Power conductors are allowed inside the pull box;

b. The pull box shall be sealable, and will be sealed by Murray City Power;

c. Customer-owned devices shall not be installed in the pull box;

d. No taps are allowed inside the pull box; and,

e. The customer shall not terminate their grounding electrode conductor in the pull box or use the pull box as a junction point for the grounding or to ground the electrode conductors.

4. For ganged meters, where the face of a cabinet exceeds the depth of the adjacent meter cabinet, clearances shall be in accordance with NEC.

5. For switchboard metering installations, the customer must provide a concrete pad for switchboard metering service sections and pull boxes.

9.4 CT METERING, UP TO 800 A

This section lists the requirements for CT metered services rated up to 480 V and 800 A.

Table 5 identifies customer-provided material for CT metering. Murray City Power will provide and install the meter, a meter test switch, current transformers, and secondary metering wiring.

Table 5 Customer Provided Material for CT-Metering

Customer Provides	See for More Information	Requirements/Application Notes
Meter Base	EUSERC 339	The CT-metering base. 6-jaw base for single-phase 13-jaw base for three-phase
CT Cabinet	Section 9.4.1 Table 6	• A weather-tight, NEMA 3R-rated EUSERC CT cabinet sized in accordance with Table 6. • The door shall be hinged and capable of being sealed
CT Mounting Base	Section 9.4.2	• EUSERC CT mounting base rated for 50,000 A fault current • Cable termination can only be made on the manufacturer-supplied studs/connectors of the transformer mounting base. • No alteration of the transformer mounting base is allowed
Conduit	Section 9.4.3	The conduit between the meter base enclosure and the CT cabinet, see Section 9.4.3.

Connectors/Terminators		Connectors for the load-side conductors to CT mounting base, as well as overhead service.
Bonding	Section 9.4.4	Bonding per Section 9.4.4 for all meter and CT enclosures.

9.4.1 CT CABINET

The CT cabinet consists of two parts: the enclosure and the mounting base for the current transformers. The cabinet is exclusively for Murray City Power metering equipment.

Requirements:

1. Only equipment associated with Murray City Power metering shall be permitted in the CT cabinet.
2. The door shall have factory-installed hinges for side opening and shall be sealable.
3. The door shall be equipped with a device to hold it in the open position at 90° or more.
4. The CT cabinet door shall open away from the meter.
5. The top of the CT mounting base shall not be more than 72 inches (72") above the finished grade.
6. The customer's service entrance conduits must exit the cabinet on the load side of the CT.
7. Customer conductors are not permitted in the Murray City Power termination space.
8. The customer shall not terminate their principal (main) grounding electrode conductor in the CT cabinet or use it as a junction point for grounding or grounding electrode conductors.
9. For multiple metered circuits, a separate termination pull box must be provided for the Murray City Power service lateral. The CT cabinet shall not be used as a load distribution center.

Table 6 CT Cabinet Requirements

Type of Service	EUSERC # for CT Cabinets	Minimum Cabinet Dimensions			EUSERC # for CT Mounting Base
		Width	Height	Depth	
Single-phase, 401-800 A	316, 317	24”	48”	11”	328A
Three-phase, 201-600 A	316, 318	36”	48”	11”	329A
Three-phase, 800 A		48”	48”	11”	329A

Notes on Table 6:

1. Where both line and load conductors enter or exit from the top or bottom of the cabinet a larger cabinet is required.

   a. The dimension of the cabinet shall be 48"W x 48"H x 14"D. (These dimensions are greater than EUSERC316and 318 minimums.)

   b. The cabinet shall have two sealable, hinged doors with handles.

2. The door shall have factory-installed hinges for side opening and shall be sealable.

Meter Base Location:

1. For single-hinged CT cabinets the meter base shall be located opposite the hinged side, and not above or below the cabinet.

2. For dual-hinged CT cabinets, the meter base can be mounted on either side of the cabinet but not above or below it.

9.4.2 CT MOUNTING BASE AND CABLE TERMINATION

CT mounting bases shall conform to EUSERC 328A, or EUSERC 329A. EUSERC 328B and 329B are also acceptable.

Requirements:

1. The CT mounting base shall meet the ratings for the available fault current at the location installed (50,000 A minimum).

2. For existing four-wire delta services, the high (power) leg conductor must be identified by orange marking and located on the right-hand bus position. The bus shall also be marked and readily identified.

3. The mounting base shall accept bar-type current transformers only.

4. No alteration of the mounting base is allowed.

5. Line and load-side cable terminations on EUSERC 328A or 329A CT landing pads require two bolts per connector.

6. Cable termination can only be made on the manufacturer-supplied studs of the transformer mounting base.

9.4.3 CT METERING CONDUIT

The customer must provide conduit between the meter base and the CT cabinet. When installing conduit, the following requirements shall be met:

Requirements for a meter within 12" of a CT cabinet:

1. Conduit shall be one-inch (1") IMC, rigid, or greater.
2. Proper fittings and bushings shall protect metering conductors.

9.4.4 CT CABINET BONDING

The CT cabinet must be properly bonded and grounded per the NEC. Figure 6 illustrates one acceptable solution.

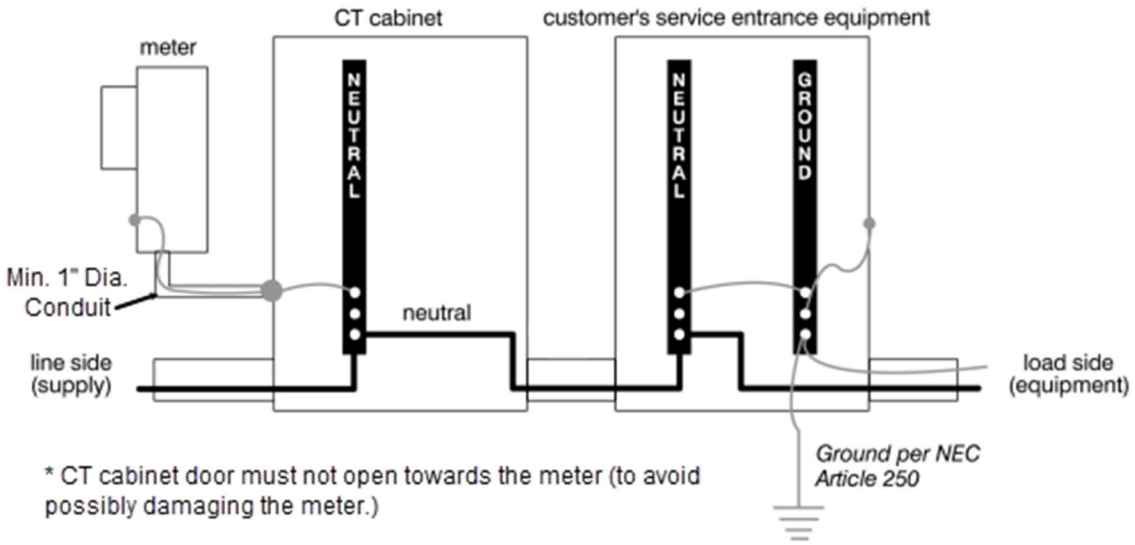


Figure 6 CT Cabinet Bonding, Example

9.4.5 CT METERING, FREE STANDING

This section lists the requirements in addition to the general requirements in this section for of free-standing CT metering installations on posts. Free-standing installations are owned by the customer. Installation requirements for service to free-standing installations are listed below.

Requirements:

1. The customer shall consult Murray City Power to determine the location of the freestanding meter installation.
2. The free-standing meter base shall meet all city ordinance requirements.
3. The meter base shall be protected from damage by use of barrier posts or other suitable protection approved prior to installation by Murray City Power.

4. The CT cabinet must be properly supported with a minimum of two three-inch (3") steel posts with installed caps. When equipment is less than 72 inches (72") apart, it shall be bonded according to the NESC.

5. The customer shall furnish, install and maintain posts, hardware, conduit, fittings, and concrete pads sufficient to support the metering.

9.4.6 COMBINATION DIRECT-CONNECT AND CT METERING

Installations requiring both direct-connect and CT metering services shall meet the requirements of both types of services as described in the previous sections. An approved wall-mounted equipment installation is shown below. Switchboard combination units are also allowed. Refer to Section 9.5, Switchboard Metering up to 4000 A for requirements.

9.5 SWITCHBOARD METERING, UP TO 4000 A

This section lists the requirements in addition to the general requirements in this section for switchboard metered service installations. A EUSERC-approved switchboard metering section is required when the service entrance rating is greater than 800 A. Switchboard metering may also be used for three-phase services over 200 A or single-phase services over 400 A.

Consult with Murray City Power regarding the design of the switchboard metering services before purchasing and installing equipment.

Requirements:

1. The customer shall provide a drawing of the proposed service equipment, including EUSERC reference numbers and a mounting pad with dimensions, to Murray City Power for review and approval. Murray City Power approval must be obtained prior to fabrication.

2. The customer shall provide and install:

   a. Switchboard enclosure with CT compartment and CT mounting base

   b. Meter base

   c. Locking equipment for the meter enclosure

   d. Concrete mounting pad for the switchboard enclosure

   e. A flat permanent surface (such as a concrete pad) extending a minimum of 36 inches (36") out from the switchboard in front of the CT compartment

3. The metering CTs shall be located in the CT compartment.

4. The CT compartment shall have a hinged door.
5. Meters shall be mounted on the compartments' hinged meter panels.
6. The door shall be equipped with a device to hold it in the open position at 90° or more.
7. Lugs for terminating the customer's ground wire (or other grounding conductors) shall be located outside the sealable section and shall be designed to allow the customer's neutral system to be readily accessible.
8. All pull and termination sections shall have full front access.
9. All removable cover panels shall have two lifting handles and be limited to a maximum weight of 25 pounds.
10. Bus bars are required from the pull section for service above 800 amps. Termination lugs are required and shall meet EUSERC 347.
11. Any customer-owned locking equipment for the metering enclosure must allow independent access by Murray City Power.
12. Only Murray City Power conductors are allowed inside the pull section.

Minimum dimensions for switchboard pull boxes (termination enclosures) are shown in Figure 7 and Table 7:

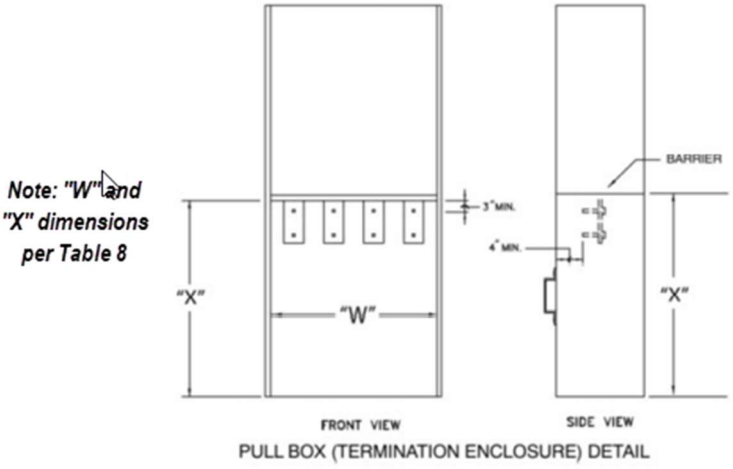


Figure 7 Switchboard Section with Termination Enclosure

Table 7 Minimum Dimensions for Switchboard Pull Box (Termination Enclosures)

Switchboard rating	**Minimum Access Opening ("W")**		**Height Dimension ("X")**	
	3-wire Service	**4-wire Service**	**Min.**	**Max.**
Below 400 A	Consult with Murray City Power			
400-800 A	24"	24"	42"	72"
801-1200 A	24"	30"		
1201-2000 A	30"	35"		
2001-3000 A	-	42"	60"	
3001-4000 A	-	44"		

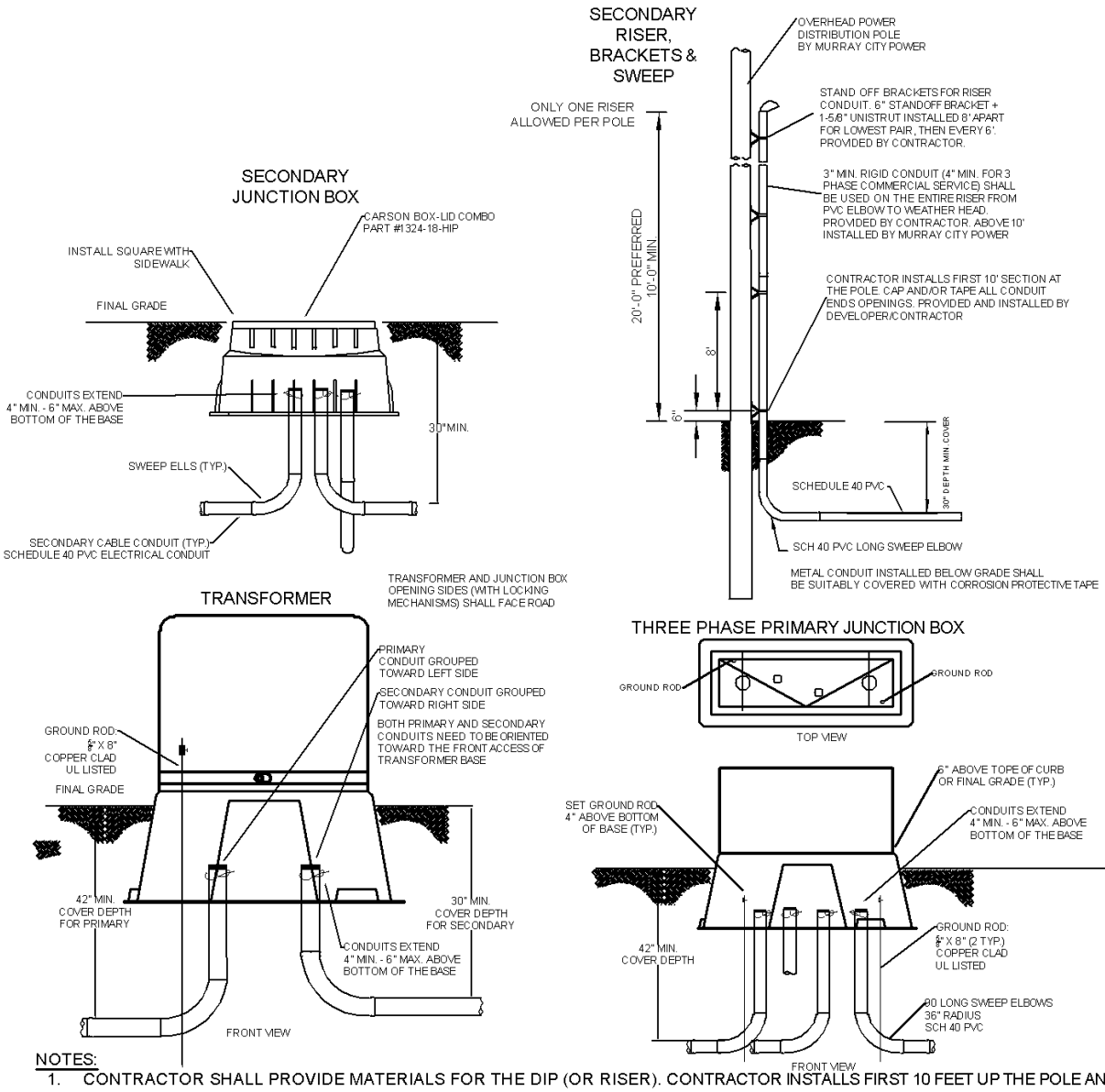
10 STREETLIGHTS

10.1 SUBDIVISION POLE-TOP LUMINARIES

Murray City will install conduit and secondary junction boxes for streetlights, at the customer's expense, according to the Murray City design. The customer may be required to dig the trench according to the Murray City design. Murray City Power provides and installs streetlights at the customer's expense. The steel base for the light pole will be installed by Murray City and paid for by the customer.

MURRAY CITY POWER

STANDARD DETAIL DRAWINGS



NOTES:

1. CONTRACTOR SHALL PROVIDE MATERIALS FOR THE DIP (OR RISER). CONTRACTOR INSTALLS FIRST 10 FEET UP THE POLE AND MURRAY CITY POWER WILL INSTALL ABOVE THAT POINT AND PULL CONTRACTOR-PROVIDED CABLE.
2. ON THREE-PHASE SERVICE CITY WILL PROVIDE METER BASE AND TEST SWITCH .
3. A CT CABINET MUST BE USED ON THREE-PHASE SERVICE ABOVE 200A.
4. FOR ALL THREE PHASE UNDERGROUND SERVICE CONTRACTOR SHALL PROVIDE 4" CONDUIT MINIMUM -- RIGID CONDUIT ABOVE GROUND, SCH 40 PVC BELOW GROUND – FROM DIP OR RISER TO METER.
5. TRANSFORMER PADS MUST BE DESIGNED ACCORDING TO MURRAY CITY POWER SPECIFICATIONS AND INSTALLED IN COMPLIANCE WITH APPLICABLE CODES.
6. BACKFILL BENEATH ELECTRICAL EQUIPMENT SHALL BE LEVEL AND BACKFILLED–COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASHTO T-99.

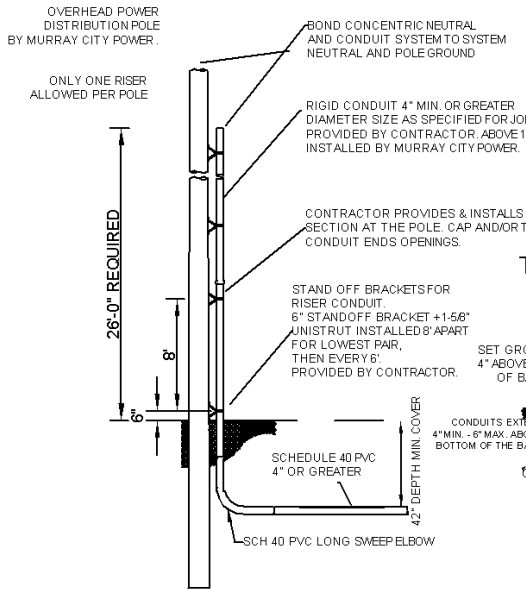
REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

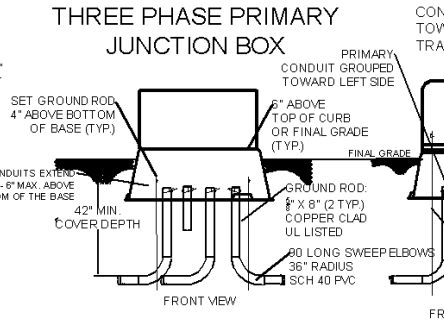
CONSTRUCTION QUICK REFERENCE

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	8/8/2022	A.1	0

PRIMARY RISER, BRACKETS & SWEEP

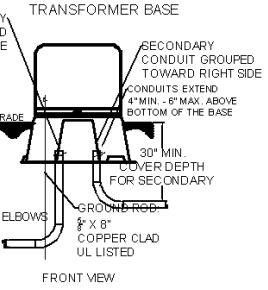


THREE PHASE PRIMARY JUNCTION BOX



TRANSFORMER

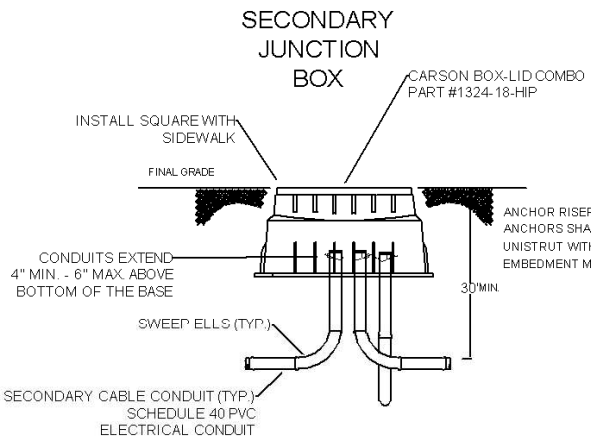
BOTH PRIMARY AND SECONDARY CONDUITS NEED TO BE ORIENTED TOWARD THE FRONT ACCESS OF TRANSFORMER BASE

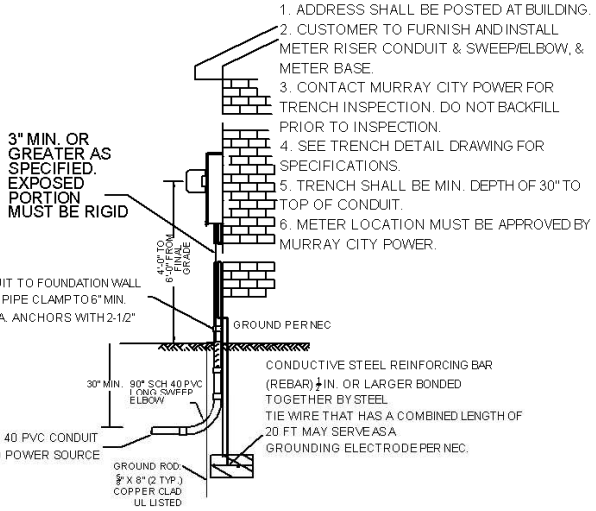


NOTES:

1. CONTRACTOR SHALL PROVIDE MATERIALS FOR THE DIP (OR RISER). CONTRACTOR INSTALLS FIRST 10 FEET UP THE POLE AND CITY WILL INSTALL ABOVE THAT POINT AND PULL CONTRACTOR-PROVIDED CABLE.
2. CUSTOMER SHALL PROVIDE METER BASE AND TEST SWITCH ON THREE-PHASE SERVICE.
3. A CT CABINET MUST BE USED ON THREE-PHASE SERVICE ABOVE 200A.
4. FOR ALL THREE PHASE UNDERGROUND SERVICE CONTRACTOR SHALL PROVIDE 4" OR GREATER RIGID AND SCHEDULE 40 PVC CONDUIT FROM DIP OR RISER TO METER.
5. TRANSFORMER PADS MUST BE SIZED AND APPROVED BY THE CITY AND INSTALLED IN COMPLIANCE WITH APPLICABLE CODES.

SECONDARY JUNCTION BOX



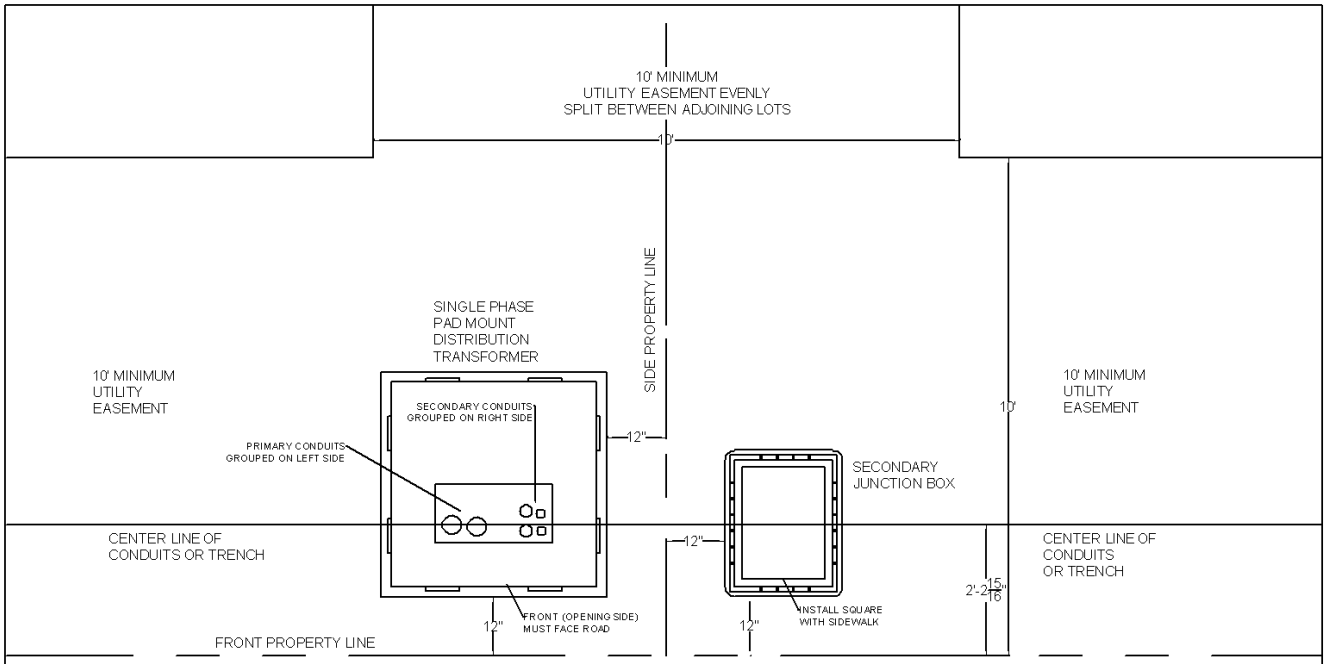


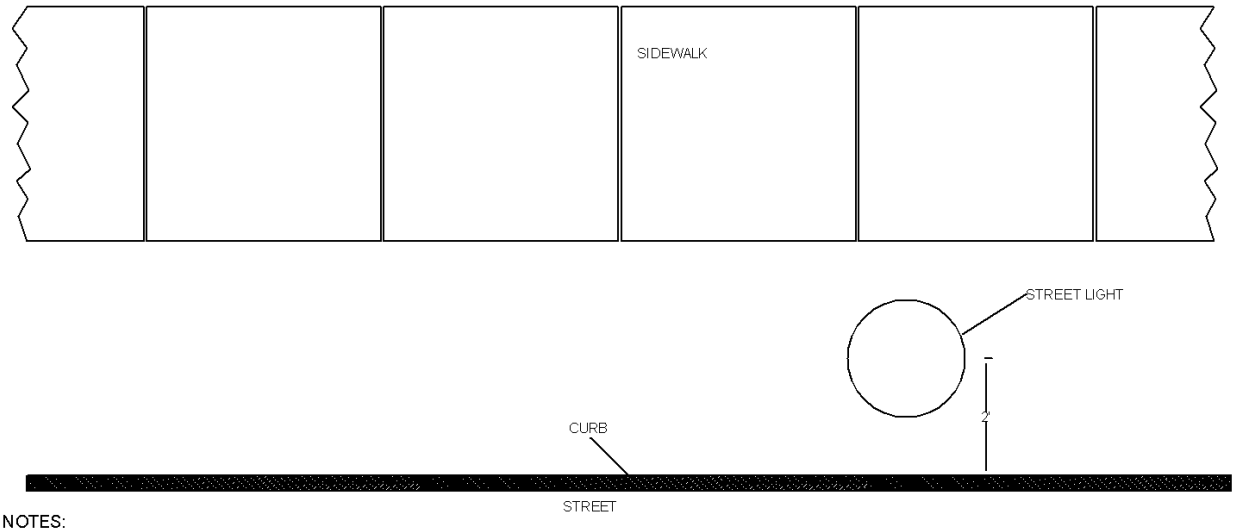
REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

TYPICAL INSTALL--PRIMARY, SECONDARY & SERVICE

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	8/8/2022	A.2	0





NOTES:

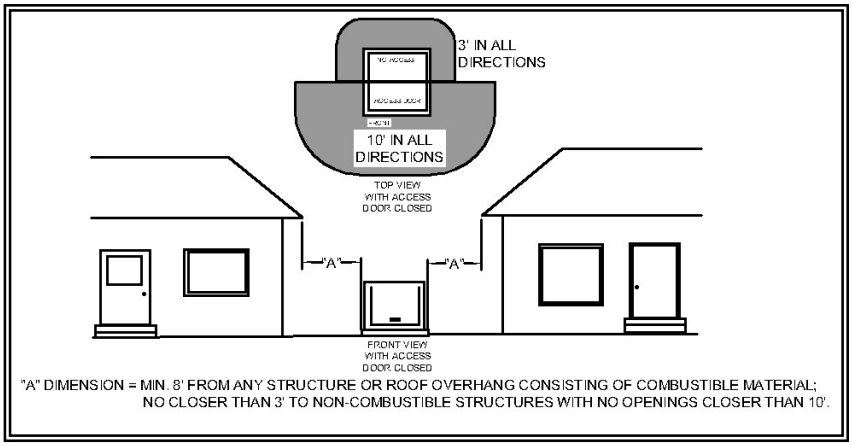
1. PRIMARY & SECONDARY JUNCTION BOXES, & BOX PADS SHALL BE PLACED ON WELL COMPACTED AND LEVEL GROUND. EXCAVATED AREAS THAT SUPPORT ELECTRICAL EQUIPMENT SHALL BE BACKFILLED AND COMPACTED IN LIFTS NO MORE THAN 2 FEET, COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASHTO T-99.
2. THE TOP OF THE TRANSFORMER PAD SHALL BE AT LEAST 2" ABOVE THE SIDEWALK.
3. THE FRONT OF THE TRANSFORMER PAD SHOULD ALWAYS FACE AWAY FROM ADJACENT STRUCTURES & BE FREE OF OBSTRUCTIONS FOR 1O FEET.
4. AT LEAST 3 FEET FROM THE SIDE AND BACK EDGES OF THE TRANSFORMER PAD SHALL BE FREE OF OBSTRUCTIONS.
5. THE EDGES OF THE TRANSFORMER PAD MUST BE AT LEAST TEN FEET FROM ANY COMBUSTIBLE STRUCTURES.
6. PRIMARY & SECONDARY JUNCTION BOXES SHALL BE PLACED SO AS TO AVOID BEING FILLED WITH DRAINAGE WATER.
7. ALL WORK SHALL BE INSPECTED AND APPROVED BY MURRAY CITY POWER BEFORE BURIAL.
8. FINAL INSPECTION AND ENERGIZING THE SYSTEM WILL BE DONE BY MURRAY CITY POWER.

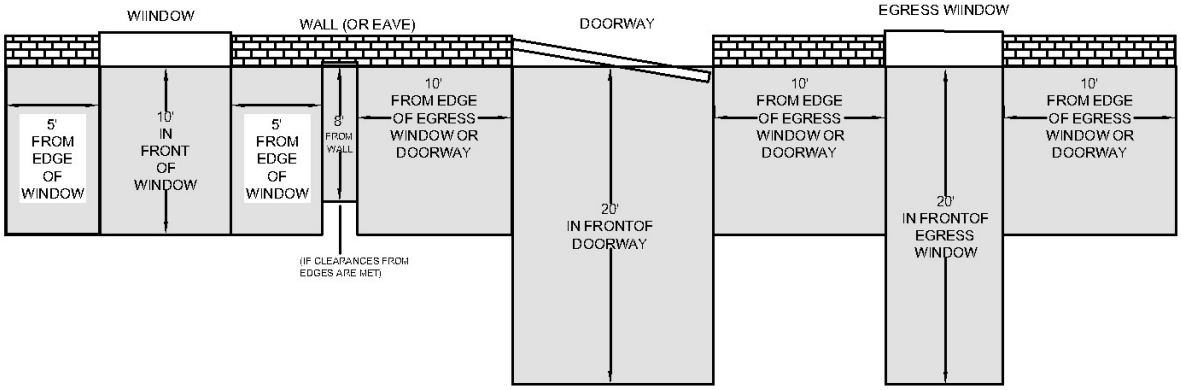
REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

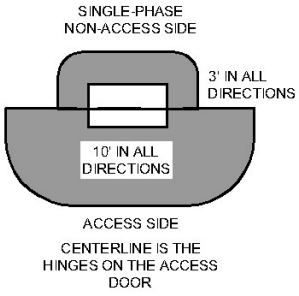
MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

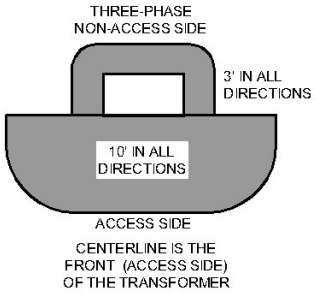
TYPICAL TRANSFORMER & SEC. JUNCT. LOCATION

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	8/8/2022	A.3	0









CLEAR WORKSPACE CLEARANCES--NO OBSTACLES IN THESE AREAS

FIRE CODE CLEARANCES--NO EQUIPMENT PADS IN THESE AREAS

1. DISTANCES ARE FROM THE EDGE OF THE EQUIPMENT PAD.
2. NO VEGETATION OVER 6" IN HEIGHT SHALL BE ALLOWED IN THE CLEAR WORKSPACE AREA.
3. NO TRIP HAZARDS SHALL EXIST IN THE CLEAR WORKSPACE AREA.

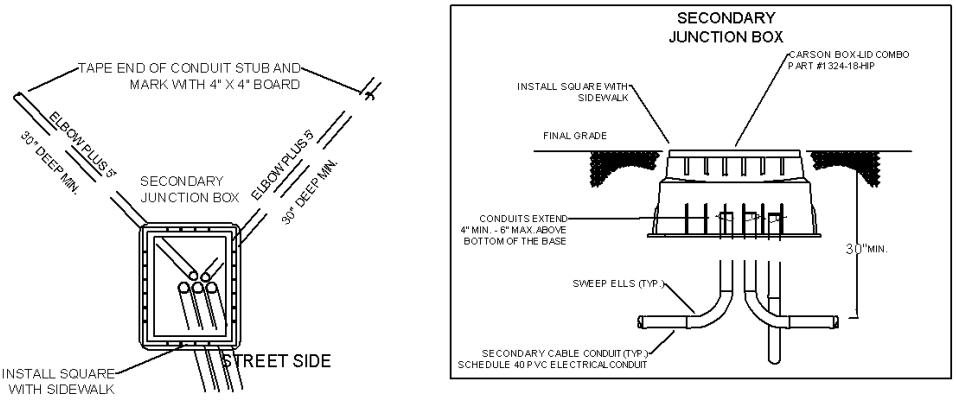
REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

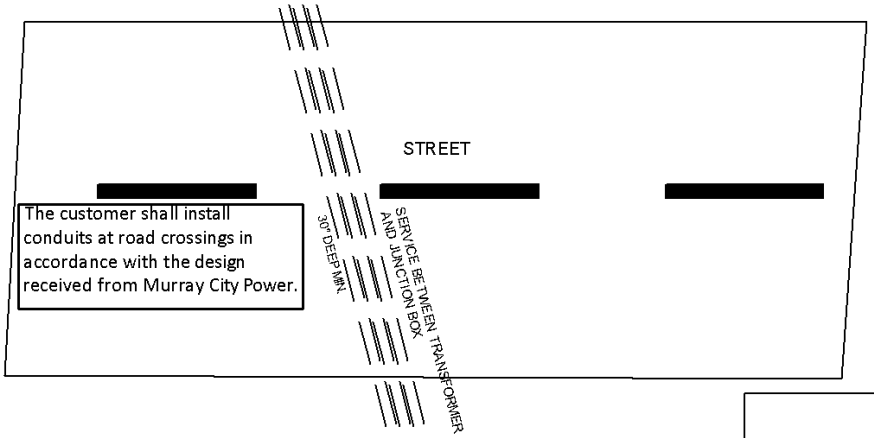
MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

FIRE CODE & TRANSFORMER CLEARANCE

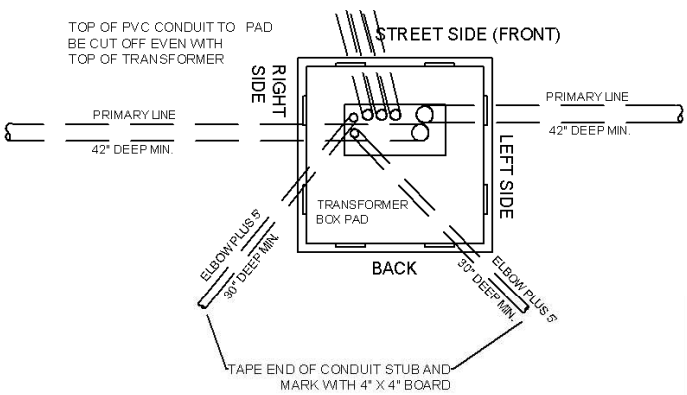
SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	10/29/2021	A.4	0

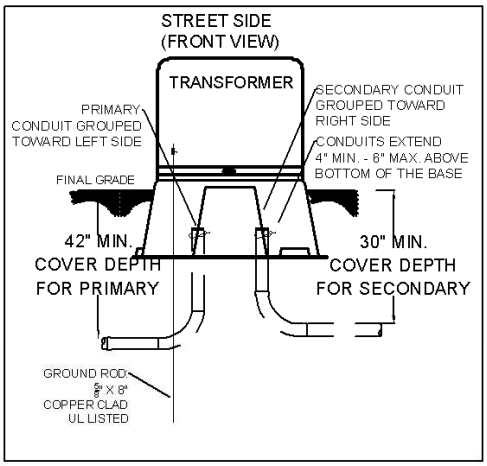
TYPICAL TRANSFORMER AND SERIVCE JUNCTION BOX INSTALLATION





ALL ELBOWS NEED TO BE 90° NOT 45°. CONDUITS IN SECONDARY JUNCTION BOXES NEED TO BE TOWARD THE CENTER OF THE BOX.





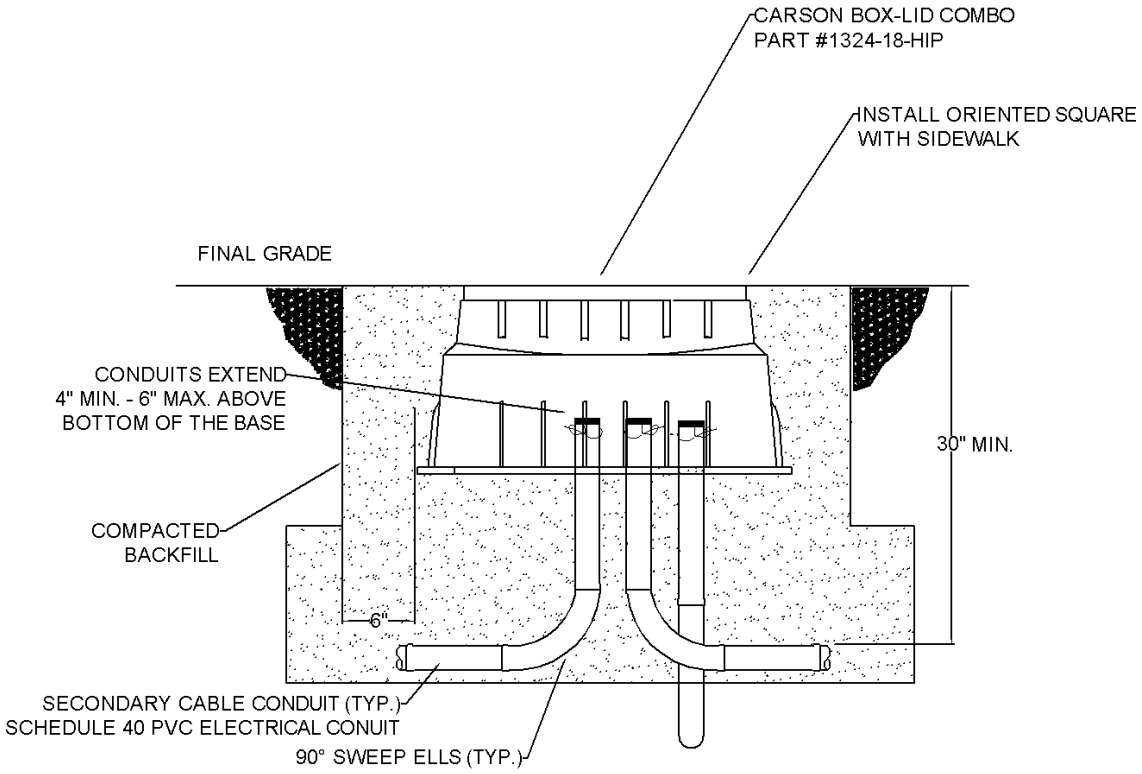
REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

TRANSFORMER & SERVICE JUNCT. BOX INSTALLATION

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	8/8/2022	A.5	0

SECONDARY JUNCTION BOX



NOTES:

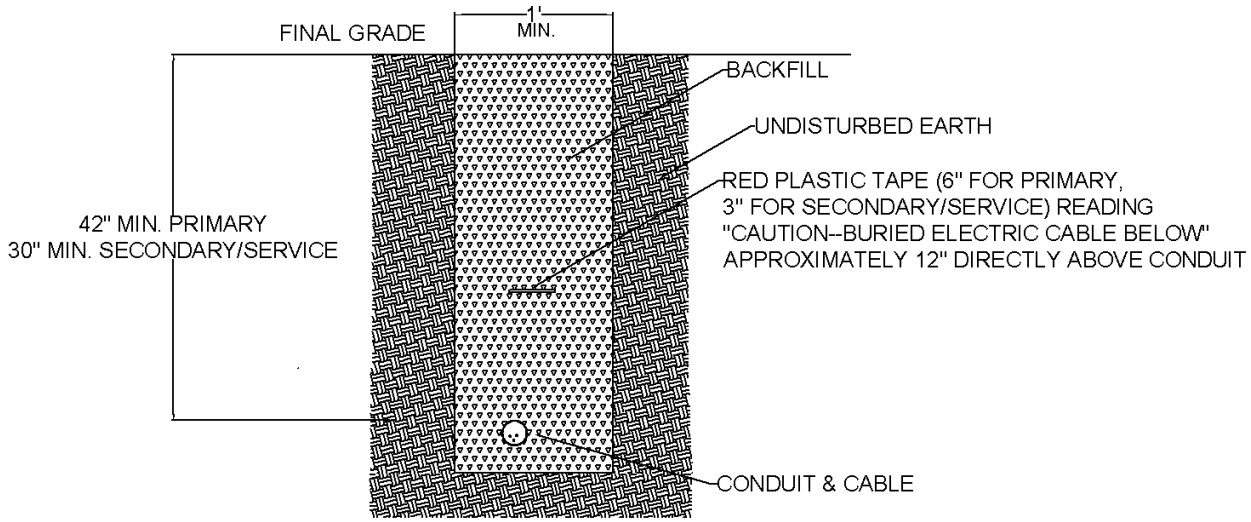
1. AREA AROUND BOX CAN EITHER BE PLANTED, HARD SURFACE OR A COMBINATION.
2. BOXES SHALL BE PLACED SO AS TO AVOID BEING FILLED WITH DRAINAGE WATER.
3. BOXES SHALL BE PLACED LEVEL ON BACKFILL COMPACTED IN LIFTS NO MORE THAN 2 FEET, COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASHTO T-99.
4. ALL WORK SHALL BE INSPECTED AND APPROVED BY MURRAY CITY POWER .

REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

SECONDARY JUNCTION BOX INSTALLATION

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	8/8/2022	A.6	0



TRENCH DETAIL

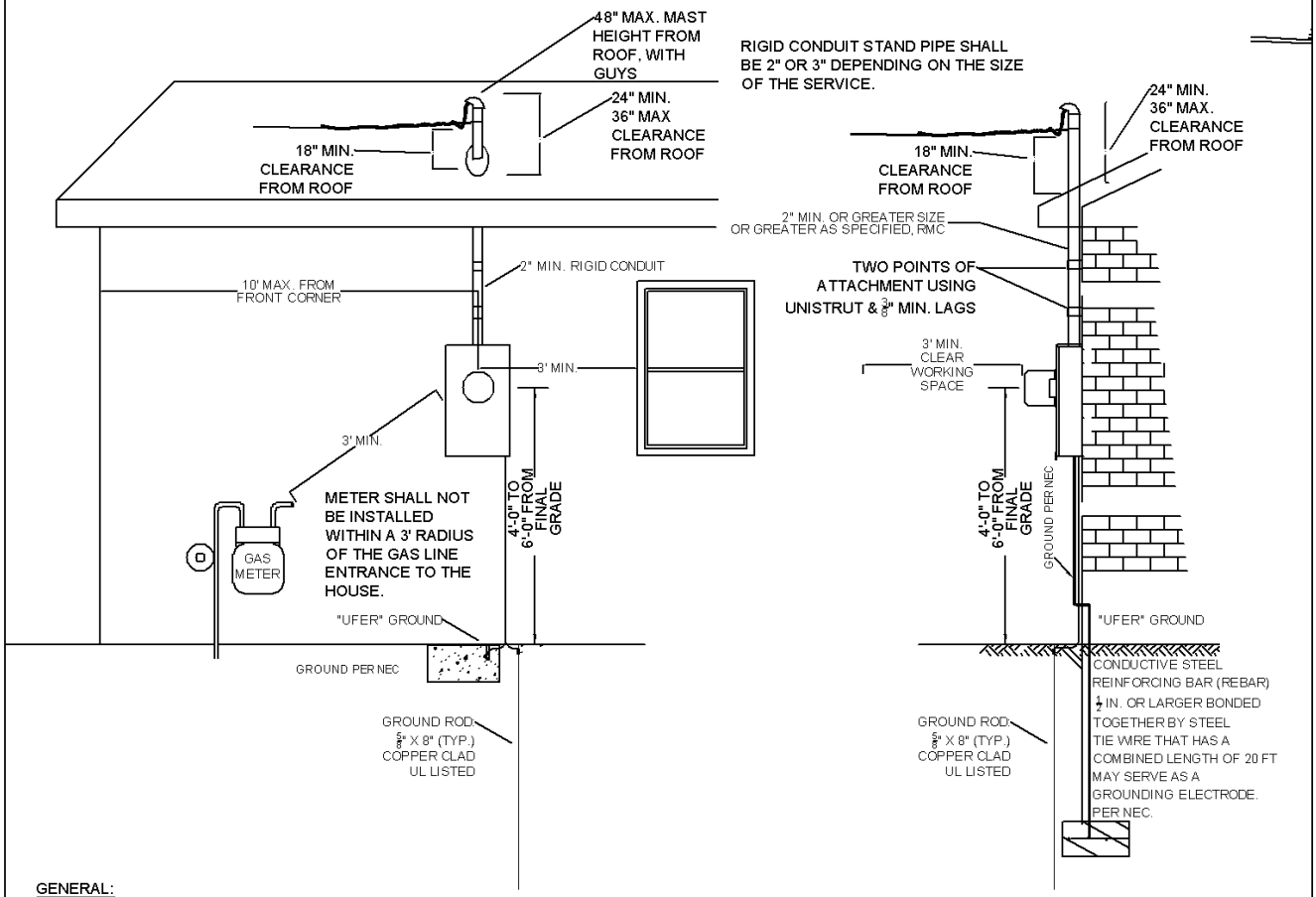
REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

TRENCH DETAIL

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	10/14/2021	A.7	0

OVERHEAD RESIDENTIAL SERVICES



GENERAL:
ALL ELECTRICAL WORK SHALL BE IN COMPLIANCE WITH THE LATEST EDITION OF THE NATIONAL ELECTRIC CODE, INTERNATIONAL BUILDING CODE, ICC ELECTRICAL CODE AND THE NATIONAL ELECTRICAL SAFETY CODE EXCEPT WHERE THESE SPECIFICATIONS ARE MORE STRINGENT. IF THERE IS A CONFLICT BETWEEN STANDARDS THE MOST STRINGENT SHALL RULE. MURRAY CITY PROVIDES ALL SERVICE WIRE TO THE METER MAST ON OVERHEAD CONNECTIONS. THE CUSTOMER SHALL PROVIDE SERVICE WIRE FROM THE WEATHER HEAD TO THE METER BASE.

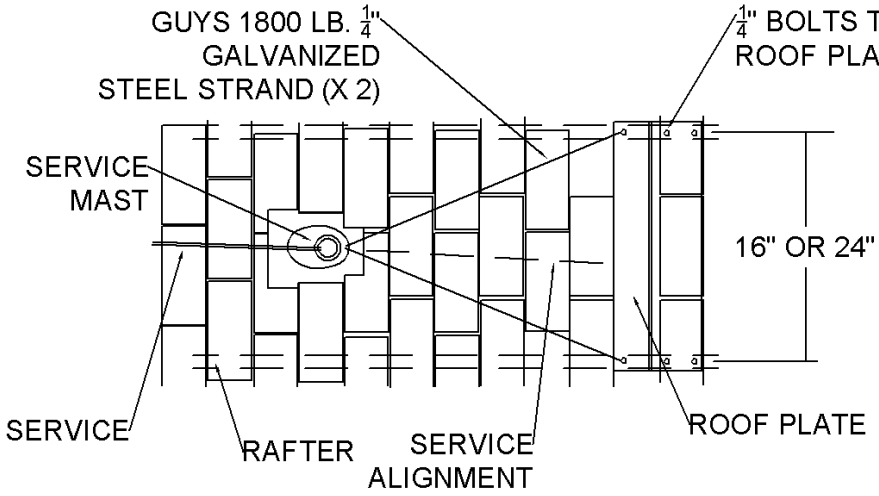
INSTALLATION:
1. ADDRESS SHALL BE POSTED AT BUILDING.
2. CUSTOMER TO SUPPLY AND INSTALL CONDUCTOR FROM THE WEATHERHEAD TO THE METER BASE.
3. MURRAY CITY POWER PROVIDES SERVICE WIRE TO THE WEATHERHEAD FROM THE POWER SOURCE.
4. IF THE POINT OF ATTACHMENT IS MORE THAN 36" ABOVE A POINT OF SUPPORT ON THE MAST, TWO INDEPENDENT GUYS ARE REQUIRED. SEE MAST GUYING DRAWING. MAXIMUM MAST HEIGHT WITH GUYS IS 48" CLEARANCE ABOVE ROOF.

REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

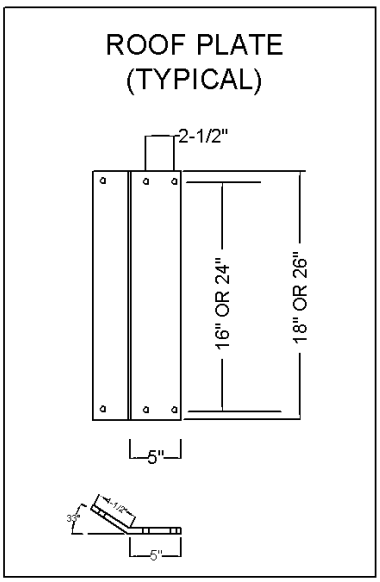
MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

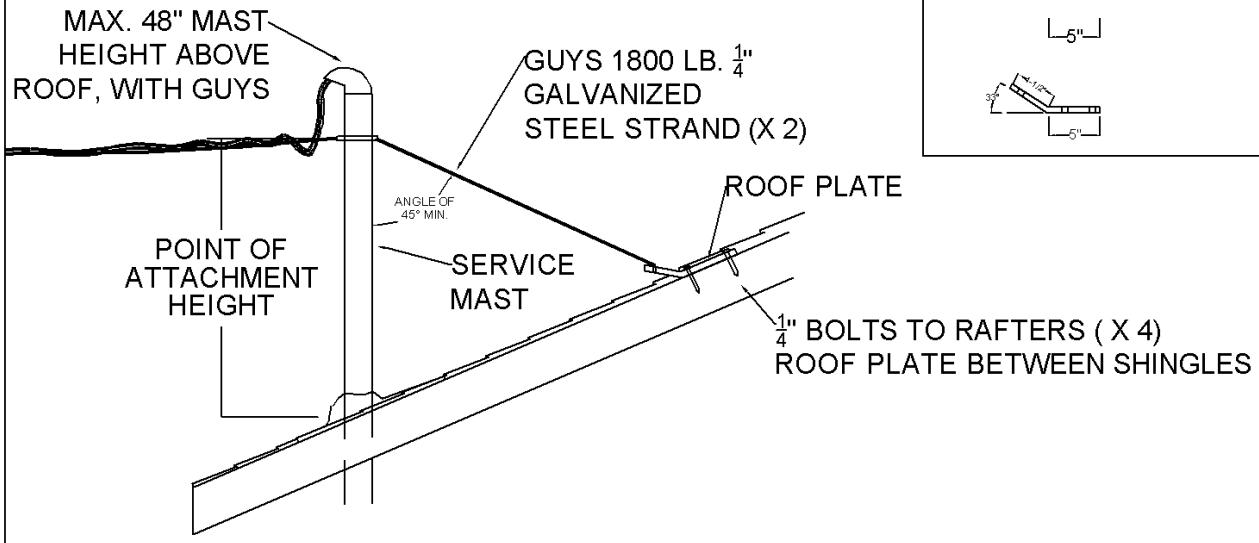
TYPICAL OVERHEAD RESIDENTIAL SERVICE

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	8/8/2022	A.8	0



THE ROOF PLATE MUST BE INSTALLED SUCH THAT THE SERVICE ALIGNMENT FALLS WITHIN THE ANGLE OF THE GUYS.





IF THE POINT OF ATTACHMENT IS MORE THAN 36" ABOVE A POINT OF SUPPORT ON THE MAST, TWO INDEPENDENT GUYS ARE REQUIRED.

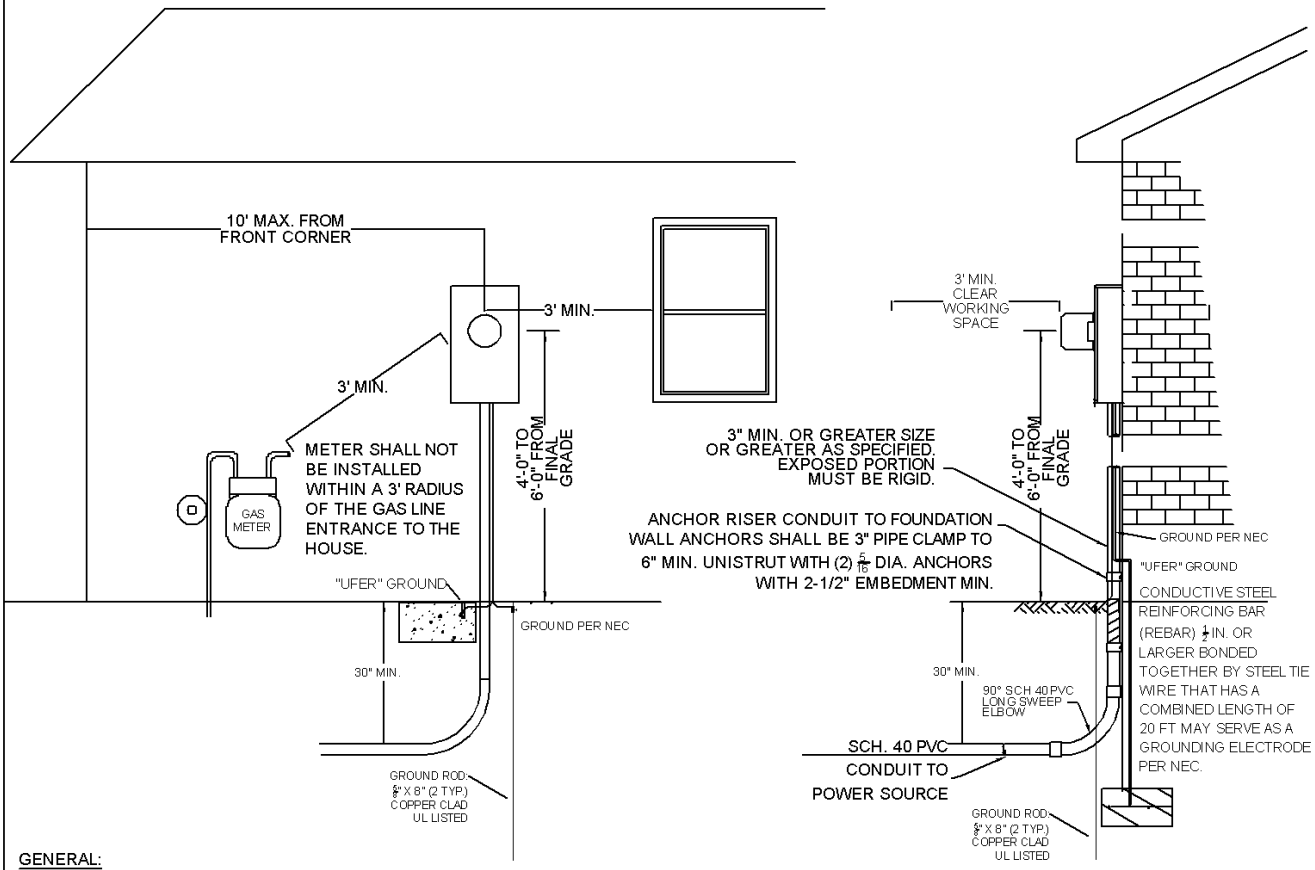
REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

GUYING OVERHEAD RESIDENTIAL SERVICE

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	8/8/2022	A.9	0

UNDERGROUND RESIDENTIAL SERVICES



GENERAL:
ALL ELECTRICAL WORK SHALL BE IN COMPLIANCE WITH THE LATEST EDITION OF THE NATIONAL ELECTRIC CODE, INTERNATIONAL BUILDING CODE, ICC ELECTRICAL CODE AND THE NATIONAL ELECTRICAL SAFETY CODE EXCEPT WHERE THESE SPECIFICATIONS ARE MORE STRINGENT. IF THERE IS A CONFLICT BETWEEN STANDARDS THE MOST STRINGENT SHALL RULE. FOR RESIDENTIAL MURRAY CITY POWER WILL DIG THE TRENCH, INSTALL THE CONDUIT, PULL THE SECONDARY SERVICE WIRE, MAKE CONNECTIONS AND SET THE METER.

INSTALLATION:

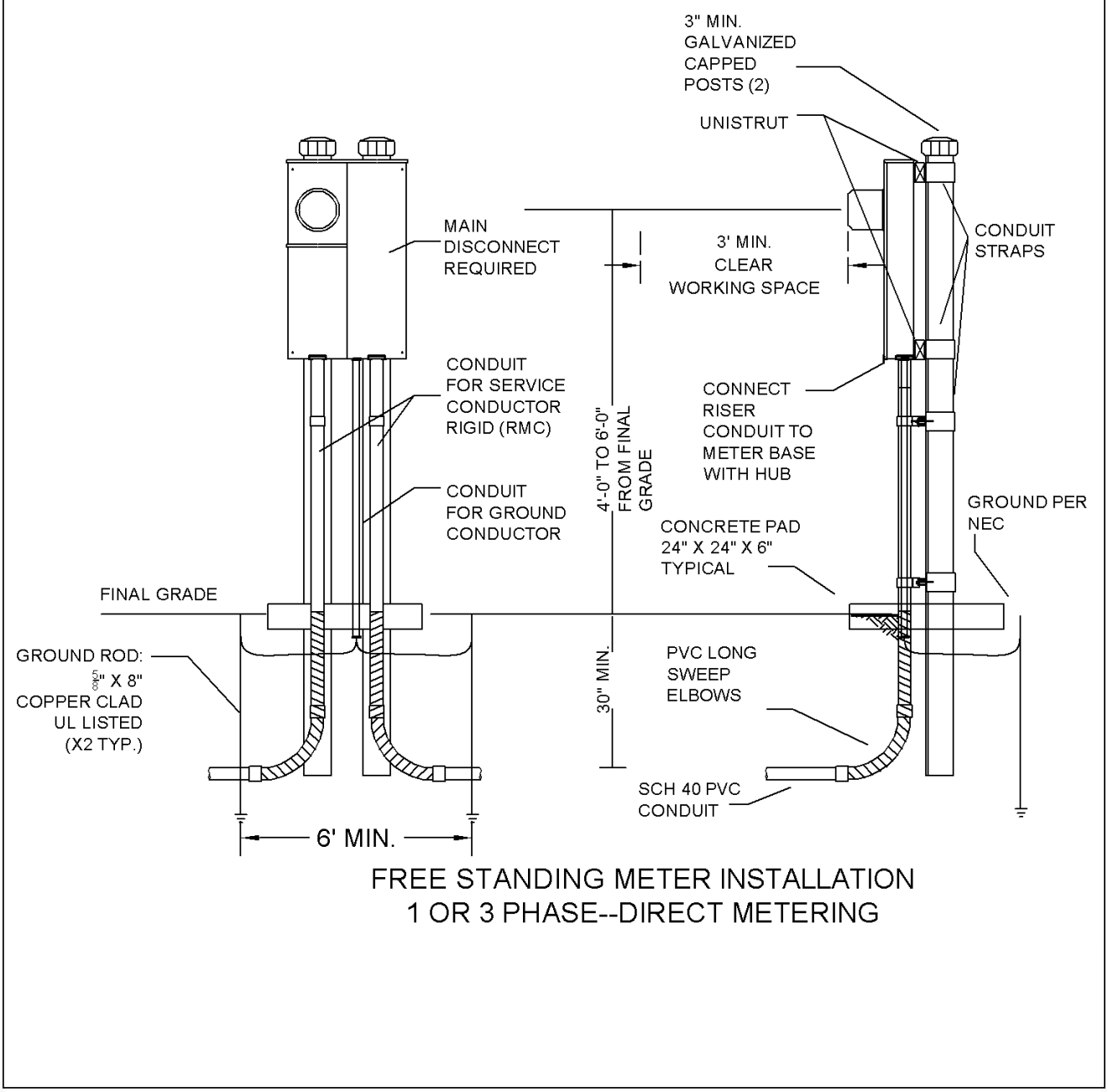
1. ADDRESS SHALL BE POSTED AT BUILDING.
2. CITY WILL FURNISH AND INSTALL CONDUIT FROM TRANSFORMER\ OR SECONDARY JUNCTION BOX, TO METER BASE FOR RESIDENTIAL.
3. CONTACT MURRAY CITY POWER FOR FOR TRENCH INSPECTION. DO NOT BACKFILL PRIOR TO INSPECTION.
4. SEE TRENCH DETAIL DRAWING FOR SPECIFICATIONS.
5. TRENCH SHALL BE MIN. DEPTH OF 30" .
6. THE CITY WILL SUPPLY CONDUCTOR FROM THE POINT OF CONNECTION TO THE METER BASE FOR RESIDENTIAL.
7. METER LOCATION MUST BE APPROVED BY MURRAY CITY POWER.
8. A CT CABINET MUST BE USED ON THREE-PHASE SERVICE ABOVE 200 A.
9. FOR ALL THREE-PHASE UNDERGROUND SERVICE, CONTRACTOR SHALL PROVIDE 4" IMC (MINIMUM) FROM DIP OR RISER TO METER.

REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

TYPICAL UNDERGROUND RESIDENTIAL SERVICE

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	8/8/2022	A.10	0



FREE STANDING METER INSTALLATION
1 OR 3 PHASE--DIRECT METERING

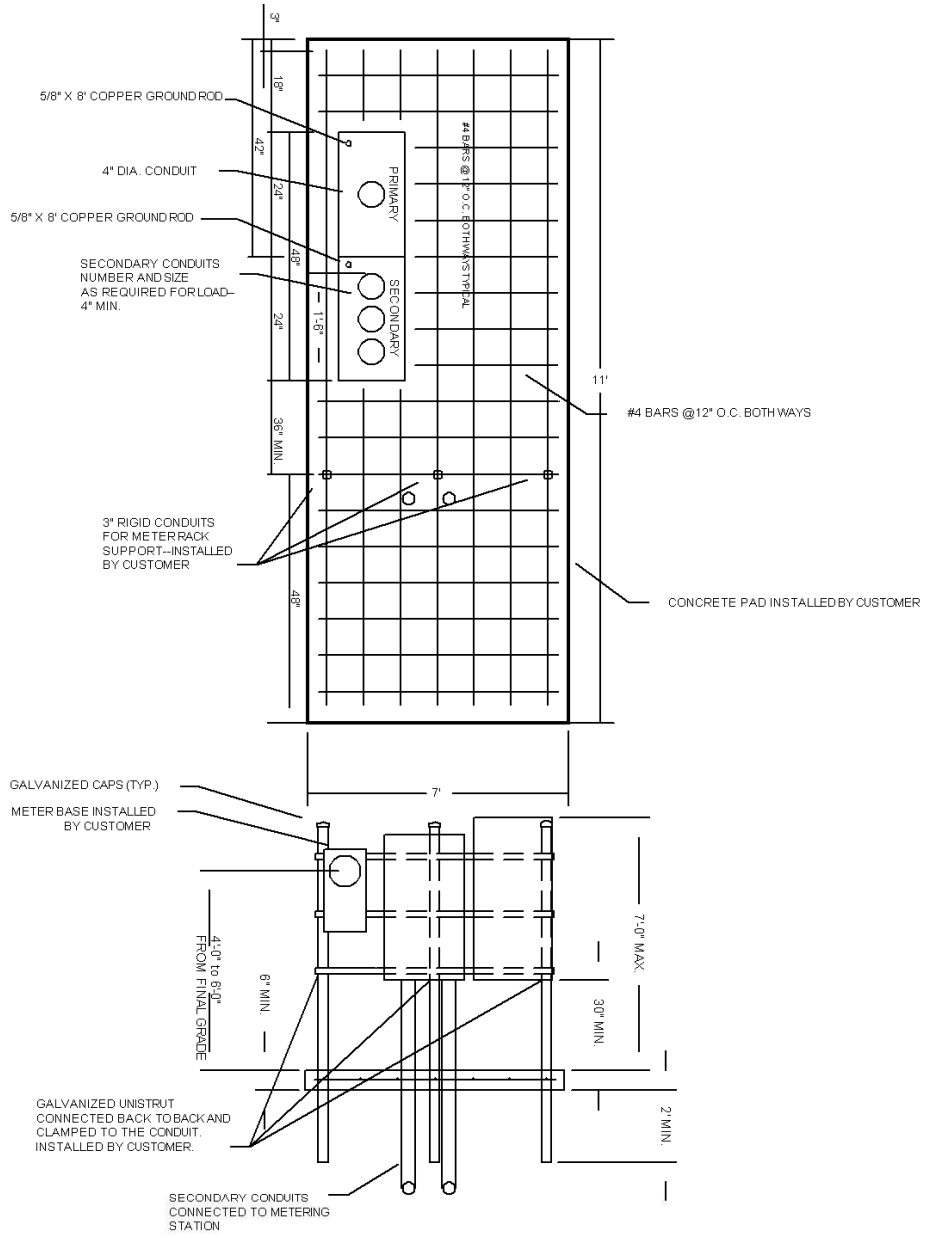
REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

TYPICAL FREE STANDING METER SERVICE

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	10/22/2021	A.11	0

THREE PHASE TRANSFORMER PAD WITH METERING STATION



NOTES:
1. SECONDARY CONDUIT NUMBER AND SIZE SHALL BE INSTALLED AS REQUIRED FOR LOAD.
2. CUSTOMER PROVIDES WIRE FROM TRANSFORMER TO METERING STATION.
3. CUSTOMER SHALL MAKE SECONDARY/SERVICE WIRE CONNECTIONS IN METERING STATION.
4. MURRAY CITY POWER WILL PERFORM CT METER WIRING.
5. TRANSFORMER PAD AND METERING STATION SITE SHALL BE LEVEL, BACKFILLED AND COMPACTED TO 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASHTO T-99.

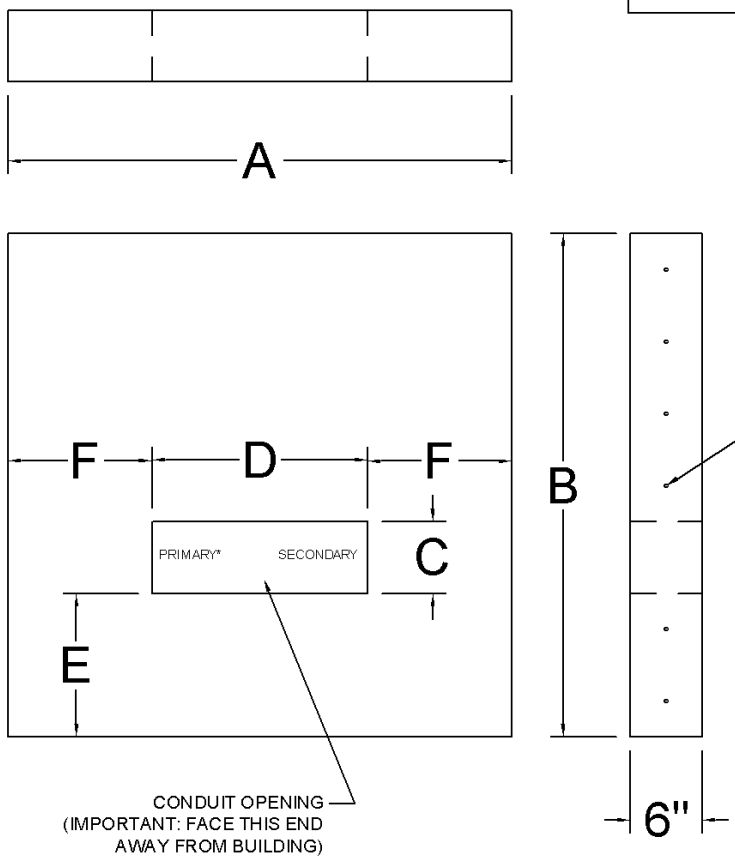
REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

TYPICAL TRANSFORMER PAD W/ METER STATION

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	10/14/2021	A.12	0

TRANSFORMER PAD DIMENSIONS IN INCHES						
KVA	A	B	C	D	E	F
SINGLE PHASE						
25	42	51	12	24	6	9
30	42	51	12	24	6	9
75	42	51	12	24	6	9
100	42	51	12	24	6	9
167	52	64	12	24	6	9
THREE PHASE						
75	81	68	11	41	18	20
112	81	80	11	41	18	20
150	81	80	11	41	18	20
225	81	82	15	41	18	20
300	81	82	15	41	18	20



* ONE 4", 36" LONG SWEEP SCHEDULE 40 ELBOW IS REQUIRED TO BE INSTALLED ON PRIMARY SIDE OF OPENING AND STUBBED 2 FEET BEYOND TRANSFORMER PAD, 42" MINIMUM DEPTH. CONTACT MURRAY CITY POWER PLANNING DEPT. FOR ELBOW DIRECTION.

REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

TYPICAL TRANSFORMER PAD

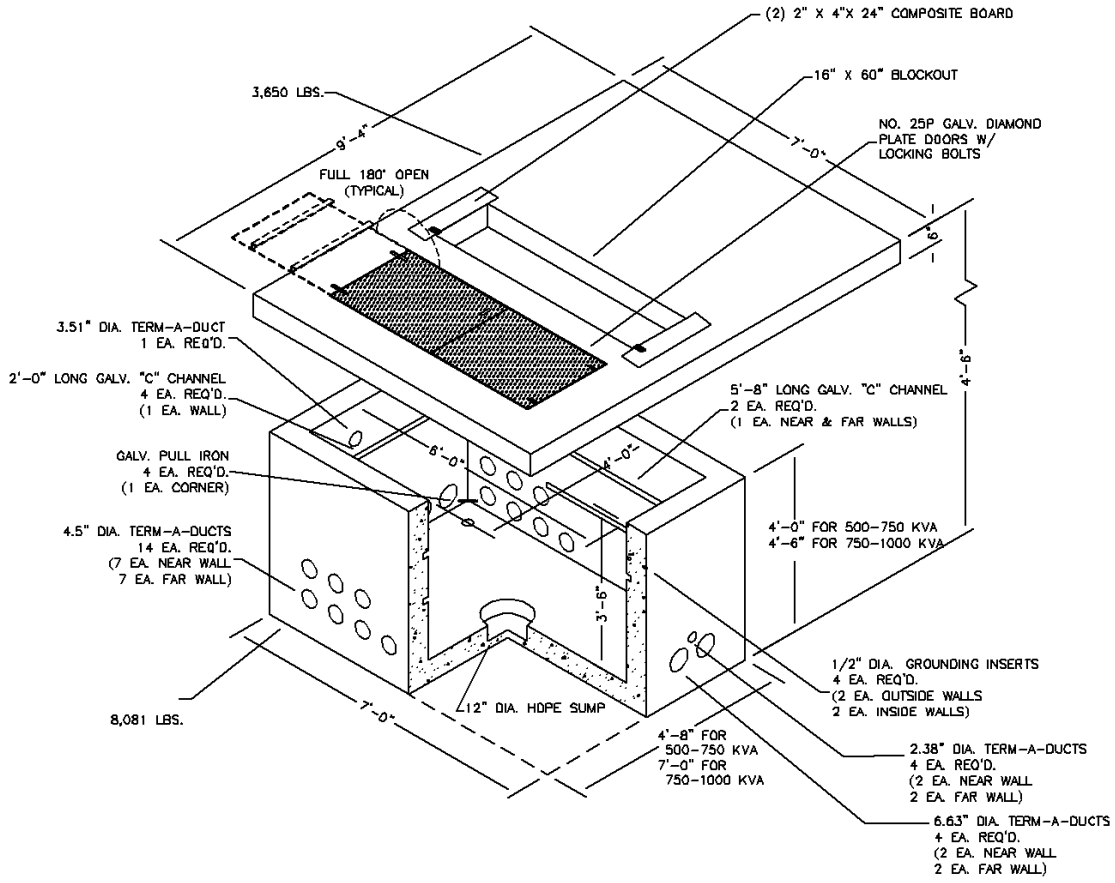
SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	10/14/2021	A.13	0

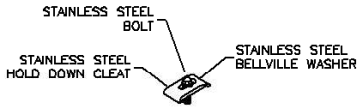
Padvault for Three Phase Transformer

2.4 – 25kV, 3–PHASE TRANSFORMER PADVAULT WITH ACCESS

84" X 56" FOR 500–750 KVA TRANSFORMERS

84" X 84" FOR 1000–2500 KVA TRANSFORMERS





HOLD DOWN CLEAT
DETAIL 1

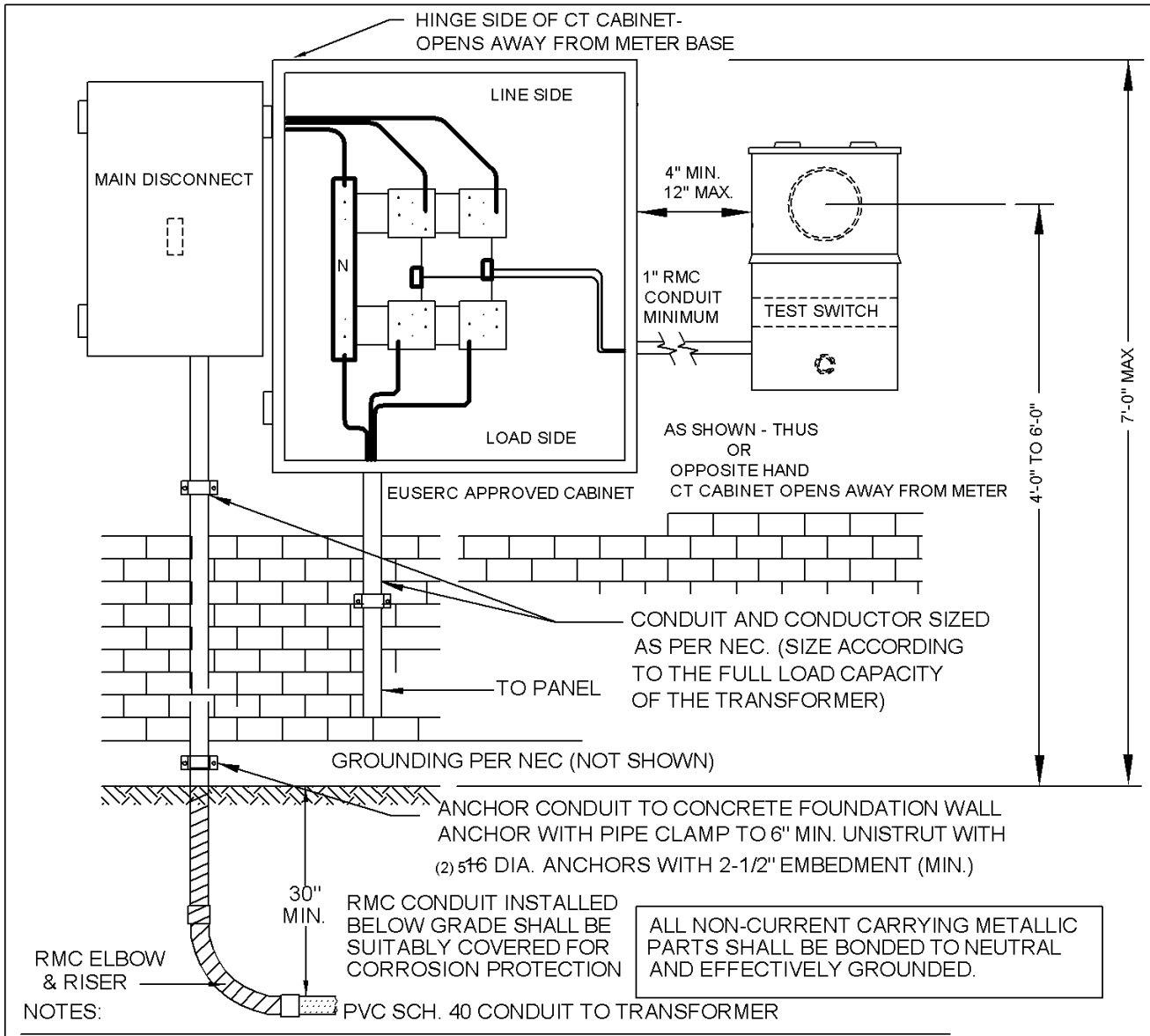
1 1/4" X 2 1/2" STAINLESS STEEL HOLD-DOWN CLEAT – 2 REQ'D.
3/8" X 1 1/4" STAINLESS STEEL BOLT – 2 REQ'D.
3/8" STAINLESS STEEL BELLVILLE WASHER – 2 REQ'D.

REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

THREE PHASE TRANSFORMER PADVAULT

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	10/15/2021	A.14	0



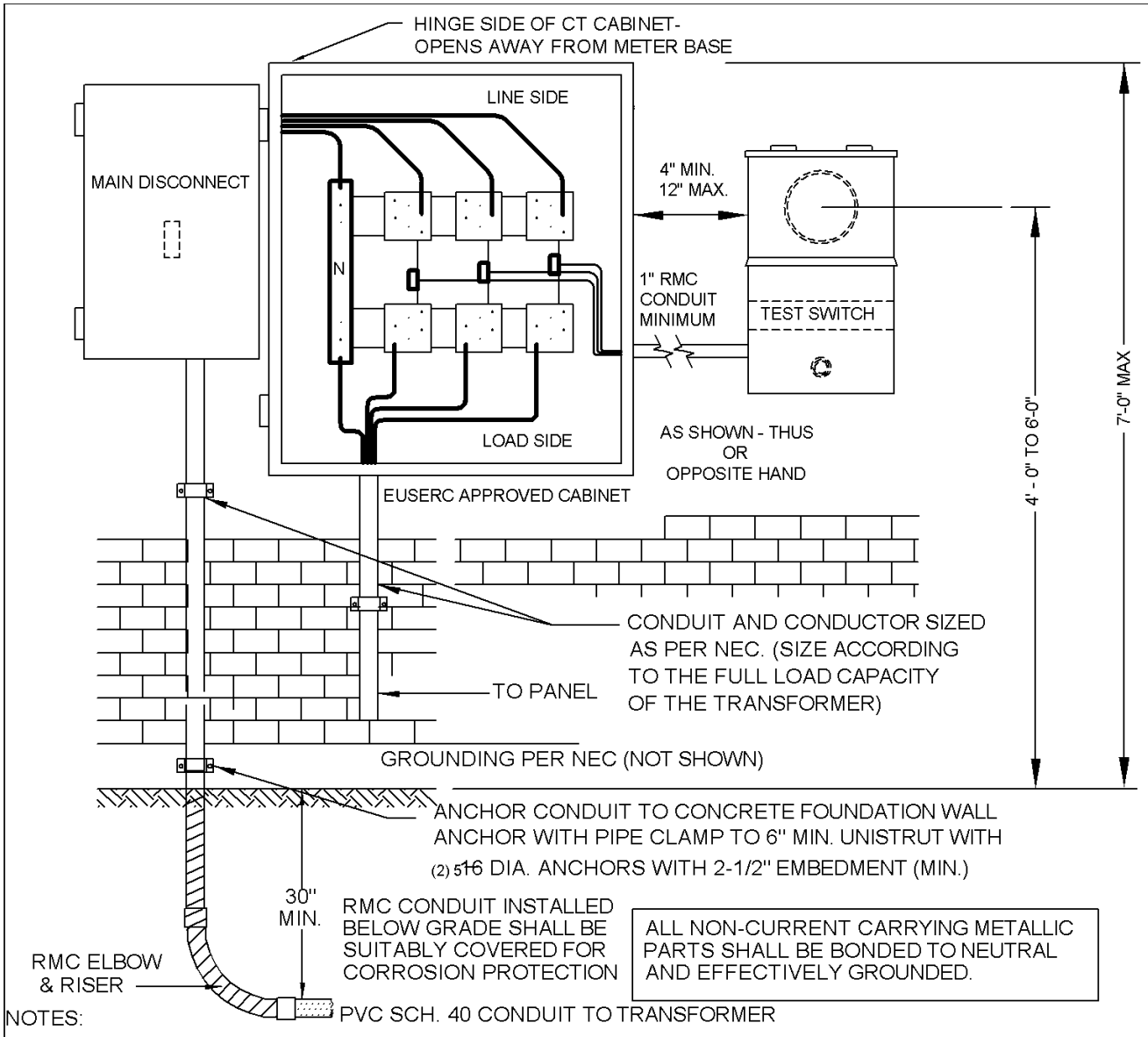
1. EUSERC APPROVED CT CABINET & METER BASE SHALL BE SEALABLE & LOCKABLE BY MURRAY CITY POWER.
2. MAIN SERVICE DISCONNECT IS REQUIRED OUTSIDE AT THE METER LOCATION
3. INSTALLATION LOCATION SHALL BE APPROVED BY MURRAY CITY POWER.
4. CONDUIT CLAMPS MUST BE ABOVE GROUND.
5. CT CABINET DOOR SHALL OPEN AWAY FROM METER BASE.
6. CONTRACTOR SHALL SUPPLY SECONDARY CONDUCTORS.
7. INSPECTION REQUIRED PRIOR TO BACK FILL OF TRENCH.
8. INSPECTION REQUIRED PRIOR TO PERMANENT POWER CONNECTION.
9. OWNER/BUILDER SHALL SUPPLY AND INSTALL PER NEC REQUIREMENTS AND MAINTAIN CONDUIT AND CONDUCTORS FROM THE CT ENCLOSURE TO THE POWER SOURCE SUPPLIED BY MURRAY CITY POWER.

REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

SINGLE PHASE CT CABINET INSTALLATION

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	8/8/2022	A.15	0



1. EUSERC APPROVED CT CABINET & METER BASE SHALL BE SEALABLE & LOCKABLE BY MURRAY CITY POWER.
2. MAIN SERVICE DISCONNECT IS REQUIRED OUTSIDE AT THE METER LOCATION
3. CT CABINET SHALL OPEN AWAY FROM METER BASE.
4. INSTALLATION LOCATION SHALL BE APPROVED BY MURRAY CITY POWER.
5. CONDUIT CLAMPS MUST BE ABOVE GROUND.
6. CONTRACTOR SHALL SUPPLY SECONDARY CONDUCTORS.
7. INSPECTION REQUIRED PRIOR TO BACK FILL OF TRENCH.
8. INSPECTION REQUIRED PRIOR TO PERMANENT POWER CONNECTION.
9. OWNER/BUILDER SHALL SUPPLY AND INSTALL PER NEC REQUIREMENTS AND MAINTAIN CONDUIT AND CONDUCTORS FROM THE CT ENCLOSURE TO THE POWER SOURCE SUPPLIED BY MURRAY CITY POWER.

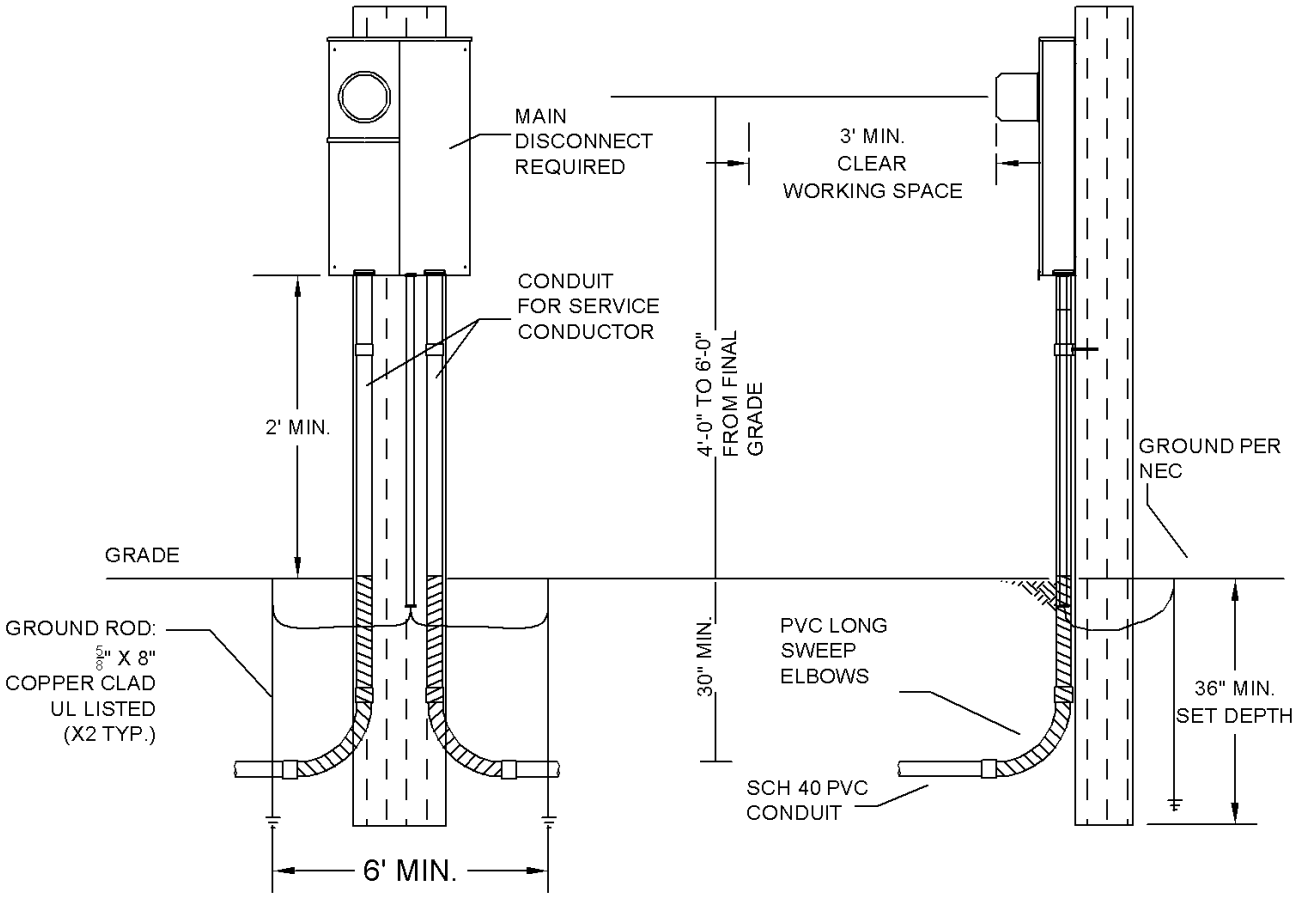
REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

THREE PHASE CT CABINET INSTALLATION

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	8/8/2022	A.16	0

UNDERGROUND TEMPORARY CONSTRUCTION METER SERVICE POST INSTALLATION



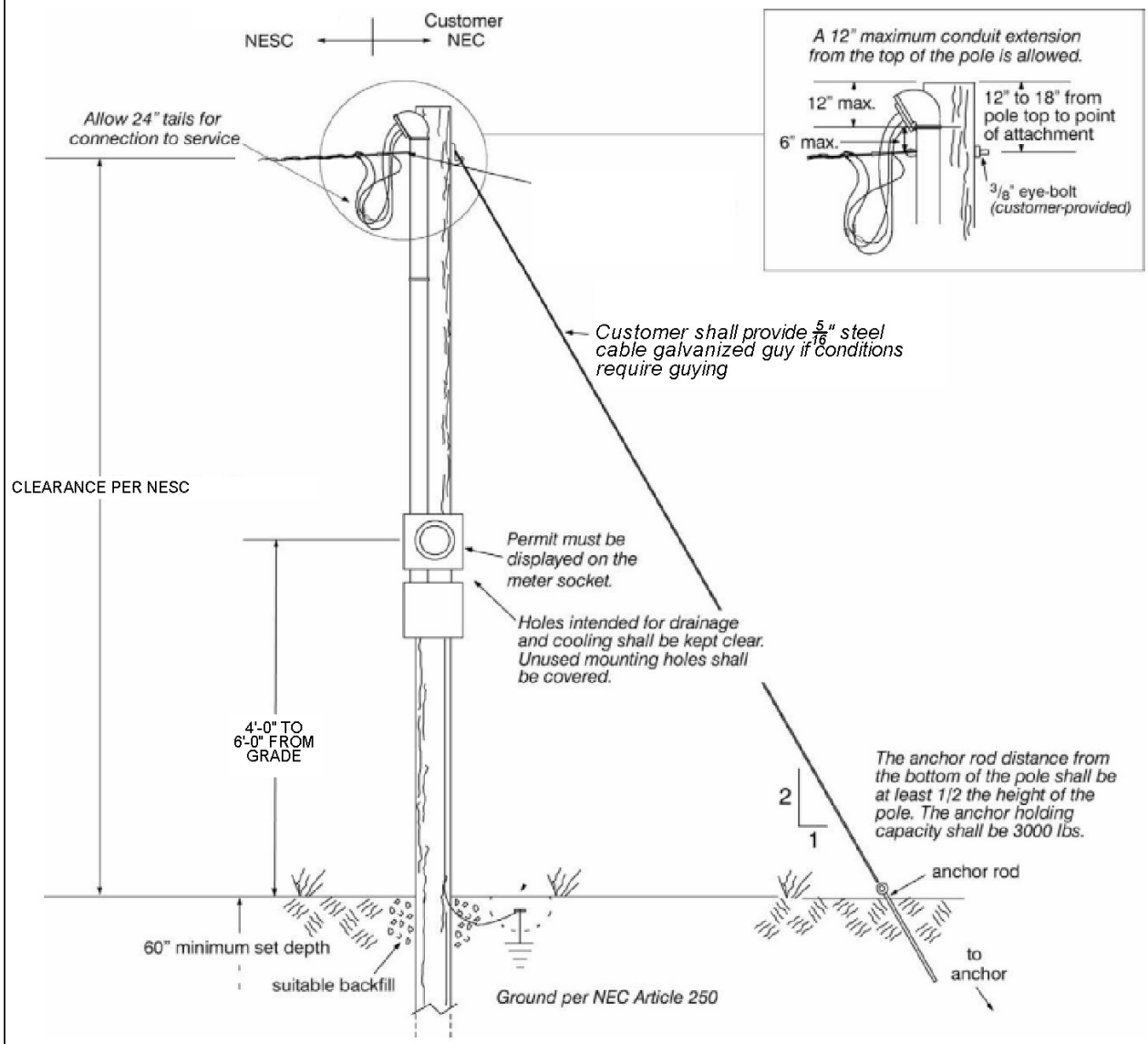
REQUIREMENTS:
1. PERMIT SHALL BE DISPLAYED ON THE METER BASE.
2. A MAIN BREAKER IS REQUIRED.
3. THE INSTALLATION SHALL BE MADE AND INSTALLED SUCH THAT IT REMAINS PLUMB AND SOUND FOR THE DURATION OF THE TEMPORARY SERVICE.
4. THE POST IS CUSTOMER-OWNEDAND SHALL BE WOOD WITH A MINIMUM NOMINAL SIZE OF 4" X 4".
5. CUSTOMER OWNS CONDUIT, CONDUCTOR, AND METER BASE.
6. CONDUIT MUST BE RIGIDLY FASTENED TO POST.
7. THE CUSTOMER SHALL PERFORM ALL TRENCHING.
8. THE CUSTOMER-SUPPLIED CONDUCTOR MINIMUM SIZE SHALL BE #8 COPPER OR #6 ALUMINUM, AND LONG ENOUGH TO CONNECT SOURCE TO METER.
9. CLEARANCES SHALL BE MAINTAINED AS REQUIRED BY MURRAY CITY POWER.
10. LOCATE TEMPORARY SERVICE ADJACENT TO POWER SOURCE AND WHERE IT IS PROTECTED FROM ACCIDENTAL DAMAGE.

REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

UNDERGROUND TEMP. CONSTRUCTION SERVICE

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	10/22/2021	A.17	0



REV	REVISION RECORD	ENG BY:	APPD BY:	DATE

MURRAY CITY POWER
ELECTRICAL SERVICE REQUIREMENTS

OVERHEAD TEMP. CONSTRUCTION SERVICE

SCALE:	INITIAL ISSUE DATE:	SHEET	REV
NOT TO SCALE	10/14/2021	A.18	0

SECTION 26 0507

ELECTRICAL CONNECTIONS FOR EQUIPMENT

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 work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-23 section making reference to electrical connections.

1.2 DESCRIPTION OF WORK:

A. Extent of electrical connection for equipment includes final electrical connection of all equipment having electrical requirements. Make final connections for all owner furnished equipment. See other applicable portions of specification for building temperature control wiring requirements.

B. Refer to Division-23 sections for motor starters and controls furnished integrally with equipment; not work of this section.

C. Refer to Division-23 section for control system wiring; not work of this section.

D. Refer to Division-23 section for Snow/ice melting, Gutter and downspout snow/ice melting system wiring; not work of this section.

E. Refer to sections of other Divisions for specific individual equipment power requirements.

1.3 QUALITY ASSURANCE:

A. NEC COMPLIANCE: Comply with applicable portions of NEC as to type products used and installation of electrical power connections.

B. UL LABELS: Provide electrical connection products and materials that have been UL-listed and labeled.

PART 2 - PRODUCTS

2.1 GENERAL:

A. For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, raceways, conductors, cords, cord caps, wiring devices, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories as needed to complete splices, terminations, and connections as required. Crimp on or slip-on type splicing materials (insulation displacement type) designed to be used without wire stripping are not acceptable. See Section 26 0532, Conduit Raceways; Section 26 2726 Wiring Devices: and Section 26 0519 Conductors and Cables for additional requirements. Provide final connections for equipment consistent with the following:

1. Permanently installed fixed equipment - flexible seal-tite conduit from branch circuit terminal equipment, or raceway; to equipment, control cabinet, terminal junction box or wiring terminals. Totally enclose all wiring in raceway.

2. Movable and/or portable equipment - wiring device, cord cap, and multi-conductor cord suitable for the equipment and in accordance with NEC requirements (Article 400).

3. Other methods as required by the National Electrical Code and/or as required by special equipment or field conditions.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL CONNECTIONS:

A. Make electrical connections in accordance with connector manufacturer's written instructions and with recognized industry practices, and complying with requirements of NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams.

C. Coordinate installation of electrical connections for equipment with equipment installation work.

D. Verify all electrical loads (voltage, phase, horse power, full load amperes, number and point of connections, minimum circuit ampacity, etc.) for equipment furnished under other Divisions of this specification, by reviewing respective shop drawings furnished under each division. Meet with each subcontractor furnishing equipment requiring electrical service and review equipment electrical characteristics. Report any variances from electrical characteristics noted on the electrical drawings to Architect before proceeding with rough-work. In summary, it is not in the Electrical Engineers scope to review the shop drawings from other trades/divisions.

E. Obtain and review the equipment shop drawings to determine particular final connection requirements before rough-in begins for each equipment item.

F. Refer to basic materials and methods Section 26 0553 Electrical Identification, Conductors, for identification of electrical power supply conductor terminations.

END OF SECTION 26 0507

SECTION 26 0510

ELEVATOR ELECTRICAL REQUIREMENTS

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 work of this section.

B. Architectural, Structural, Vertical Transportation, Mechanical and other applicable documents are considered a part of the electrical documents insofar as they apply as if referred to in full. Contractor must review the entire set of plans and specifications. Reviewing only the electrical set is not acceptable.

C. Elevator Shop Drawings.

1.2 DESCRIPTION OF WORK:

A. The extent of electrical work is indicated on drawings and/or specified in Divisions 26, 27 and 28 sections of the specification. Provide all labor, materials, equipment, supervision and service necessary for a complete/operating/code compliant electrical system.

B. Carefully review elevator shop drawings prior to ordering elevator disconnects. Confirm physical dimensions of disconnect fit within enclosure (if provided) from elevator manufacturer. Review elevator shop drawings prior to ordering disconnect. Notify engineer in writing immediately, should any discrepancy occur. Confirm voltage and phase of equipment and compare with electrical drawings.

C. Coordinate the installation with the elevator manufacturer, including the sequencing of the electrical installation.

D. Anticipated 40-HP 277/480V/3P/60hz Electrical Specifications.

1. Machine Roomless Elevator
2. No generator backup power connection. Manufacturer to provide Battery lower system as required.
3. Coordinate the exact location of disconnect and extend power accordingly.
4. Provide required data lines to new elevator as required.

1.3 QUALITY ASSURANCE:

A. Coordination: All electrical equipment placement and installation shall be coordinated with the elevator contractor and shall not be located until elevator equipment is installed or coordination has been arranged with elevator contractor’s equipment placement.

B. Regardless of whether shown on drawings:

1. All electrical equipment, located less than 1225 mm (48 in.) above the pit floor, shall be weatherproof (NEMA 4X) and have wiring identified for use in wet locations in accordance with the requirements in NFPA 70.
2. Receptacles:
   a. Provide one 120V/20A dedicated GFCI receptacle in <u>each</u> elevator machine rooms, machinery spaces and elevator pit areas. Provide an additional 120V/20A dedicated receptacle in the pit for a sump pump. Any receptacle installed in pits, machinery spaces, or elevator car tops shall be GFCI. Exception: Sump pump shall not require GFCI protection.
   b. Provide one GFCI receptacle located at the top of the hoistway and

machine room.

3. Clearances around all electrical equipment in the elevator machine room shall comply with NEC 110-26 electrical clearances requirements. The electrical contractor's work and equipment placement shall be coordinated with the elevator contractor's equipment placement.

4. All electrical piping runs provided by the electrical contractor and elevator contractor to the elevator equipment shall be run overhead or in a manner which does not restrict access to and around any equipment.

5. Lighting:

   a. Elevator Pits:

      i. Provide light fixture and light switch at the pit.

      ii. The location shall be determined after coordination with the elevator contractor so that the light fixture is located out of the way of all elevator equipment.

      iii. Sub-Pit Light fixture and Light Switches (when present): If there is more than one level of an elevator pit, a three-way switch shall be provided in both the pit areas to operate a light fixture located in both locations. A light fixture shall be installed in each pit level. Both light fixtures shall be wired so that they both operate at the same time by light switches at both pit levels.

      iv. The switch shall be a minimum of 18 inches above the elevator lowest landing doorsill and adjacent to (not behind) the pit access ladder.

      v. The elevator pit shall have a separate branch circuit supplying pit lighting and receptacle(s) and another for the pit sump pump.

   b. Elevator Machine Rooms:

      i. Light switches shall be required in all elevator machine rooms adjacent to the jamb side of the machine room entry door.

      ii. A separate branch circuit shall supply the elevator machine room space lighting and receptacles.

      iii. Provide 200 Lux (19FC) light level measured at the floor level.

   c. Elevator Cars:

      i. Provide a separate branch circuit to supply the car lights, receptacle(s), auxiliary lighting power source, and ventilation on each elevator car. It shall be lockable and shall be supplied in all elevator machine rooms. One disconnect required for each elevator. A label stating the location of the supply side overcurrent protection device is required on the disconnect.

   d. Hoistway:

      i. Provide light fixture every 1.5 stories within the hoistway and at the top of the hoistway if elevator disconnect is mounted on the elevator cab.

6. Fire Alarm:

a. Provide a smoke detector and heat detector within each elevator hoistway.

b. Provide a smoke detector and heat detector in machine room.

c. Provide a heat detector within the space that houses the elevator controller. Heat detector to activate shunt trip and be located within 24" of the sprinkler head.

d. For each group of elevators, provide a normally closed contact representing the smoke detector at the designated return landing.

e. For each group of elevators, provide a normally closed contact representing all smoke detectors located in lobbies, hoistways, or machine rooms / machine space, but not the smoke detector at the designated return landing or the smoke detectors as described in i. and ii. below:

   i. If a smoke detector is located in the hoistway at or below the lower of the two recall landings, it shall be wired to activate the same normally closed contact as the smoke detector located in the lobby at the lower of the two recall landings.

   ii. If machine rooms / machine space is located at the designated return landing, the smoke detectors located therein shall be wired to activate the same normally closed contact as the smoke detector at the designated landing.

f. Requirements for intermittently illuminating the fire hat visual signal in the car operating panel, either i. or ii. apply.

   i. For a single unit or for a group of elevators having one common machine room / machine space and one common hoistway, provide one additional normally closed contact representing the machine room / machine space and hoistway smoke detectors.

   ii. If the group contains more than one hoistway and hoistway smoke detectors are installed, or if the group has more than one machine room / machine space, provide one normally closed contact for each elevator. The contact is to represent the smoke detector in the machine room / machine space for that particular elevator, and any smoke detectors in the hoistway containing that particular elevator.

g. If sprinklers are installed in the hoistway or machine room / machine space(s), a means to automatically disconnect the mainline power supply to the affected elevator and any other power supplies used to move the elevator, upon or prior to the application of water is required and shall be provided (unless prohibited by local code). Smoke detectors shall not be used to activate sprinklers in hoistways or machine rooms / machine spaces or to disconnect the mainline power supply.

h. Heat sensors used to automatically disconnect the mainline power supply prior to the application of water from sprinklers shall be provided with a normally closed contact with wiring from the sensing device to a controller designated by Elevator Manufacturer / Elevator Equipment Installer. The normally closed contact shall be closed when the heat

sensor is not activated and shall be open when the heat sensor is activated.

7. Sump Pumps:

   a. Provide (1) 120V receptacle on a dedicated 20A circuit in each elevator pit for the elevator sump pump.

8. Elevator Main Disconnect:

   a. Provide in all elevator machine rooms in sight of elevator motor and controller and adjacent to machine room entry door, one disconnect required for each elevator. Provide a label on the disconnect stating location of overcurrent protection device.

   b. Hydraulic Elevator Only: Main Line Disconnect Auxiliary Contact for Emergency Battery Lowering Operation: This item is provided by the electrical contractor within the main line disconnect: If an emergency lowering system is utilized on a hydraulic elevator, there shall be an auxiliary contact associated with the main line disconnect.

   c. Shunt Trip Required When Sprinklers are Present: Electrical contractor shall provide a shunt trip for the elevator main line power in order to remove power from elevator controls before any sprinkler is activated in the elevator machine room and hoistway overhead. The shunt trip shall be installed in the elevator machine room.

9. Emergency Power Requirements:

   a. Provide the emergency (standby) power unit and means for starting it, and deliver to the elevator via disconnect switches in the machine room / machine space, sufficient power to operate one or more elevators at a time at full rated speed and rated load.

   b. Provide an Automatic Power Transfer Switch for each power feeder to monitor both Normal and Emergency (Standby) Power conditions and to perform the transfer from one to the other. Switch shall have two sets of normally closed dry contacts, one to be open when the switch is in the Emergency (Standby) Power position, the other to open upon initiation of power transfer and to close when transfer is complete. Switch shall have an inhibit function which will delay transfer to Normal and / or Emergency (Standby) Power by an adjustable period of 0 -300 seconds. Switch shall have a Phase Monitor feature, which prohibits the transfer of power between "live" sources unless the sources are in phase with each other. If a Shunt Trip device is provided, an additional Normally Closed contact is required from the Emergency (Standby) Power source.

10. Emergency Phone and Data Line: Provide (2) ¾" conduits from the communications utility to each elevator machine room / elevator controller. Electrical contractor shall provide electrical conduit for both the emergency elevator phone and required data line to the elevator machine room, to the elevator controller, and terminated on the elevator controller with coordination from the elevator contractor.

11. Provide copper elevator feeder conductors and grounding conductors.

1.4 SUBMITTALS

A. Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 ELEVATOR DISCONNECTS:

A. GENERAL:

1. Provide Power Module Switch in a single NEMA enclosure with all necessary relay(s), control transformer and other options (as listed below), and as shown on drawings. The Power Module Switch shall have an ampere rating as required in the elevator shop drawings, and shall include a horsepower rated fusible switch with shunt trip capabilities.

2. The amp rating of the switch shall be based upon elevator manufacturer requirements and utilize Class J Fuses. It shall include a 100VA control power transformer with primary and secondary fuses. Unit shall also contain an isolation relay (3PDT, 10 amp, 120V). A normally open dry contact shall be provided by the Fire Alarm Safety System to energize the isolation relay and activate the shunt trip solenoid.

3. Provide the following additional features:

   a. Key to Test Switch

   b. “ON” Green Pilot Light

   c. If elevator is hydraulic, provide 1P NC Mechanically Interlocked Auxiliary Contact.

   d. Fire Alarm Voltage Monitoring Relay (Needed to comply with NFPA 72)

   e. NEMA enclosure appropriate for the environment installed.

   f. All switches shall have shunt trip capabilities at 120Vac from remote fire safety signal.

B. ACCEPTABLE MANUFACTURER:

1. Manufacturer: Subject to compliance with requirements. Provide elevator-disconnect of one of the following:

   a. Bussman Quick-Spec Power Module Switch Elevator Disconnect.

   b. Littlefuse LPS Series Elevator Disconnect.

PART 3 - EXECUTION

A. Install disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate motor and circuit disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.

C. Install disconnect switches used with motor driven appliances, and motors and controllers within sight of controller position.

D. Grounding: Grounding shall be supplied from the elevator main line disconnect and controller to the upstream panel and building ground. Ground wire shall be the same size as phase wires to minimize electrical noise interference.

E. Non-elevator related piping and equipment is prohibited in the machine room or hoistway.

END OF SECTION 26 0510

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SECTION 26 0519

CONDUCTORS AND CABLES (600V AND BELOW)

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 work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to conductors and cables specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of electrical conductor and electrical cable work is indicated by drawings and schedules.

B. Types of conductors and cables in this section include the following:

1. Copper Conductors (600V)
2. Aluminum Conductor (600V)
3. 0-10V Class 1 Circuits

C. Applications for conductors and cables required for project include:

1. Power Distribution
2. Feeders
3. Branch Circuits
4. 0-10V Class 1 Circuits

1.3 RECORDS SUBMITTAL:

A. Submit record in triplicate of megohmmeter readings to Architect/Engineer. Please see paragraphs 3.2A AFTER INSTALLATION TEST FOR CABLE 600 VOLTS AND BELOW for testing requirements.

1.4 QUALITY ASSURANCE:

A. Comply with NEC as applicable to construction and installation of electrical conductors and cable. Comply with UL standards and provide electrical conductors and cables that have been UL-listed and labeled.

B. Comply with applicable portions of NEMA/Insulated Cable Engineers Association standards pertaining to materials, construction and testing of conductors and cable.

C. Comply with applicable portions of ANSI/ASTM and IEEE standards pertaining to construction of conductors and cable.

1.5 SUBMITTALS:

A. Refer to Section 26 0502 for electrical submittal requirements.

PART 2 - PRODUCTS

2.1 COPPER AND ALUMINUM CONDUCTORS (600V):

A. Provide factory-fabricated conductors of sizes, ratings, materials, and types indicated for each service. Where not indicated provide proper selection to comply with project's installation requirements and NEC standards. Provide conductors in accordance with the

following:

1. Service Entrance Conductors – Copper/Aluminum conductor; see drawings for insulation type.
2. Distribution and Panelboard Feeders; and Other Conductors, #2 AWG and Larger – Copper/Aluminum conductor; see drawings for insulation type.
3. Branch Circuit Conductors and All Conductors #3 AWG and Smaller - Copper conductor, with THHN/THWN insulation. Size all conductors in accordance with NEC; minimum size to be #12 AWG.
4. Aluminum Conductors. Where aluminum conductors are specified for use, provide compact stranded Aluminum Association 8000- series alloy conductor material.
    a. Stabiloy - Alcan Cable
    b. Triple E - Southwire

B. Provide connectors and terminations for aluminum-alloy conductors of hydraulic compression type only, listed under UL 486-B, and marked "AL 7CU" for 75o rated circuits, and "AL9CU" for 90o rated circuits.

C. Provide a maximum of three phase conductors in any one conduit or as approved by electrical engineer. Where phase conductors share a common neutral they must have a means to simultaneously disconnect all ungrounded conductors at the point where the branch circuits originate. The ungrounded and neutral conductors of a multi-wire branch circuit must be grouped together by wire ties at the point of origination.

D. Provide neutral and ground wire as specified elsewhere in documents.

E. Provide separate neutral conductor for all single phase branch circuits installed. No shared neutrals are allowed. Neutral conductor shall be the same size as the phase conductor.

2.2 COPPER LOW VOLTAGE CONDUCTORS (0-10V CIRCUITS):

A. 0-10V Class 1 Circuits:

1. General:
    a. Provide Class 1 circuits for all 0-10V dimming installations. Class 1 circuits shall be permitted to be installed with other circuits as specified in NEC 725.48 (A) and (B):
        i. Class 1 circuits shall be permitted to occupy the same cable, cable tray, enclosure, or raceway without regard to whether the individual circuits are alternating or direct current, provided all conductors are insulated for the maximum voltage of any conductors in the cable, cable tray, enclosure or raceway.
        ii. Class 1 circuits shall be permitted to be installed with power supply conductors as specified:
            1. Class 1 and power supply circuits shall be permitted to occupy the same cable, enclosure, or raceway only when functionally associated.
        iii. Utilize VIOLET and PINK copper conductors, with THHN/THWN insulation.

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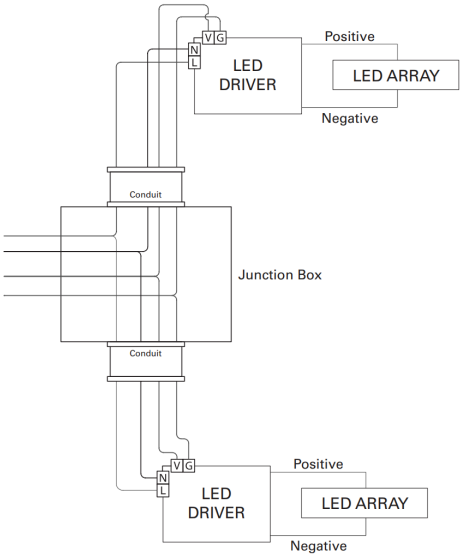

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install electric conductors and cables as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation", and in accordance with recognized industry practices.

B. Coordinate installation work with electrical raceway and equipment installation work, as necessary for proper interface.

C. Cables may be pulled by direct attachment to conductors or by use of basket weave pulling grip applied over cables. Attachment to pulling device shall be made through approved swivel connection. Nonmetallic jacketed cables of small size may be pulled directly by conductors by forming them into a loop that pull wires can be attached; remove insulation from conductors before forming the loop. Larger sizes of cable may be pulled by using basket weave pulling grip, provided the pulling force does not exceed limits recommended by manufacturer; if pulling more than one cable, bind them together with friction tape before applying the grip. For long pulls requiring heavy pulling force, use pulling eyes attached to conductors.

D. Do not exceed manufacturer's recommendations for maximum allowable pulling tension, side wall pressure, and minimum allowable bending radius. In all cases, pulling tension applied to the conductors shall be limited to 0.008 lbs. per circular mil of conductor cross-section area.

E. Pull in cable from the end having the sharpest bend; i.e. bend shall be closest to reel. Keep pulling tension to minimum by liberal use of lubricant, and turning of reel, and slack feeding of cable into duct entrance. Employ not less than one man at reel and one in pullhole during this operation.

F. For training of cables, minimum bend radius to inner surface of cable shall be 12 times cable diameter.

G. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50% greater than specified above for training.

H. Use only wire and cable pulling compound recommended by the specific cable manufacturer, and that is listed by UL.

I. Seal all cable ends unless splicing is to be done immediately. Conduit bodies shall not contain splices.

J. Support all cables in pullholes, concrete trenches, and similar locations by cable racks

and secure to rack insulators with nylon cord or self-locking nylon cable ties. Place each cable on separate insulator. In manholes, pullholes, concrete trenches, and similar locations, wrap strips of fire-proofing tape (approx. 1/16 inch thick by 3 inches wide) tightly around each cable spirally in half-lapped wrapping or in two butt-joined wrappings with the second wrapping covering the joints in the first. Apply tape with the coated side toward the cable, and extend tape one inch into the ducts. To prevent unraveling, random wrap the fireproofing tape the entire length of the fireproofing with pressure sensitive glass cloth tape. Provide fireproofing tape of a flexible, conformable fabric having one side coated with flame retardant, flexible, polymeric coating and/or a chlorinated elastomer not less than 0.050 inch thick weighing not less than 2.5 pounds per square yard. Provide tape that is noncorrosive to cable sheath, self-extinguishing, and that will not support combustion. Construct tape of materials that do not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

K. Follow manufacturer's instructions for splicing and cable terminations.

L. Fire Protected Feeders/Circuit:

1. Provide protected circuits for emergency feeders for the following occupancies:
    a. Educational occupancies with more than 300 occupants.
2. Feeders shall be protected by one of the following. Electrical contractor shall be responsible for meeting one of the following methods:
    a. Feeder is protected by a listed assembly with a minimum 2 hour fire rating.
    b. Feeder is listed a fire-resistive cable assembly.
    c. Feeder is encased in a minimum of 2” concrete.

3.2 AFTER INSTALLATION TEST FOR CABLE 600 VOLTS AND BELOW:

A. Prior to energization, test cable and wire for continuity of circuitry, and for short circuits, Megger all circuits of 100 amp and greater rating. Correct malfunctions. Record all test data and provide written test report.

B. Subsequent to wire and cable connections, energize circuitry and demonstrate functioning in accordance with requirements.

3.3 IDENTIFICATION OF FEEDERS: Refer to Section 26 0553 for requirements.

END OF SECTION 26 0519

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SECTION 26 0526

GROUNDING

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 work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Provide grounding as specified herein, and as indicated on drawings. Provide a new grounding system as required to accommodate new service entrance and demolition of old incoming electrical service equipment.

B. Provide grounding and bonding of all electrical and communication apparatus, machinery, appliances, building components, and items required by the NEC to provide a permanent, continuous, low impedance, grounding system.

C. Unless otherwise indicated, ground the complete electrical installation including the system neutral, metallic conduits and raceways, boxes, fittings, devices, cabinets, and equipment in accordance with all code requirements.

D. Ground each separately derived system, as described in NEC Section 250-30, unless otherwise indicated.

E. Types of grounding in this section include the following:

1. Underground Metal Water Piping
2. Metal Building Frames
3. Grounding Electrodes
4. Grounding Rods
5. Separately Derived Systems
6. Service Equipment
7. Enclosures
8. Systems
9. Equipment
10. Other items indicated on drawings

F. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to electrical grounding and ground fault protection systems. Comply with applicable ANSI and IEEE requirements. Provide products that have been UL listed and labeled.

B. Resistance from the service entrance ground bus, through the grounding electrode to earth, shall not exceed 5 ohms.

1.4 SUBMITTALS:

A. Submit the name of test agency to be used for testing specified in this section. Submit results of tests specified in this section. Also include test results in Operation and

Maintenance Manuals as specified.

PART 2 – PRODUCTS

2.1 MATERIALS AND COMPONENTS:

A. GENERAL: Except as otherwise indicated, provide each electrical grounding system as specified herein, and as shown on drawings, including but not necessarily limited to, cables/wires, connectors, terminals (solderless lugs), grounding rods/electrodes and plate electrodes, bonding jumper braid, and other items and accessories needed for complete installation. Where materials or components are not otherwise indicated, comply with NEC, NEMA and established industry standards for applications indicated.

B. ELECTRICAL GROUNDING CONDUCTORS: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC. Provide with green insulation.

C. GROUND RODS: Steel with copper welded exterior, 3/4" dia. x 10' long. Weaver or Cadweld.

D. GROUND WELL BOXES FOR GROUND RODS: Precast concrete box 9-1/2" W. x 16" L. X 18" D. with light duty concrete cover for non-traffic areas or rated steel plate for traffic areas. Provide covers with lifting holes. Engrave cover with "GROUND ROD".

E. CONCRETE ENCASED GROUNDING ELECTRODE (UFER GROUND): #2/0 AWG bare copper conductor.

F. INSULATED GROUNDING BUSHINGS: Plated malleable iron body with 150 degree Centigrade molded plastic insulating throat, lay-in grounding lug with hardened stainless steel fasteners, OZ-Gedney BLG, or Thomas & Betts #TIGB series.

G. CONNECTIONS TO PIPE: For cable to pipe, OZ-Gedney G-100B series or Thomas & Betts #390X series, or Burndy type GAR.

H. CONNECTIONS TO STRUCTURAL STEEL, GROUND RODS, OR SPLICES: For splicing and/or connecting conductors, use exothermic welds or high pressure compression type connectors. Provide exothermic weld kits manufactured by Cadweld or Thermoweld. If high compression type connectors are used for cable-to-cable, or cable-to-steel, or cable-to-ground rod connections, provide Thomas & Betts #53000 series, or Burndy Hyground series.

I. BONDING JUMPERS: OZ-Gedney Type BJ, or Thomas & Betts #3840 series, or Burndy type GG and type B braid.

J. INTERSYSTEM BONDING TERMINAL: Provide one 12” L. x 2” H x ¼” thick copper bus bar. Mount on wall adjacent to Main Electrical Service Equipment on insulating standoffs, 18” A.F.F. Furnish complete with lugs for connecting systems grounding cables. All holes shall be drilled for 2 hole compression lugs. Provide 6 spare lugs. Connect to equipment grounding bus in Main Electrical Service Equipment with No. 4 AWG copper conductor.

PART 3 - EXECUTION

3.1 INSTALLATION OF GROUNDING SYSTEMS:

A. Install electrical grounding systems in accordance with manufacturer's written instructions and with recognized industry practices to ensure grounding devices comply with requirements.

B. Install clamp-on connectors only on thoroughly cleaned and metal contact surfaces, to ensure electrical conductivity and circuit integrity.

C. Provide grounding for the entire raceway, enclosure, equipment and device system in accordance with NEC. All non-metallic raceways shall include copper grounding conductor sized in accordance with NEC. Include copper grounding conductor in all

raceway installed in suspended slabs.

D. Provide service entrance grounding by means of ground rods (quantity of two, driven exterior to building), by means of bonding to water main, and by means of bonding to building structural steel. In addition, provide a grounding electrode for not less than 30 lineal feet in concrete footing or foundation that is in direct contract with earth. Size electrode in accordance with NEC, but in no case, smaller than No. 4 AWG bare copper. Support electrode so as to be below finished grade near the bottom of the trench, and approximately three inches from the bottom or sides of the concrete. Locate a point of connection for inspection.

E. Provide grounding conductors for dimming systems in accordance with manufacturer's requirement.

3.2 GROUNDING ELECTRODES:

A. Concrete Encased Grounding Electrode (UFER Ground): Provide a #2/0 AWG minimum bare copper conductor encased along the bottom of concrete foundation or footings that are in direct contact with the earth and where there is no impervious water-proofing membrane between the footing and the soil. Extend electrode through a horizontal length of 30 feet minimum and encase with not less than 2 nor more than 5 inches of concrete separating it from surrounding soils. At point of emergence from concrete, run electrode through a protective non-metallic sleeve and extend to the main building [reference] ground bus.

B. [Supplementary Grounding Electrode (Ground Ring, Grid, and Driven Rods): Provide driven ground rod(s) installed in listed ground well box(s) and filled with gravel after connection is made. Interconnect ground rod(s) with structural steel and adjacent rods with minimum #4 AWG bare copper conductor. Locate ground rod a minimum of 10 feet from any electrode of another electrical system or from adjacent ground rod(s)].

C. Separately Derived Electrical System Grounding Electrode: Ground each separately derived system per requirements in NEC Section 250-26 unless indicated otherwise.

D. GROUNDING ELECTRODE CONDUCTOR: Provide grounding electrode conductor sized per NEC table 250-94 or as indicated.

E. POWER SYSTEM GROUNDING: Connect the following items using NEC sized copper grounding conductors to lugs on the Main Building Ground Bus

1. Grounding electrode conductor from concrete encased electrode, and from ground rods.
2. Conductor from main incoming cold water piping system.
3. Conductor from building structural steel.
4. Ground for separately derived systems.

F. Run main grounding conductors exposed or in metallic conduit if protection or concealment is required.

G. EQUIPMENT BONDING/GROUNDING: Provide a NEC sized conductor, whether indicated or not on the drawings, in raceways as follows:

1. Non-metallic conduits and ducts.
2. Distribution feeders.
3. Motor and equipment branch circuits.
4. Device and lighting branch circuits.
5. Provide grounding bushings and bonding jumpers for all conduit terminating in reducing washers, concentric, eccentric or oversized knockouts at panelboards, cabinets and gutters.

H. Provide bonding jumpers across expansion and deflection couplings in conduit runs, across pipe connections at water meters, and across dielectric couplings in metallic cold

water piping system.

I. Provide bonding wire in all flexible conduit.

3.3 TESTING:

A. Obtain and record ground resistance measurements both from service entrance ground bus to the ground electrode and from the ground electrode to earth. Install additional bonding and grounding electrodes as required to comply with resistance limits specified under this Section.

B. Include typewritten records of measured resistance values in the Operation and Maintenance Manual.

C. Use independent testing agency for all testing.

D. Use test equipment expressly designed for the purpose intended. Submit name of testing agency for review and approval, in writing, to the Engineer prior to the performance of any testing.

END OF SECTION 26 0526

SECTION 26 0529

SUPPORTING DEVICES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification section, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is a part of each Division-26, 27 and 28 section making reference to supports, anchors, sleeves, and seals, specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of supports, anchors, and sleeves is indicated by drawings and schedules and/or specified in other Division-26 sections. See Section 260532, Raceways, for additional requirements.

B. Work of this section includes supports, anchors, sleeves and seals required for a complete raceway support system, including but not limited to: clevis hangers, riser clamps, C-clamps, beam clamps, one and two hole conduit straps, offset conduit clamps, expansion anchors, toggle bolts, threaded rods, U-channel strut systems, threaded rods and all associated accessories.

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to construction and installation of electrical supporting devices. Comply with applicable requirements of ANSI/NEMA Std. Pub No. FB 1, "Fittings and Supports for Conduit and Cable Assemblies". Provide electrical components that are UL-listed and labeled.

PART 2 - PRODUCTS

2.1 MANUFACTURED SUPPORTING DEVICES:

A. GENERAL:

1. Provide supporting devices; complying with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation; and as herein specified. See drawings for additional requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF SUPPORTING DEVICES:

A. Install hangers, anchors, sleeves, and seals as required, in accordance with manufacturer's written instructions and with recognized industry practices to ensure supporting devices comply with requirements. Comply with requirements of NECA, NEC and ANSI/NEMA for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structures. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. For pre-and post tensioned construction, use pre-set inserts for support of all electrical work. Do not use toggle bolts,

moly bolts, wood plugs or screws in sheetrock or plaster as support for any equipment or raceway.

D. Independent support wires are not allowed as indicated as per NEC 300.11(B).

E. RACEWAYS:

1. Support raceways that are rigidly attached to structure at intervals not to exceed 8 feet on center, minimum of two straps per 10 foot length of raceway, and within 12" of each junction box, coupling, outlet or fitting. Support raceway at each 90° degree bend. Support raceway (as it is installed) in accordance with the following:

NUMBER OF RUNS	3/4" TO 1-1/4" 0	1-1/2" & LARGER 0
1	Full straps, clamps or hangers.	Hanger
2	Full straps, clamps or hangers.	Mounting Channel
3 or more	Mounting Channel	Mounting Channel

2. Support suspended raceways on trapeze hanger systems; or individually by means of threaded rod and straps, clamps, or hangers suitable for the application. Do not use "tie wire" as a portion of any raceway support system; do not support raceway from ceiling support wires.

F. FLOOR MOUNTED EQUIPMENT:

1. Provide rigid attachment of all floor mounted equipment to the floor slab or structural system. Provide 5/8" bolts or expansion anchors at each 90 degree corner and at intervals not to exceed 48" on center along entire perimeter of the equipment. Provide rigid attachment for all floor mounted switchboards, panelboards, power and control equipment, motor control centers, dimmer cabinets, transformers (provide neoprene vibrations isolators at anchor points), oil switches, battery packs and racks, and similar equipment furnished under Division 26, 27 and 28.

G. WIREWAYS, BUS DUCTS AND CABLE TRAYS:

1. Provide vertical and lateral support systems for all wireways, busway, and cable trays that are supported from overhead structure. See Sections 260536 and 262500 for additional requirements.

END OF SECTION 26 0529

SECTION 26 0532

CONDUIT RACEWAY

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 work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to electrical raceways and specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of raceways is indicated by drawings and schedules.

B. Division-26 is responsible to provide conduit and rough-in for all thermostat controls located within walls. Coordinate with the Controls Contractor and verify exact location of all thermostats. Obtain and review submittals of Temperature Control Equipment from Controls Contractor and Divisions 21-23.

C. Types of raceways in this section include the following:

1. Electrical Metallic Tubing
2. Flexible Metal Conduit
3. Intermediate Metal Conduit
4. Liquid-tight Flexible Metal Conduit
5. Rigid Metal Conduit
6. Rigid Non-metallic Conduit

1.3 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 three (3) years.

B. STANDARDS: Comply with applicable portions of NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components that have been UL-listed and labeled. Comply with NEC requirements as applicable to construction and installation of raceway systems.

1.4 SUBMITTALS:

A. Not Required.

PART 2 – PRODUCTS

2.1 METAL CONDUIT AND TUBING:

A. GENERAL:

1. Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) as indicated; with minimum trade size of 3/4".

B. RIGID METAL CONDUIT (RMC): FS WW-C-0581 and ANSI C80.1.

C. INTERMEDIATE STEEL CONDUIT (IMC): FS WW-C-581.

D. PVC EXTERNALLY COATED RIGID STEEL CONDUIT: ANSI C80.1 and NEMA Std. Pub. No. RN 1.

E. ALUMINUM CONDUIT: Not acceptable.

F. ELECTRICAL NON-METALLIC TUBING (ENT) SYSTEM: Not acceptable.

G. MC CABLE: Only acceptable as indicated below.

1. MC Cable is acceptable for all branch circuits installed in gypsum wallboard walls from the home run device box to the last device box on the branch circuit and all boxes in between, from the home run device box to the branch panel, the circuit shall be installed in an approved raceway. **All MC Cable shall be provided with anti-short fittings.**

2. MC Cable is acceptable for all light fixture whips not longer than six feet in length. Located in removable grid ceilings. MC Cable is unacceptable to be installed from light fixture to light fixture. **All MC Cable shall be provided with anti-short fittings.**

   a. The use of MC-PCS cable is acceptable for light fixture whips utilizing 0-10v control schemes, not longer than 72” in length, located above removable grid ceilings. All MC cable shall be provided with anti-short fittings.

      i. Acceptable Manufacturers

         1. AFC – MC Luminary Cable
         2. Encore – MC-LED Lighting Cable
         3. Southwire – MC-PCS Duo

3. Before any rough-in of MC cable, the contractor shall conduct a on-site meeting with owner and engineer to review standards and overall rough-in requirements. Contractor shall conform to all owner and engineer requirements.

4. Contractor mock-up one classroom for review of electrical installation prior to continuing installation of MC cabling.

H. RIGID AND INTERMEDIATE STEEL CONDUIT FITTINGS:

1. Provide fully threaded malleable steel couplings; raintight and concrete tight where required by application. Provide double locknuts and metal bushings at all conduit terminations. Install OZ Type B bushings on conduits 1-1/4" and larger.

I. ELECTRICAL METALLIC TUBING (EMT): FS WW-C-563 and ANSI C80.3.

J. EMT FITTINGS:

1. Provide insulated throat nylon bushings with non-indenter type malleable steel fittings at all conduit terminations. Install OZ Type B bushings on conduits 1" larger. Cast or indenter type fittings are not acceptable.

K. FLEXIBLE METAL CONDUIT: FS WW-C-566, of the following type;

1. Zinc-coated steel.

L. FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1, Class 1, and Style A.

M. LIQUID TIGHT FLEXIBLE METAL CONDUIT:

1. Provide liquid-tight, flexible metal conduit; constructed of single strip, flexible continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coated with liquid-tight jacket of flexible polyvinyl chloride (PVC).

N. LIQUID-TIGHT FLEXIBLE METAL CONDUIT FITTINGS: FS W-F-406, Type 1, Class 3, Style G.

O. EXPANSION FITTINGS: OZ Type AX, or equivalent to suit application.

2.2 NON-METALLIC CONDUIT AND DUCTS:

A. GENERAL:

1. Provide non-metallic conduit, ducts and fittings of types, sizes and weights as indicated; with minimum trade size of 3/4".

B. UNDERGROUND PVC PLASTIC UTILITIES DUCT:

1. Minimum requirements shall be schedule 40 for encased burial in concrete and for Type II for direct burial.

C. PVC AND ABS PLASTIC UTILITIES DUCT FITTINGS:

D. ANSI/NEMA TC 9, match to duct type and material.

E. HDPE CONDUIT: Not acceptable.

2.3 CONDUIT; TUBING; AND DUCT ACCESSORIES:

A. Provide conduit, tubing and duct accessories of types and sizes, and materials, complying with manufacturer's published product information, that mate and match conduit and tubing. Provide manufactured spacers in all duct bank runs.

2.4 SEALING BUSHINGS:

A. Provide OZ Type FSK, WSK, or CSMI as required by application. Provide OZ type CSB internal sealing bushings.

2.5 CABLE SUPPORTS:

A. Provide OZ cable supports for vertical risers, type as required by application.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL RACEWAYS:

A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and in accordance with the following:

1. SERVICE ENTRANCE CONDUCTORS, AND CONDUCTORS OVER 600 VOLTS:

a. Install in rigid metal conduit (RMC), or intermediate metal conduit (IMC); except where buried below grade, install in non-metallic conduit or duct, individually encased in concrete. See duct banks.

2. FEEDERS UNDER 600 VOLTS:

a. Install in electric metallic tubing (EMT). Below concrete slab-on-grade or in earth fill, install in non-metallic plastic conduit. In areas exposed to weather, moisture, or physical damage, install in RMC or IMC. In suspended slabs, install in EMT (NOT APPROVED).

3. BRANCH CIRCUITS, SIGNAL AND CONTROL CIRCUITS, AND INDIVIDUAL EQUIPMENT CIRCUITS RATED LESS THAN 100 AMPS:

a. Install in electric metallic tubing (EMT). Below concrete slab-on-grade or in earth fill, install in non-metallic plastic duct. In areas exposed to weather, moisture, or physical damage, install in RMC or IMC. In suspended slabs, install in EMT (NOT APPROVED).

4. UTILITY COMPANY COORDINATION:

a. For installation of conduits for Rocky Mountain Power (RMP) feeders provide Schedule 40 PVC with long radius sweep fiberglass elbows. Coordination RMP standards for trench width, depth and spacing from other utilities. Provide back fill material of sand, screened backfill, etc., acceptable to RMP or as specified elsewhere in these specifications, whichever is more stringent.

B. Coordinate with other work including metal and concrete deck work, as necessary to interface installation of electrical raceways and components.

C. Install raceway in accordance with the following:

1. Provide a minimum of 12" clearance measured from outside of insulation from flues, steam and hot water piping, etc. Avoid installing raceways in immediate vicinity of boilers and similar heat emitting equipment. Conceal raceways in finished walls, ceilings and floor (other than slab-on-grade), except in mechanical, electrical and/or communication rooms, conceal all conduit and connections to motors, equipment, and surface mounted cabinets unless exposed work is indicated on the drawings. Run concealed conduits in as direct a line as possible with gradual bends. Where conduit is exposed in mechanical spaces, etc., install parallel with or at right angles to building or room structural lines. Do not install lighting raceway until piping and duct work locations have been determined in order to avoid fixtures being obstructed by overhead equipment.
2. PVC conduit not allowed within CMU and block type walls.
3. The required raceway size, for any given installation, shall remain the same throughout the entire length of the run. At no point shall any conduit be reduced in size.
4. Where cutting raceway is necessary, remove all inside and outside burrs; make cuts smooth and square with raceway. Paint all field threads (or portions of raceway where corrosion protection has been damaged) with primer and enamel finish coat to match adjacent raceway surface.
5. Provide a minimum of 1 ½” from nearest surface of the roof decking to raceway.
6. In open gymnasiums, auditoriums, etc; all conduit shall be installed in straight lines parallel to, or at right angles to, the structure or adjacent building elements. Separations between conduits and fastenings of conduits shall be neat and consistent. Conduit shall be installed as tight to the bottom of structural elements when parallel to joists as code will allow. Overall installation shall be accomplished in an aesthetic and workmanlike manner. No conduits shall be allowed to run perpendicular to the bottom chord and at the bottom of the joists.
7. Provide conduit from device to device in open and/or exposed ceilings. Ceilings with clouds are considered open/exposed ceiling. No exposed cables shall be seen from below.
8. Provide a maximum of three phase conductors in any one conduit or as approved by electrical engineer. Where phase conductors share a common neutral they must have a means to simultaneously disconnect all ungrounded conductors at the point where the branch circuits originate. The ungrounded and neutral conductors of a multi-wire branch circuit must be grouped together by wire ties at the point of origination.
9. Provide neutral and ground wire as specified elsewhere in documents.
10. Provide separate neutral conductor for all single phase branch circuits installed. No shared neutrals are allowed. Neutral conductor shall be the same size as the phase conductor.

D. Comply with NEC for requirements for installation of pull boxes in long runs.

E. Cap open ends of conduits and protect other raceways as required against accumulation

of dirt and debris. Pull a mandrel and swab through all conduit before installing conductors. Install a 200 lb. nylon pull cord in each empty conduit run.

F. Replace all crushed, wrinkled or deformed raceway before installing conductors.

G. Do not use flame type devices as a heat application to bend PVC conduit. Use a heating device that supplies uniform heat over the entire area without scorching the conduit.

H. Provide rigid metal conduit (RMC) for all bends greater than 22 degrees in buried conduit. Provide protective coating for RMC bend as specified herein.

I. Where raceways penetrate building, area ways, manholes or vault walls and floors below grade, install rigid metal conduit (RMC) for a minimum distance of 10 feet on the exterior side of the floor or wall measured from interior face. Provide OZ, Type FSK, WSK or CSMI sealing bushings (with external membrane clamps as applicable) for all conduit penetrations entering walls or slabs below grade. Provide segmented type CSB internal sealing bushings in all raceways penetrating building walls and slabs below grade, and in all above grade raceway penetrations susceptible to moisture migration into building through raceway.

J. Install liquid-tight flexible conduit for connection of motors, transformers, and other electrical equipment where subject to movement and vibration.

K. Install spare 3/4" conduits (capped) from each branch panelboard into the ceiling and floor space. Run five into the ceiling space and five into the floor space. Where the floor is not accessible run six conduits into the ceiling space. Run conduits the required distance necessary to reach accessible ceiling space.

L. Provide OZ expansion fittings on all conduits crossing building expansion joints, both in slab and suspended.

M. Provide OZ cable supports in all vertical risers in accordance with NEC 300-19; type as required by application.

N. Complete installation of electrical raceways before starting installation of cables/conductors within raceways.

O. Raceway installation below grade:

1. Apply protective coating to metallic raceways in direct contact with earth or fill of any type; consisting of spirally wrapped PVC tape (1/2" minimum overlap of scotch wrap tape or equal); or factory applied vinyl cladding (minimum thickness .020 inches). Completely wrap and tape all field joints.
2. Burial depths must comply with NEC Section 300-5 but in no case be less than 24", unless noted otherwise on drawings.
3. Utility burial depths must comply with RMP requirements or AHJ, but in no case be less than 48" minimum, unless noted otherwise on drawings, diagrams etc.

P. Raceway installation below slab-on-grade, or below grade:

1. For slab-on-grade construction, install runs of rigid plastic conduit (PVC) below slab. All raceway shall be located a at top of sub-grade and a minimum of 6” below bottom of slab. Stake down conduits as required to keep conduits from floating or moving. Coordinate strictly with other trades at grade level structural members for correct installation. Install RMC (with protective coating) for raceways passing vertically through slab-on-grade. Slope raceways as required to drain away from electrical enclosures and to avoid collection of moisture in raceway low points.
2. Apply protective coating to metallic raceways in direct contact with earth or fill of any type; consisting of spirally wrapped PVC tape (1/2" minimum overlap of scotch wrap tape or equal); or factory applied vinyl cladding (minimum thickness .020 inches). Completely wrap and tape all field joints.

3. Mark all buried conduits that do not require concrete encasement by placing yellow plastic marker tape (minimum 6" wide) along entire length of run 12" below final grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.
4. Burial depths must comply with NEC Section 300-5 but in no case be less than 24", unless noted otherwise on drawings.
5. Do not locate utility feeds under any structure. Verify all utility power paths with RMP prior to any rough-in. Utility burial depths must comply with RMP requirements or AHJ, but in no case be less than 48" minimum, unless noted otherwise on drawings, diagrams etc.

Q. Raceway installation in suspended slabs:

1. No conduit can be installed in suspended slabs.

R. Raceway installation in hazardous locations:

1. Install RMC in all hazardous locations as defined by NEC. Provide suitable fittings, seal-offs, boxes, etc. to comply with requirements.
2. Engage at least five full threads on all fittings. Provide inspection fittings with explosion proof drains to prevent water accumulation in conduit runs. Install seal-offs for arcing or high temperature equipment, at housing with splices or taps and where conduits enter or leave the hazardous area. Provide seal-offs of the appropriate type for vertical or horizontal installation. Ground all metallic parts.

S. DUCTBANKS:

1. Provide ductbank construction as indicated using 3000 psi at 28 day strength concrete. Use Type II low alkali per ASTM C150. Use ASTM C-33 aggregate gradation with maximum size of 3/4". Use W/C ratio of 0.50. Install #4 reinforcing bar per ASTM 615 grade 50 in each corner of ductbank. Provide minimum 4" concrete cover on all sides of exterior conduits. Provide polypropylene pull rope in all spare duct.

T. Electrical Identification: Refer to Section 260553 for requirements.

END OF SECTION 26 0532

SECTION 26 0533

ELECTRICAL BOXES AND FITTINGS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specifications sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is a part of each Division-26, 27 and 28 section making reference to electrical wiring boxes and fittings specified herein. See Section 260532, Raceways, for additional requirements.

1.2 DESCRIPTION OF WORK:

A. The extent of electrical box and electrical fitting work is indicated by drawings and schedules.

B. Types of electrical boxes and fittings in this section include the following:

1. Outlet Boxes
2. Junction Boxes
3. Pull Boxes
4. Floor Boxes
5. Conduit Bodies
6. Bushings
7. Locknuts
8. Knockout Closures
9. Miscellaneous Boxes and Fittings

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to construction and installation of electrical boxes and fittings. Comply with ANSI C 134,1 (NEMA Standards Pub No. OS 1) as applicable to sheet-steel outlet boxes, device boxes, covers and box supports. Provide electrical boxes and fittings that have been UL-listed and labeled.

1.4 SUBMITTALS:

A. Submit manufacturer’s data including specifications, installation instruction and general recommendations for each type of floor box used on project.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS:

A. INTERIOR OUTLET BOXES:

1. Provide one piece, galvanized flat rolled sheet steel interior outlet wiring boxes with accessory rings, of types, shapes and sizes, including box depths, to suit each respective location and installation, construct with stamped knockouts in back and sides, and with threaded screw holes with corrosion-resistant screws for securing box and covers and wiring devices; minimum size 4"x4"x2-1/8".

2. Provide an 'FS' box, with no knockouts when surface mounted in a finished, non-utility space. Surface mounting is only acceptable when approved by the Architect.

B. INTERIOR OUTLET BOX ACCESSORIES:

1. Provide outlet box accessories as required for each installation, including mounting brackets, hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, that are compatible with outlet boxes being used and fulfilling requirements of individual wiring applications.

C. WEATHERPROOF OUTLET BOXES:

1. Provide corrosion-resistant cast-metal weatherproof outlet wiring boxes, of types, shapes and sizes (including depth) required, with threaded conduit ends, cast-metal face plates with spring-hinged waterproof caps suitably configured for each application, with face plate gaskets and corrosion-resistant fasteners.

D. JUNCTION AND PULL BOXES:

1. Provide code-gage sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

E. FLOOR BOXES:

1. Single Service Floor Box: Provide leveling and fully adjustable floor service receptacle outlets and fittings of types and ratings indicated; and with finish as selected by Architect. Equip with wiring devices as specified in Section 262726. Provide boxes compatible with floor system; provide epoxy-coated stamped steel boxes or cast iron boxes for slab-on-grade construction; provide stamped steel boxes for suspended slabs. Equip with tile and/or carpet flanges to accommodate floor finish material. Boxes shall be available in one, two or three gang configurations. Boxes shall comply with UL Standard UL514A.

2. Multi-Service Floor Box: Provide leveling and fully adjustable multi compartment floor box; there shall be multiple independent wiring compartments; the floor box shall permit tunneling from end power compartment to end power compartment. Floor box shall accommodate a minimum of two duplex receptacles and two mounting plates for telecommunication devices. Equip with wiring devices as specified in Section 262726. Provide boxes compatible with floor system; with finish as selected by Architect. Provide epoxy-coated stamped steel boxes or cast-iron boxes for slab-on-grade construction; provide stamped steel boxes for suspended slabs. Equip with tile and/or carpet flanges to accommodate floor finish material. Boxes shall comply with UL Standards UL514A and/or UL514C.

3. Manufacturer: subject to compliance with requirements, provide floor boxes as indicated on the drawings.

   a. Harvey Hubbell, Inc.

   b. Wiremold

F. CONDUIT BODIES:

1. Provide galvanized cast-metal conduit bodies, of types, shapes and sizes to suit respective locations and installation, construct with threaded-conduit-entrance ends, removable covers, and corrosion-resistant screws.

G. BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS:

1. Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable steel conduit bushings and offset connectors, of types and sizes to suit respective uses and installation.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS:

A. GENERAL:

1. Install electrical boxes and fittings where indicated, complying with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
2. Coordinate installation of electrical boxes and fittings with wire/cable and raceway installation work.
3. Provide coverplates for all boxes. See Section 262726, Wiring Devices.
4. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.
5. Provide knockout closures to cap unused knockout holes where blanks have been removed.
6. Install boxes and conduit bodies to ensure ready accessibility of electrical wiring. Do not install boxes above ducts or behind equipment. Install recessed boxes with face of box or ring flush with adjacent surface. Seal between switch, receptacle and other outlet box openings and adjacent surfaces with plaster, grout, or similar suitable material.
7. Fasten boxes rigidly to substrates or structural surfaces, or solidly embed electrical boxes in concrete or masonry. Use bar hangers for stud construction. Use of nails for securing boxes is prohibited. Set boxes on opposite sides of common wall with minimum 10" of conduit between them. Set boxes on opposite sides of fire resistant walls with minimum of 24” separation.
8. Provide a minimum of 1 ½” from the nearest surface of the roof decking to the installed boxes.
9. Provide electrical connections for installed boxes.

END OF SECTION 26 0533

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SECTION 26 0536

RACEWAY SYSTEMS

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 work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 Section making reference to electrical raceways specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of raceways is indicated by drawings and schedules.

B. Types of raceways in this section include the following:

1. Surface Metal Raceways
2. Wire Basket Cable Tray Systems

1.3 QUALITY ASSURANCE:

A. STANDARDS:

1. Comply with applicable portions of NEMA standards pertaining to raceways. Comply with applicable portions of UL safety standards pertaining to electrical raceway systems; and provide products and components that have been UL-listed and labeled. Comply with NEC requirements as applicable to construction and installation of raceway systems.
2. Comply with the following publications and standards for construction and installation or wire basket cable tray:
   a. Comply with NEC Article 392
   b. NEMA VE-1; NEMA VE-2-2001
   c. NFPA 70B
   d. ASTM B633; ASTM A653; ASTM A510

1.4 SUBMITTALS:

A. Refer to section 26 0502 submittal requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURED RACEWAY SYSTEMS:

A. GENERAL:

1. Provide electrical raceways of types, grades, sizes, weights [wall thicknesses], and number of channels, for each service indicated. Provide complete assembly of raceway including, but not necessarily limited to, couplings, offsets, elbows, expansion joints, adapters, holddown straps, end caps, and other components and accessories as needed for complete system.

B. SURFACE METAL RACEWAYS:

1. Provide galvanized steel surface metal raceways of sizes and channels indicated. Provide fittings indicated that match and mate with raceway. Paint with manufacturer's standard prime coating and finish color as indicated. Provide receptacles on centers as indicated on drawings or as directed by engineer.

2. MANUFACTURER:
    a. Subject to compliance with requirements, provide surface metal raceways of one of the following:
        i. Wiremold Company AL3300

C. WIRE BASKET CABLE TRAY SYSTEMS:

1. MANUFACTURER:
    a. Subject to compliance with requirements, provide cable tray system of one of the following (OR APPROVED EQUAL):
        i. Cooper B-Line WB400 Series Systems
        ii. Cablofil, Inc.
        iii. P/W Industries
        iv. Hubbell Incorporated
        v. MonoSystems
2. Provide wire basket cable tray of types, grades, ratings, and sizes as specified and indicated meeting all requirements of NEMA VE-1. Provide complete assembly of raceway including, but not necessarily limited to, offsets, adapters, connector plates, splice plates, brackets, connector assemblies, holddown clamp assemblies, grounding clamps and other components and accessories as needed for complete system.
3. WIRE BASKET: Wire basket shall be made of high strength steel wires conforming to ASTM A510, and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
    a. All straight section longitudinal wires shall be straight, with no bends.
    b. Straight sections shall be furnished in standard 118 inch lengths.
    c. Wire basket shall have a 4 inch usable loading depth by 18 inches wide.
    d. Wire basket shall be electro-plated zinc in accordance with ASTM B633 SC2, with clear chromate sealer.
    e. Wire basket shall have a load capacity of 116 lbs per foot based on 5 foot spacing between supports.
4. BENDS: Horizontal and vertical bends, and horizontal tees shall be field formed. Inside radius of field bends shall be no less than 12 inches, and in no case smaller than required to comply with minimum radius requirement of cable manufacturer. Horizontal bends and tees shall be made such that the side rail of the tray is continuous with no gaps.
5. SPLICE ASSEMBLIES: Splice assemblies shall consist of splice plates and clamp/connectors furnished by the tray system manufacturer as standard components of the system. Splice assemblies shall be used to join separate horizontal sections together. Splice plates shall be approximately 2.7 inches long by 1.6 inches high, zinc-plated. Clamp/connectors shall be the bolted type consisting of welded stud plates with threaded studs and serrated flanged locknuts. Hardware shall be zinc-plated.
6. ACCESSORES AND COMPONENTS: Support accessories shall be zinc-plated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.
7. Provide all fittings including connector plates, splice plates, clamps, supports, etc.
8. Grind all rough edges, drip concentrations, etc., to smooth finish. Apply cold zinc spray to all field cut surfaces.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL RACEWAYS:

A. Install electrical raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA "Standard of Installation", and complying with recognized industry practices.

B. Provide a minimum of (4) 4” trade size Hilti Speedsleeves (or STI EZPath) with at least one spare for each and every firewall penetration where cable tray meets the wall.

C. Provide a minimum of (4) 4” trade size conduits within cable where inaccessible ceilings that span more than 12’.

D. Coordinate with other work including metal and concrete deck work, as necessary to interface installation of electrical raceways and components.

E. Seal joints of underfloor ducts with sealing compound or tape prior to placing concrete.

F. Level and square raceway runs, and install at proper elevations/heights.

3.2 ADJUSTING AND CLEANING:

A. Upon completion of installation of raceways, inspect interiors of raceways; remove burrs, dirt and construction debris.

END OF SECTION 26 0536

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SECTION 26 0548

ELECTRICAL SEISMIC CONTROL

PART 1 – GENERAL

1.1 WORK INCLUDED:

A. Anchorage and seismic restraint systems for all Division 26 isolated and non-isolated equipment, cable tray, and conduit systems.

B. Equipment/cable tray/conduit to isolated and/or seismically supported shall include but not be limited to the following:

1. Pad Mounted Equipment
2. Conduit
3. Cable Tray
4. Light Fixtures

1.2 RELATED WORK:

A. Requirements: Provide Electrical Seismic Control in accordance with the Contract Documents.

B. Section 26 0500 – Electrical General Provisions

1.3 REFERENCES:

A. International Building Code, Current Edition in use by Jurisdictional Authority.

B. NFPA Bulletin 90A, Current Edition.

C. UL Standard 181.

1.4 SYSTEM DESCRIPTION

A. The Division 26 Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the following:

1. Short period design spectral response acceleration coefficient SDS=0.70.
2. One second period design spectral response acceleration coefficient SD1=0.28.
3. Site Class B.
4. Seismic Design Category D.

1.5 QUALITY ASSURANCE:

A. All supports, hangers, bases, anchorage and bracing for all isolated equipment and non-isolated equipment shall be designed by a professional engineer licensed in the state where the project is located, employed by the restraint manufacturer, qualified with seismic experience in bracing for electrical equipment. Shop drawings submitted for earthquake bracing and anchors shall bear the Engineer's signed professional seal. All calculations/design work required for the seismic anchorage and restraint of all Division 26 equipment and systems shall be provided by a single firm.

B. The above qualified seismic engineer shall determine specific requirements for equipment anchorage and restraints, locations and sizes based on shop drawings for the electrical equipment that have been submitted, reviewed and accepted by the Architect/Engineer for this project.

C. Seismic Engineer or the Engineer's Representative shall field inspect final installation and certify that bracing and anchorage are in conformance with the Seismic Engineer's design. A certificate of compliance bearing the Seismic Engineer's signed Professional Engineer's seal shall be submitted and shall be included in each copy of the Operation and Maintenance Manuals.

D. The Division 26 Contractor shall require all equipment suppliers furnish equipment that meets the seismic code, with bases/skids/curb designed to receive seismic bracing and/or anchorage. All isolated and non-isolated electrical equipment bracing to be used in the project shall be designed from the Equipment Shop Drawings and certified correct by the equipment manufacturer for seismic description listed in Paragraph 1.4 above, with direct anchorage capability.

1.6 SUBMITTALS:

1. Refer to Section 26 0502 for electrical submittal requirements.

PART 2 – PRODUCTS:

2.1 RESTRAINT EQUIPMENT AND SYSTEMS:

A. Acceptable Manufacturers and Suppliers for Non-Isolated Systems:

1. Mason Industries, Inc.
2. Korfund
3. Amber/Booth Company
4. Vibration Mountings and Control Company
5. Kinetics
6. International Seismic Application Technology
7. Tolco

B. Manufacture and design of restraints and anchors for isolated equipment shall be by the manufacturer of the vibration isolators furnished for the equipment.

2.2 SNUBBERS:

A. Snubbers shall be all-directional and consist of interlocking steel members restrained by replaceable shock absorbent elastomeric materials a minimum of 3/4 inch thick.

B. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8 inch or more than 1/4 inch.

C. Snubbers shall be Mason Industries Z -1011 or accepted equivalent.

PART 3 – EXECUTION

3.1 DESIGN AND INSTALLATION:

A. General:

1. All electrical equipment cable tray and conduit shall be braced, anchored, snubbed or supported to withstand seismic disturbances in accordance with the criteria of this specification. Provide all engineering, labor, materials, and equipment for protection against seismic disturbances as specified herein. The following electrical components are exempt from seismic restraint requirements.
   a. Components in Seismic Design Categories A and B (see 1.4 above).
   b. Components in Seismic Design Category C (see 1.4 above) that have an important factor IP of 1.0 (see 1.4 above).
   c. Components that have an importance factor IP of 1.0 (see 1.4 above), that are mounted less than four feet above the floor, that weigh less than

400 pounds, and that have flexible ductwork, piping, and conduit connections.

d. Components that have an importance factor IP of 1.0 (see 1.4 above), that weigh 20 pounds or less, and that have flexible ductwork, piping, and conduit connections.

e. Electrical components in Seismic Design Categories D, E, or F where all of the following apply:

i. The component importance factor, I_p, is equal to 1.0;

ii. The component is positively attached to the structure;

iii. Flexible connections are provided between the component and associated ductwork, piping, and conduit; and either

1. The component weighs 400 lb (1,780 N) or less and has a center of mass located 4 ft (1.22 m) or less above the adjacent floor level; or

2. The component weighs 20 lb (89 N) or less or, in the case of a distributed system, 5 lb/ft (73 N/m) or less.

2. Powder-actuated fasteners (shot pins) shall not be used for component anchorage in tension applications in Seismic Design Category D, E, or F.

3. Attachments and supports for electrical equipment shall meet the following provisions:

a. Attachments and supports transferring seismic loads shall be constructed of materials suitable for the application and designed and constructed in accordance with a nationally recognized structural code such as, when constructed of steel, AISC, Manual of Steel Construction (Ref. 9.8-1 or 9.8-2).

b. Friction clips shall not be used for anchorage attachment.

c. Expansion anchors shall not be used for electrical equipment rated over 10 hp (7.45 kW). Exception: Undercut expansion anchors.

d. Drilled and grouted-in-place anchors for tensile load applications shall use either expansive cement or expansive epoxy grout.

e. Supports shall be specifically evaluated if weak-axis bending of light-gauge support steel is relied on for the seismic load path.

f. Components mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction. The design force shall be taken as 2Fp. The intent is to prevent excessive movement and to avoid fracture of support springs and any non- ductile components of the isolators.

g. Seismic supports shall be constructed so that support engagement is maintained.

B. Pad Mounted Equipment

1. Spring Isolated Equipment:

a. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless

the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. Snubbers shall be installed with factory set clearances.

2. Non-Isolated Equipment:

   a. The section 260548 (Electrical Seismic Control) Contractor shall be responsible for thoroughly reviewing all drawings and specifications to determine all equipment i.e. switchboards, transformers, generators, etc. to be restrained. This Contractor shall be responsible for certifying that this equipment is mounted and braced such that it adheres to the system description criteria in part 1.4 of this specification section.

C. Conduit, Conduit Racks/Trapeze Assemblies, Cable Tray and Bus Duct:

1. Seismic braces for be omitted when the distance from the supporting structure to the raceway support point is 12” or less. Where rod hangers are used, they shall be equipped with swivels to prevent inelastic bending in the rod.
2. Seismic braces may be omitted where the total weight of the assembly is less than 10 lb/ft.
3. Seismic braces for individual conduit may be omitted for conduit less than 2.5 inch trade size.
4. A rigid conduit system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.
5. Unbraced conduit attached to in-line equipment shall be provided with adequate flexibility to accommodate differential displacements.
6. At the interface of adjacent structures or portions of the same structure that may move independently, utility lines shall be provided with adequate flexibility to accommodate the anticipated differential movement between the ground and the structure.
7. Provide large enough pipe sleeves through wall or floors to allow for anticipated differential movements.
8. For spaces, where the Importance Factor (Ip) is equal to 1.5, all electrical components that are attached to structures that could displace relative to one another and for isolated structures where components cross the isolation interface, the components shall be designed to accommodate the eismic relative dispalcements.

D. Light Fixtures

1. Light fixtures, lighted signs, and ceiling fans not connected to ducts or piping, which are supported by chains or otherwise suspended from the structure, are not required to satisfy the seismic force and relative displacement requirements provided they meet all of the following criteria:
   a. The design load for such items shall be equal to 1.4 times the operating weight acting down with a simultaneous horizontal load equal to 1.4 times the operating weight. The horizontal load shall be applied in the direction that results in the most critical loading for the design.
   b. Seismic interaction effects shall not cause an effect so that the failure of the non-essential component causes a failure of an essential component.
   c. The connection to the structure shall allow a 360° range of motion in the horizontal plane.

d. The component is less than 20 lbs and has flexible connections and an importance factor (Ip) equal to 0.

END OF SECTION 26 0548

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SECTION 26 0553

ELECTRICAL IDENTIFICATION

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 work of this section.

B. Requirements of the following Division 26 Sections apply to this section:

1. “Basic Electrical Requirements”.
2. “Basic Electrical Materials and Methods”.

1.2 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 labels for raceways, cables and conductors.
3. Operational instruction signs.
4. Warning and caution signs.
5. Equipment labels and signs.
6. Arc-flash hazard labels

B. Related Sections: The following sections contain requirements that relate to this section:

C. Division 9 Section “Painting” for related identification requirements.

D. Refer to other Division 26 sections for additional specific electrical identification associated with specific items.

1.3 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 “National Electrical Code”

1.4 SUBMITTALS:

1. Refer to Section 26 0502 for electrical submittal requirements.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. American Labelmark Co.
2. Calpico, Inc.
3. Cole-Flex Corp.
4. Emed Co., Inc.
5. George-Ingraham Corp.
6. Ideal Industries, Inc.
7. Kraftbilt

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8. LEM Products, Inc.
9. Markal Corp
10. National Band and Tag Co.
11. Panduit Corp.
12. Radar Engineers Div., EPIC Corp.
13. Seton Name Plate Co.
14. Standard Signs, Inc.
15. W.H Brady, Co.

2.2 ELECTRICAL IDENTIFICATION PRODUCTS

A. Colored Conduit Systems for raceway identification:

1. Factory-painted conduit and/or factory-painted couplings and fittings

B. Colored paint for raceway identification:

1. Use Kwal Paint colors as specified in Part 3 – Execution.

C. Color Adhesive Marking Tape for Raceways, Wires and Cables:

1. Self-adhesive vinyl tape not less than 3 mills thick by 1” to 2” in width.

D. Underground Line Detectable Marking Tape:

1. Permanent, bright colored, continuous-printed, acid- and alkali-resistant plastic tape specifically compounded for direct-burial service. Not less than 6” wide by 4 mills thick.
2. With metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep.
3. Printed legend indicative of general type of underground line below.

E. Wire/Cable Designation Tape Markers:

1. Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with pre-printed numbers and letters.

F. Brass or Aluminum Tags:

1. Metal tags with stamped legend, punched for fastener.
2. Dimensions: 2” X 2” 19 gage.

G. Engraved, Plastic Laminated Labels, Signs and Instruction Plates:

1. Engraving stock plastic laminate, 1/16” minimum thickness for signs up to 20 sq. in. or 8” in length; 1/8 “ thick for larger sizes. Engraved legend in 1/4” high white letters on black face and punched for mechanical fasteners.

H. Arc-flash Hazard Labels:

1. ANSI Z535.4 Safety Label.
2. Adhesive backed polyester with self-laminating flap. Chemical, abrasion and heat resistant.
3. Dimensions: 5” x 3.5”
4. Information contained: Arc-flash boundary; Voltage; Flash Hazard Category; Incident Energy (arc rating); checkboxes for the required Personal Protective Equipment (PPE) and the date that the calculations were performed.

I. Equipment Labels:

1. Adhesive backed polyester with self-laminating flap. Chemical, abrasion and heat resistant.
2. Dimensions: minimum 5” x 2”

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3. Conductor-Identification-Means Labels:
    a. Information contained: the method utilized for identifying ungrounded conductors within switchboards, distribution panels and branch circuit panels.
4. Available-Fault-Current Labels:
    a. Information contained: maximum available fault current at the respective piece of equipment, and date of calculation of fault current.
5. Source-of-Supply Labels:
    a. Information contained: indicate the device or equipment where the power supply originates.

J. Baked Enamel Warning and Caution Signs for Interior Use:
1. Preprinted aluminum signs, punched for fasteners, with colors legend and size appropriate to location.

K. Fasteners for Plastic-Laminated and Metal Signs:
1. Self-tapping stainless steel screws or # 10/32 stainless steel machine screws with nuts, flat and lock washers.

L. Cable Ties:
1. Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18" minimum width, 50-lb. Minimum tensile strength, and suitable for a temperature range from minus 40° F. to 185° F. Provide ties for specified colors when used for color coding.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Lettering and Graphics:
1. 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.

B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.

C. Sequence of Work:
1. Where identification is to be applied to surfaces that require a finish, install identification after completion of finish work.

D. Conduit Identification:
1. Identify Raceways of Certain Systems with Color Coding. Acceptable means of color identification are as follows:
    a. Colored adhesive marking tape.
    b. Field-painted colored bands.
    c. Factory-painted conduit.
    d. Color exposed or accessible raceways of the following systems for identification. Make each color band 2 inches wide, completely encircling conduit. Apply bands at changes in direction, at penetrations of walls and floors, and at 20-foot maximum intervals in straight runs. Apply the following colors:
        i. Fire Alarm System: Red
        ii. AV: White

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iii. Intercom: Purple

iv. Telephone/Data: Blue

v. Access Control: Green

vi. Intrusion: Gray

vii. IP Surveillance: Yellow

viii. Elevator Phone: Black

ix. Legally Required Emergency Systems: Red with Black Stripe (Per NEC 700.10(A))

2. Identify Junction, Pull and Connection Boxes.

   a. Code-required caution sign for boxes shall be pressured-sensitive, self-adhesive label indication system voltage in black, preprinted on orange background. Install on outside of box cover. Also label box covers on outside of cover with identity of contained circuits. Use pressure-sensitive plastic labels at exposed locations and similar labels or plasticized card stock tags at concealed boxes.

3. Label and paint the covers of the systems junction boxes as follows:

SYSTEM	COLOR (ALL COLORS ARE KWAL PAINT)	
Fire Alarm	Red Alert	AC118R
AV	White	
Intercom	Purple	
Data	Neon Blue	7076A
WAPs	Fiesta Orange	AC107Y
Elevator	Flat Black	
Access Controls	Java Green	AC098N
Intrusion	Gray	
IP Surveillance Cameras	Competition Yellow	7225A
Legally Required EM System	Red/Black Stripe	

E. Underground Electrical Line Identification.

1. During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground line detectable marking tape, located directly above line at 6 to 8 inches below finished grade. Where multiple lines are installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.

2. Install detectable marking tape for all underground wiring, both direct-buried and in raceway.

3. Provide red marker dye applied to concrete encased ductbank.

F. Conductor Color Coding.

1. Provide color coding for secondary service, feeder and branch circuit conductors throughout the project secondary electrical system as follows:

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120/208 Volts	Phase	277/480 Volts
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

2. Switch legs, travelers and other wiring for branch circuits shall be of colors other than those listed above.
3. Use conductors with color factory applied the entire length of the conductors except as follows:
   a. The following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than No. 10 AWG.
   b. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
   c. In lieu of pressure-sensitive tape, colored cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

G. Power Circuit Identification.
1. Securely fasten identifying metal tags or aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms with 1/4-inch steel letter and number stamps with legend to correspond with designations on Drawings. If metal tags are provided, attach them with approximately 55-lb monofilament line or one-piece self-locking nylon cable ties.
2. Tag or label conductors as follows:
   a. Future Connections: Conductors indicated to be for future connection or connection under another contract with identification indicting source and circuit numbers.
   b. Multiple Circuits: Where multiple branch circuits or control wiring or communications/ signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by mean of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear 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:

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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 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. Warning and caution signs shall be furnished and installed on, but not be limited to the following equipment and locations:
    a. Entrances to rooms and other guarded locations that contain exposed live parts 600 volts or less; signs shall forbid unqualified personnel to enter.
    b. Switch and Overcurrent device enclosures with splices, taps and feed-through conductors. Provide warning label on the enclosures that identifies the nearest disconnecting means for any feed-through conductors.
    c. Entrances to buildings, vaults, rooms or enclosures containing exposed live parts or exposed conductors operating at over 600 volts: DANGER-HIGH VOLTAGE-KEEP OUT.
    d. Metal-enclosed switchgear, unit substations, transformers, enclosures, pull boxes, connection boxes and similar equipment operating at over 600 volts shall have appropriate caution signs and warning labels.
    e. Indoor and Outdoor substations operating over 600 volts. Provide warning signs, instructional signs and single-line diagrams in accordance with NEC 225.70.

I. Emergency Operating Signs: Install engraved laminated 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.

J. 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. Except as otherwise indicated, provide single line of text, with 1/4“-high lettering on 1-inch-high label (1 1/2-inch-high where two lines are required) white lettering in black field. White lettering in red field for Emergency Power Systems. 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. Each service disconnect, to identify it as a service disconnect.
    b. Panelboards (exterior and interior), electrical cabinets, and enclosures. For subpanels, identify feeder circuit served from.
    c. Switches in fusible panelboards shall be labeled. Main switches shall be identified.
    d. Access doors and panels for concealed electrical items.
    e. Electrical switchgear and switchboards.
    f. Motor control centers.
    g. Motor starters, including circuit origination, HP, heater size, FLA, and mechanical equipment designation.
    h. Disconnect switches.
    i. Pushbutton stations.
    j. Power transfer equipment.
    k. Contactors.

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l. Dimmers.

m. Control devices.

n. Transformers.

o. Power generating units, to include transfer switches.

p. Telephone switching equipment.

q. Clock/program master equipment.

r. Call system master station.

s. TV/AV equipment.

t. Fire alarm master station or control panel.

u. Variable frequency drives.

v. Lighting Control Equipment.

w. Uninterruptable Power Supply.

K. Post Conductor-Identification-Means labels at locations of switchboards, distribution panels and branch circuit panels. The labels shall identify the color-coding used on ungrounded conductors for each voltage system used on the premises.

L. Apply Available-Fault-Current labels at the service entrance equipment.

M. Apply Source-of-Supply labels on the exterior covers of equipment (except in single- or two-family dwellings) as follows:

1. Each switchboard supplied by a feeder.
2. Each branch circuit panelboard supplied by a feeder.
3. Each disconnect switch serving elevators, escalators, moving walks, chairlifts, platform lifts and dumbwaiters.
4. Each dry type transformer (or primary-side disconnect switch at transformer). If the primary-side disconnect is remote from the transformer, both the remote disconnect and the transformer shall be labeled, and the transformer label shall also indicate the location of the disconnect.
5. Each feeder disconnect, branch circuit disconnect, panelboard or switchboard in a remote building or structure.
6. Each on-site emergency power source, with sign placed at service entrance equipment to comply with NEC 700.

N. The label shall identify the device or equipment where the power supply originates, and the system voltage, phase or line and system at all termination, connection and splice points. For example: Feeder Power Supply for Panel “XX” Originates at Panel “XX” (or Switchboard “XX”, Transformer “XX”, Switch “XX”, etc.); 120/208 volts, 3-phase, Phase Color Identification (or 120/240, 277/480, etc.).

O. Install Arc-flash hazard labels on the following equipment:

1. Each piece of service entrance equipment.
2. Each power distribution switchboard or panel.
3. Each individually mounted circuit breaker.
4. Each branch circuit panelboard.
5. Each motor control center.
6. Each individually mounted motor starter.
7. Each meter socket enclosure.

P. 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.

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Q. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

R. Engrave all receptacle plates other than those serving 120 volt, single phase devices. State voltage and amperage characteristics: Example; “208V 30A”.

S. Mark each device box (for each type of wiring device) with a permanent ink felt tip marker, indicating the circuit that the device is connected to: Example; “CKT A-1”

T. Label circuit breaker feeding fire alarm panel “Fire Alarm Circuit”. Using plastic laminate label, white lettering on a red background.

END OF SECTION 26 0553

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SECTION 26 0573

PROTECTIVE DEVICE STUDY

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 work of this section.

1.2 DESCRIPTION OF WORK:

A. Studies in this section include the following:

1. Fault current protective device and equipment evaluation
2. Protective device coordination study
3. Arc-flash hazard analysis and study

1.3 QUALITY ASSURANCE:

A. Provide protective device and arc-flash hazard studies performed by qualified engineers of the equipment manufacturer or an approved consultant. Studies must bear the professional engineer's stamp of the engineer in responsible charge of the protective device studies. Perform all work in accordance with latest IEEE and ANSI standards.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 – STUDIES

2.1 FAULT CURRENT PROTECTIVE DEVICE & EQUIPMENT EVALUATION

A. Perform fault current analysis with the aid of a computer and appropriate software. Include as input data the maximum available short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected, and other source impedances.

B. Coordination Criteria:

1. All overcurrent protective devices serving the essential electrical system shall be coordinated for the period of time that a fault's duration extends beyond 0.1 second. Provide overcurrent protection devices with larger frames sizes to ensure coordination has been achieved.

2. Coordination shall not be required as follows:

a. Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exist on the transformer secondary.

b. Between overcurrent protective devices of the same size (ampere rating) in series.

C. Calculate fault current close and latch duty values and interrupting duty values on the basis of assumed three-phase bolted short circuits at each switchgear bus, medium voltage controller, switchboard, low voltage motor control center, distribution panelboard, branch circuit panel and other significant locations throughout the system. Include

symmetrical fault currents, and X/R ratios in the fault current tabulations. For each fault location, list the total duty on the bus, as well as the individual contribution from each connected branch, with its respective X/R ratio. Calculate ground fault currents at each bus. Incorporate major motor contributions in determining momentary and interrupting ratings of protection devices.

D. Perform an evaluation to determine the adequacy of circuit breakers, molded case switches, automatic transfer switches, and fuses, by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Apply appropriate multiplying factors based on system X/R ratios and protective device rating standards. Report problem areas or inadequacies in the equipment due to short circuit currents prior to release for fabrication of switchgear, switchboards and/or appliance panelboard.

2.2 PROTECTIVE DEVICE COORDINATION STUDY

A. Perform a protective device coordination study including the necessary calculations and logic decisions required to select power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. Perform the studies in accordance with the latest applicable IEEE and ANSI standards.

B. Include all medium and low voltage classes of equipment in the coordination study from the building or plant service protective devices down to and including the largest rated device in the low voltage motor control centers and panelboards. Include the phase and ground overcurrent protection as well as settings of all other adjustable protective devices.

C. Develop time-current characteristics of the specified protective devices on log-log paper. Include complete titles, representative one-line diagram and legends, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuses. Indicate on plots the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents. Adhere to all restrictions of the National Electrical Code. Maintain proper coordination intervals and separation of characteristic curves.

D. Provide coordination plots for phase and ground protective devices on a system basis. Provide a sufficient number of separate curves to clearly indicate the coordination achieved.

E. Provide the selection and settings of the protective devices in a tabulated form listing circuit identification, IEEE device number, current transformer ratios and connection, manufacturer and type, range of adjustment and recommended settings. Provide a tabulation of the recommended power fuse selection for medium voltage fuses where applied in the system. Promptly report any discrepancies, problem areas, or inadequacies prior to release for fabrication of switchgear, switchboards and/or appliance panels.

2.3 ARC-FLASH HAZARD ANALYSIS AND STUDY

A. Perform an arc-flash hazard analysis and study. Include the necessary calculations required to determine the level of Personal Protection Equipment (PPE) that a worker must use, the Arc Flash Boundary in inches, and the incident energy at each location. This information shall be calculated and determined for each piece of service entrance equipment, each power distribution switchboard or panel, each separately-mounted circuit breaker, each motor control center, each individually mounted motor starter, and for each branch circuit panelboard.

B. Perform the analysis and study in accordance with IEEE 1584.

C. Furnish and install a label at each piece of service equipment, each power distribution

switchboard or panel, each separately mounted circuit breaker, each motor control center, each individually mounted motor starter, and each branch circuit panel board. The label shall be an ANSI approved Arc Flash Warning Label that warns and instructs workers of the arc flash hazard, voltage, arc flash boundary, and required PPE (Personal Protective Equipment).

2.4 ANALYSIS/REPORT

A. Include the following in the report.

1. Description, purpose, basis and scope of the study and a single line diagram of that portion of the power system that is included within the scope of the study.
2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties and commentary regarding same. Include formulas and description of methods used.
3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
4. Fault current calculations including a definition of terms and guide for interpretation of computer printout.
5. Recommended size for power fuses and recommended settings for ground fault relays and for all adjustable trip relays, circuit breakers, etc.
6. Tabulation of arc-flash calculations for each location and tabulation of arc-flash hazard, voltage, boundary and required PPE for each equipment item listed in the arc-flash analysis.

2.5 PROTECTIVE DEVICE TESTING, CALIBRATION AND ADJUSTMENT

A. Provide adjustments to circuit breakers and switchboard AIC ratings as deemed necessary by the analysis/report, with no additional cost to the Owner. Provide over current protection devices with larger frame sizes to ensure coordination has been achieved.

B. Provide the services of a qualified field engineer employed by the equipment manufacturer, and necessary tools and equipment to test, calibrate and adjust the protective relays, ground fault relays and circuit breaker trip devices as recommended in the Protective Device Study.

2.6 TYPEWRITTEN DEVICE SETTING TABULATION:

A. Provide type written tabulation that includes all settings for each protective relay, ground fault relay and circuit breaker solid-state trip devices. Enclose the table in a protective plastic sleeve and affix to the main service entrance equipment.

END OF SECTION 26 0573

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SECTION 26 0923

OCCUPANCY SENSORS

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 work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to wiring devices specified herein.

1.2 DESCRIPTION OF WORK:

A. The extent of occupancy sensor work is indicated by drawings and schedules.

B. Types of occupancy sensors in this section include the following:

1. Dual Technology Wall Switch
2. Dual Technology Wall Switch with Dimming and Daylight Control.
3. Dual Technology Ceiling Sensor w/ Control Pack

1.3 QUALITY ASSURANCE:

A. Comply with NEC and NEMA standards as applicable to construction and installation of occupancy sensors. Provide occupancy sensors that have been UL listed and labeled.

B. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems, motor loads and any other passive infrared or microwave systems.

1.4 SUBMITTALS:

A. Refer to Section 26 0502 for electrical submittal requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURER: The manufacturer shall have a minimum of five years of experience in the sensor and lighting control industry. Sensors and related relays shall be compatible with the specific lighting types controlled. All sensors shall be of the same manufacturer, mixing brands of sensors is not acceptable.

A. DUAL TECHNOLOGY WALL SWITCH: Where units are indicated provide a sensor that meets the following minimum requirements:

1. Sensor shall utilize PIR (Passive Infrared) to turn on the lights and then PIR or US (Ultrasonic) technologies to keep lights on.
2. Sensor shall incorporate an inrush current limiter circuit to protect the relay contacts.
3. Sensor shall utilize single or dual dry relay contacts for control of the lighting loads. Contractor shall verify requirements in coordination with the drawings.
4. Sensor shall have a self-adjusting time delay, selectable 5, 15 and 30 minutes.
5. Sensor shall have automatic sensitivity adjustment and be microprocessor controlled.
6. Sensor shall have light level sensing 0 to 200 footcandles.

7. Sensor shall have a 180 degree field of view, coverage up to 800 square feet and shall detect 6 inches of hand movement towards the sensor up to 300 square feet; and body motion towards the sensor up to 1000 square feet.
8. Sensor shall be rated for 0 to 800 watts at 120VAC and 0 to 1200 watts at 277VAC.
9. Sensor shall be automatic on and shall have an automatic to off override switch on the unit. Switch shall be equipped with an air gap switch to disconnect power to the lighting load.
10. Sensor shall have real time motion indicator on the front of the unit.
11. Sensor shall mount to a single gang switch box.
12. Subject to compliance with the above requirements. Provide models of one of the following:
    a. Douglas
    b. Greengate ONW-D
    c. Wattstopper

B. DUAL TECHNOLOGY WALL SWITCH WITH DIMMING AND DAY-LIGHT CONTROL: Where units are indicated, provide a sensor that meets the following minimum requirements:

1. Dual technology sensors shall have one of its two technologies, not require motion to detect occupancy.
2. Sensors shall offer a minimum on timer of at least 15 minutes, in order to prevent all cycling of lamps before they have burned for the lamp manufacturers minimum recommended time period.
3. Sensors shall utilize an occupancy time delay that keeps lights on after last detected occupancy. Factory default setting of the occupancy time delay shall be 15 minutes.
4. Manual adjustment to the occupancy time delay so as to increase it shall be accommodated.
5. Sensor shall be capable of switching both 120 VAC and 277 VAC.
6. Sensor shall recess into single gang switch box and fit standard GFI opening.
7. Sensor shall meet NEC grounding requirements by providing a dedicated ground connection and intrinsically grounding through its mounting strap.
8. Line and load wire connections shall be interchangeable.
9. Wall switch sensor shall have field programmable adjustments for selecting operational modes, occupancy time delays, minimum on time, and photocell set-point.
10. Sensor shall be capable of both auto-on and manual operation.
11. Combination photocell/dimming sensors set point and deadband shall be automatically calibrated through the sensors microprocessor by initiating the automatic set point programming procedure. Min and max dim settings as well as set point may be manually entered.
12. Subject to compliance with the above requirements, provide models of one of the

following:

a. Douglas

b. Sensor-switch – N5X-PDT-D Series

c. Wattstopper – DW-311 (No Daylight Dimming, use when daylighting is not required)

C. DUAL TECHNOLOGY CEILING SENSOR: Where units are indicated, provide a sensor that meets the following minimum requirements:

1. Sensor shall incorporate ultrasonic (microphonics) and infrared technologies in a single unit.
2. Sensor shall be Class 2, low voltage; capable of mounting in the ceiling for maximum coverage.
3. Sensor shall use internal microprocessor for motion signal analysis and automatic self-adjustment.
4. Sensor shall have automatic self-adjustment algorithm that adjusts timer and sensitivity settings to maximize performance and minimize energy usage.
5. Sensor shall have manual time-out adjustment from 8 minutes to 32 minutes and automatic time out from 8 minutes to 100 minutes.
6. Sensor shall have test time-out setting of 8 seconds, with automatic return to 8 minutes after one hour if sensor is left in test mode.
7. Sensor's microprocessor shall automatically extend timer by 1 hour in response to recognition to false off condition. After 5 hours, sensor reduces extended time by 30 minutes and continues to reduce by 30 minute increments over the next few days.
8. Sensor's microprocessor shall automatically reduce either PIR or ultrasonic sensitivity in response to false on condition.
9. Sensor microprocessor will automatically monitor PIR background threshold signal level and makes corresponding sensitivity adjustments automatically.
10. Sensor microprocessor algorithm shall incorporate automatic adaptation to continuous airflow.
11. For airflow that is so intense as to mask motion, sensor shall flash indicator LED code to indicate excessive airflow.
12. Sensor's microprocessor shall use a four week learning period and develop a circadian calendar.
13. An internal 24 hour 7 day clock establishes what periods the room is typically occupied, biasing sensor to keep lights on while normally occupied and off when normally unoccupied.
14. Sensor shall have selection settings for the following dual technology schemes:
    a. High Sensitivity and High Confidence (miser mode)
15. Sensor shall be available with either 180 degrees or 360 degrees coverage pattern.
16. Infrared lens shall have 360 degree field of view. Two types of lens shall be available, standard and extra dense.
17. Sensor shall have a variety of mask inserts for PIR coverage rejection to prevent false tripping.
18. Transducers shall be protected from tampering.
19. Sensor shall have manual adjustments for timer and sensitivities and override switches to force manual adjustment mode.

20. Sensor shall have adjustable sensitivity from 0% to 100% for both ultrasonic and infrared.
21. Controls shall be behind cover to resist tampering. All adjustments shall be accessible from the front of the sensor.
22. Sensor shall be available with a photocell adjustment from 20 to 3,000 Lux.
23. Sensor shall provide internal operating status and settings confirmation via LED motion lamp indicator.
24. Sensor shall have two (if 180 degree) or three (if 360 degree) real time LED motion indicators visible from the front of the unit: Red = infrared; green = ultrasonic.
25. Subject to compliance with the above requirements, provide models of one of the following:
    a. Douglas
    b. Hubbell-ATD Series
    c. Sensor Switch-CM-PDT Series
    d. Wattstopper-DT Series
    e. Mytech-Omni-DT Series
    f. Lithonia - LMTO Series
    g. Leviton – OSC UOW Series
    h. Greengate OMC – DT Series

D. 24 VDC POWER/CONTROL PACK: Where units are indicated, provide a power/control pack that meets the following minimum requirements:

1. Control module shall consist of a DC power supply and a dry contact relay for switching a lighting load.
2. Control module shall consist of a DC power supply and a dry contact relay for HVAC control.
3. Control module shall be available in versions to accept 120, and 277 VAC line voltages.
4. Output shall be 24VDC nominal, and shall be inherently safe, low voltage, limited power output (Class 2).
5. Output shall supply 100mA current, in addition to current consumed internally to operate internal relay.
6. Relay shall utilize normally open, silver alloy dry contacts, and shall be rated for a 20A ballast load at 120V and 277V.
7. Relay function shall not require more than 5 mA control current to operate.
8. Control module shall have line voltage wiring, consisting of input voltage and relay contact connections, exiting from one end, and low voltage DC connections, consisting of ground, power, and control wires, exiting from the other end.
9. Control module shall be sized to fit inside a standard 4” x 4” junction box.
10. Control module shall be equipped with a 1/2” EMT threaded male fitting on the line voltage end, such that it may be mounted to the outside of a junction box with the line voltage wiring internal to the box and the low voltage wiring external.
11. Control module shall be equipable with accessory 1/2” EMT threaded male fitting on the low voltage end, such that it may be mounted to the inside of a ballast cavity with the box and line voltage wiring internal to the cavity and the low voltage wiring external.

12. Slave module shall be available for switching additional circuits. Slave module has same construction and specifications as control module except without power supply function.
13. Subject to compliance with the above requirements, provide models of one of the following:
    a. Douglas
    b. Hubbell-CU Series
    c. Sensor Switch-PP-20 Series
    d. Wattstopper-BEP Series
    e. Mytech-MP Series
    f. Lithonia - LPCS Series
    g. Greengate SP20-MV Series
    h. Leviton – OSC/OSA Series

PART 3 – EXECUTION

3.1 INSTALLATION OF LIGHTING CONTROL EQUIPMENT:

A. Install occupancy 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.

B. Comply with requirements of NEC, and applicable portions of NECA's "Standard of Installation" pertaining to general electrical installation practices.

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. Contractor shall be on site as required, to adjust lighting control units for proper operation.

E. Mount the switchpack in a standard 4" junction box. Mount sensor to a standard 4” junction boxes. Refer to manufacturer supplied mounting instructions.

F. All lighting programing shall meet the requirements of the IECC 2018 or current energy code applied to the project.

3.2 FIELD QUALITY CONTROL:

A. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of system with requirements.

B. System start-up: Provide a factory authorized technician to verify the installation and test the system.

C. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

D. Contractor shall visit the job site 3 months after the owner has taken occupancy and adjust any units not operating properly, otherwise remove and replace with new units.

3.3 PRODUCT SUPPORT AND SERVICES:

A. System Start-Up: Provide a factory authorized technician to verify the installation, test the system, and train the owner on proper operation and maintenance of the system. Before requesting start-up services, the installing contractor shall verify that:

1. The sensors have been fully installed in accordance with manufacturer’s

installation instructions.

2. Low voltage wiring for overrides and sensors is completed.
3. Accurate 'as-built' load schedules have been prepared.
4. Proper notification of the impending start-up has been provided to the owner's representative.
5. Programming of all switches, sensors, power packs, relays, etc. shall be completed by factory authorized technician, prior to final and training.

B. Factory support: Factory telephone support shall be available at no cost to the owner during the warranty period. Factory assistance shall consist of assistance in solving programming or other application issues pertaining to the control equipment. The factory shall provide a toll free number for technical support.

C. Functional Testing:

1. The owner shall hire a third party that will conduct and certify the functional testing.

2. Lighting controls devices shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working conditions in accordance with the construction documents, manufacturer's instructions and code requirements. The following shall be performed:

   a. Certify that sensors have been located, aimed and calibrated per manufacturer recommendations.

   b. Status indicator operates properly.

   c. Fixtures that are controlled by auto-on controls turn on to permitted level.

   d. Fixtures that are controlled by manual on controls operate when manually activated.

   e. Fixtures do not turn on incorrectly due to HVAC or movement outside the controlled area.

   f. Confirm that occupancy sensors turn off after space is vacated and do not turn on unless space is occupied.

   g. Simulate unoccupied conditions and confirm that vacancy sensors only turn on manually and turn off after space is vacated.

3. The party responsible for the functional testing shall provide documentation that the installed lighting controls meet or exceed all performance criteria and shall not be directly involved in the design or construction of the project.

3.4 WARRANTY:

A. Manufacturer shall provide a one (1) year limited warranty on lighting control system. A ten (10) year limited warranty shall be provided on the lighting control relays.

3.5 RECORD DRAWINGS:

A. Refer to Section 26 0502 for electrical Record Drawings Requirements (Following Lighting Controls).

3.6 MANUFACTURER AUTHORIZED PERSONNEL TRAINING:

A. Building Operating Personnel Training: Train Owner's building personnel in procedures for starting-up, testing and operating lighting control system equipment.

END OF SECTION 26 0923

SECTION 260943

LIGHTING CONTROL EQUIPMENT

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 work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Provide a lighting control system, including all system components, wiring, and any ancillary equipment necessary for a complete and working system. The system shall include all necessary components to achieve control and monitoring of all lighting fixtures, supporting both relay-switched and dimmed lighting solutions and controlled receptacles.

B. Electrical drawings show general zoning intent and lighting control narrative.

C. Energy Code: The system shall comply with latest edition of IECC energy code.

D. Types of lighting control equipment specified in this section, includes the following:

1. Low voltage relay control panels
2. Occupancy sensors
3. Daylight sensors
4. Wallstations/Switches
5. Lighting Load Controllers (Room Controllers)
6. Emergency Lighting Control Units/Generator Transfer Devices

E. Requirements are indicated elsewhere in these specifications for work including but not limited to raceways, electrical boxes and fittings required for installation of lighting control equipment, not work of this section.

1.3 QUALITY ASSURANCE:

A. Manufacturers: Firms regularly engaged in manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years. To ensure a uniform installation and single responsibility, all switching and dimming equipment described herein shall be supplied by a single manufacturer.

B. Installer: Qualified with at least 3 years of successful installation experience on projects with lighting control equipment installation work similar to that required for project.

C. NEC Compliance: The control system shall comply with all applicable National Electrical Codes regarding electrical wiring standards.

D. NEMA Compliance: The control system shall comply with all applicable portions of the NEMA Standard regarding the types of electrical equipment enclosure.

E. Codes and Standards: Provide units that meet the requirements of IEEE Std. 2000.1.1999.

F. Independent Testing Laboratory: Provide units that have been tested and listed under UL 916 energy management equipment.

G. Component Pre-testing: All control equipment shall undergo strict inspection standards. The equipment shall be previously tested and burned-in at the factory prior to installation.

1.4 SUBMITTALS:

A. Refer to Section 26 0502 for electrical submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide lighting control equipment of one of the following;

1. Lutron Vive Lighting Controls
2. GreenGate Controls
3. Acuity nLight Controls
4. Leviton Lighting Controls

B. Regarding Wireless Systems: Not approved per district standard.

C. Manufacturer's representative for division 26 and bidding controls shall be accountable for the comprehensive lighting controls package's finalization in alignment with the design intent depicted in the drawings and complying with IECC 2021 requirements. The lighting representative is required to develop detailed shop drawings demonstrating the lighting control system's topology and the essential connections necessary for its proper functioning. Lighting control devices shown are to provide general intent only. Manufacturers representative to provide all additional devices and modify device locations as required to meet IEC 2021 requirements

2.2 SYSTEM DESCRIPTION:

A. The lighting control system shall provide seamless control and monitoring of all lighting included in the scope of work regardless of whether it is relay switched or dimmed.

B. The lighting control system shall consist of low voltage relay control panels with programmable switch inputs, the panel shall be microprocessor controlled with a touchscreen interface display. The touchscreen shall provide relay status information viewable through a protected windowed enclosure. All local programming shall be permissible through the self-prompting touchscreen.

C. Programmable intelligence shall include:

1. Time of day control (64 time-of-day/holiday schedules)
2. 32 holiday dates
3. Timed inputs (adjustable from 1 to 99 minutes)
4. Timed override (from touchscreen, adjustable from 1 to 999 minutes, then resumes normal schedule)
5. Pre-set controls
6. Auto daylight savings adjust

7. Low voltage Dimming/Central Dimming Controls:
    a. 0-10V dimming capability
    b. Daylighting control via 0-10V dimming relays and programming
    c. DMX or other dimming protocols as indicated on plans
8. Astronomical clock with offsets
9. Local control (from touchscreen and local switch)
10. Digital wallstations/switches
11. Flash warning of impending off for occupants
12. Network override

D. The controller shall permit lighting to be overridden on for after-hours use or cleaning. The controller shall provide priority and masking choices to allow for customizing the functions of switch inputs, thereby enabling wallstations/switches to function differently at different times of day. These overrides shall be digital, network or hard-wired inputs.

E. The lighting control system shall be fully programmable through PC programming software. Programming shall be permitted through a direct RS-232 connection, modem or TCP/IP.

1. Shall include with user-friendly software suitable for operation on computer workstations which serve as central control stations for the selection and operation of lighting scenes.

2. All software shall be programed by the vendor and delivered ready to use. This program shall include preparation of all graphics, and displays required as a part of this project.

F. The control system shall provide networking between lighting control panels. The network shall support up to a maximum of 254 control panels. Panels shall permit data sharing for global controls. All inputs shall be transferable over the network to create any switching pattern.

G. The lighting control system shall log all control events. Log reports shall be available through the integral touchscreen or enterprise software.

H. All lighting programing shall meet the requirements of the IECC 2021 or current energy code applied to the project.

2.3 EQUIPMENT:

1. Low Voltage Dimming (0-10V):
    a. Capable of controlling any 0-10V source with the required dimming channels.
    b. 0-10V analog voltage signal.
    c. Provide isolated 0-10V output signal conforming to IEC 60929.
    d. Sink current via IEC 60929.
    e. Source current.

2. Indoor Lighting: Provide a sensor with a Fresnel lens providing for a 60° cone shape response area. The unit shall work with a range between 10-100 foot-candles.

3. Wallstations: Provide low voltage push-button type switches up to 8 button configurations to match requirements of lighting control within the room. Provide factory engraved labeling for individual push buttons. Provide in a color to match wiring devices and coverplates to match devices and plates in Wiring Devices (Section 26 2726). Wallstation shall connect to the room controller via the room controller local network. Wallstations that require user interface to allow for raise/lower control of dimming, loads shall include a slider function or similar. All wallstations shall have the ability to be independently program or be re-programmed on site and without the need to replace or send the device to the manufacturer for re-programming.
4. Provide wiring in conduit located within the walls and non-accessible ceilings. Provide wiring above accessible ceilings in conduit to system enclosure to system enclosure.

B. Room Controllers:

1. The room controller shall provide the following functionality;
   a. Provide interface with room occupancy sensor to provide lighting and receptacle control and be programmable as either manual on/automatic off. Provide interface with room wallstations to provide multi-level switching and/or variable dimming. Provide interface with daylight sensors to provide daylighting controls of lighting fixture via multi-level (step dimming) and/or variable dimming.
2. The room controller shall be a fully functional lighting control system to match the room lighting and control requirements. The controller shall provide the following features:
   a. Separate compartments for line voltage, emergency voltage and low voltage connections.
   b. Breakouts for direct conduit connections.
   c. Dual voltage (120/277 VAC)
   d. Low voltage connections using standard RJ-45 connectors.
   e. Zero cross circuitry for each load.
   f. Relay and 0-10V dimming zone configuration to match room requirements.
   g. The ability to be independently program or be re-programmed on site and without the need to replace or send the device to the manufacturer for re-programming.
3. Emergency Lighting: When the room controller is provided with emergency relay, the controller shall be UL 924 Listed and monitor the normal power circuit. The UL 924 relay will track the normal power operation. Upon loss of normal power the emergency lighting will be forced on to full bright (if dimming) until normal power is restored. The following features shall be included:
   a. 120/277 VAC
   b. Push-to-test
4. Daylight sensors shall work with the room controller to provide automatic daylight dimming capabilities for loads connected to the room controller. The daylight sensor shall include the following features:
   a. An additional photodiode that measures only the visible spectrum.
   b. The sensor shall have three light level ranges;
      i. Low (3-300 LUX), high (30-3000 LUX) and direct sun (300-30,000 LUX).
   c. The sensor shall provide the capability of controlling multiple (up to

three) daylight zones for dimming daylight harvesting.

d. The sensor shall include an internal photodiode that measures light in a 60 degree angle cutting off the unwanted light from the interior of the room.

5. Ceiling Mounted Occupancy Sensors: Sensors shall utilize dual-technology (ultrasonic and infrared technologies) and have the following additional features:

a. Sensor shall be class 2, low voltage; capable of mounting in the ceiling for maximum coverage.

b. Sensor shall have automatic self-adjustment algorithm that adjusts timer and sensitivity settings to maximize performance and minimize energy usage.

c. Sensor shall have 360 degree field of view.

d. Sensor shall incorporate non-volatile memory such that all settings and parameters are saved in protected memory.

e. Sensor shall have time delays from 10 to 30 minutes.

f. Sensor shall provide a visual means of indication that motion is being detected via an LED.

g. Sensors shall have readily accessible, user adjustable settings for time delay and sensitivity.

h. Provide internal additional isolated relay with NO, NC and common outputs for use with HVAC control, data logging and other control options.

6. Wallstations: Provide low voltage push-button type switches up to 8 button configurations to match requirements of lighting control within the room. Provide factory engraved labeling for individual push buttons. Provide in a color to match wiring devices and coverplates to match devices and plates in Wiring Devices (Section 26 2726). Wallstation shall connect to the room controller via the room controller local network. Wallstations that require user interface to allow for raise/lower control of dimming, loads shall include a slider function or similar. All wallstations shall have the ability to be independently program or be re-programmed on site and without the need to replace or send the device to the manufacturer for re-programming.

C. Emergency Power Control (CEPC)/ Emergency Lighting Control Units (ELCU)/Generator Transfer Devices (Required when not built into Room Controller, Relay Panel, etc):

1. The Emergency Power Control (CEPC)/Lighting Control Unit (ELCU) shall provide all required functionality to allow any standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building. The unit shall be installed flush to the ceiling so that test switch & LED’s are in plain view of room occupants as required by some local electrical codes.

2. The device shall automatically illuminate connected emergency loads upon utility power interruption, regardless of room switch position. (NEC 700.24)

3. Local room switch or lighting control shall turn both regular & emergency luminaires on at the same time (no dedicated emergency room switch required).

4. The emergency lighting control unit shall allow control of emergency lighting fixtures in tandem with normal lighting in an area while ensuring that emergency lighting will turn on immediately to full brightness upon loss of normal power supplying the control device. Emergency lighting operation shall be independent

for each controlled area and shall not require a generalized power failure for proper operation.

5. The unit shall be compatible with 2-wire, 3-wire, 0-10V, & DALI dimming systems & ballasts.

6. The device shall be self-contained, measure 1.70” x 2.97” x 1.64,” and provide integral one half inch pip nipple mount with snap in locking feature for mounting into a standard junction box KO.

7. The device shall have normally closed dry contacts capable of switching 20 amp emergency ballast loads @ 120-277 VAC, 60 Hz, or 10 amp tungsten loads @ 120 VAC, 60 Hz.

8. The device shall have universal rated voltage inputs provided for normal power sense and normal switched power at 120-277 VAC, 60 Hz.

9. The device shall have an integral momentary test switch. Pressing and holding this switch shall instantly force the unit into emergency mode and turn on emergency lighting. Releasing the test switch shall immediately return the unit to normal operation.

10. The unit shall provide dedicated leads and 24 VDC source for connection to remote test switch, fire alarm system, or other external system capable of providing a normally closed dry contact closure. Breaking contact between the terminals shall force and hold the emergency lighting on until the terminals are again closed. An integral LED indicator shall indicate the unit’s current remote activation status.

11. The device shall provide separate LEDs to indicate the presence of normal and emergency power sources. The LEDs shall indicate the unit’s current operational mode (normal or emergency).

12. The device’s normal power input lead shall be connected to the line side of the control device such that any upstream fault causing a loss of power, including the tripping of the branch circuit breaker, will force the unit into the emergency mode and turn on the emergency lighting.

13. The unit shall automatically switch emergency lighting on and off as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting on regardless of the state of any external control device until normal power is restored.

14. The unit shall utilize zero crossing circuitry to protect relay contacts from the damaging effects of inrush current generated by switching electronic ballast loads.

15. The unit shall have UL 94-V0 or UL 94-5VA flame rating & be approved for installation above the suspended ceiling.

16. To ensure quality and reliability, the unit shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.

17. The device shall not generate any objectionable electrical or mechanical noise.

18. The unit shall be UL and cUL listed and labeled for connection to both normal and emergency lighting power sources.

PART 3 - EXECUTION:

3.1 INSTALLATION OF LIGHTING CONTROL EQUIPMENT:

A. Install lighting control system components and ancillary equipment as indicated, in accordance with equipment manufacturers written instructions, and with recognized industry practices, to ensure that lighting control equipment complies with requirements.

B. Comply with Requirements of NEC, and applicable portions of NECA's 'Standard of Installation' pertaining to general electrical installation practices.

C. Coordinate with other electrical work, including raceways, electrical boxes and fittings, as necessary to interface installation of lighting control equipment work with other work.

D. Electrical Identification: Refer to Section 26 0553 for requirements.

3.2 FIELD QUALITY CONTROL:

A. Upon completion of installation and after circuitry has been energized, demonstrate capability and compliance of system with requirements.

B. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

3.3 PRODUCT SUPPORT AND SERVICES:

A. System Start-Up: Provide a factory authorized technician to verify the installation, test the system, and train the owner on proper operation and maintenance of the system. Before requesting start-up services, the installing contractor shall verify that:

1. The control system has been fully installed in accordance with manufacturer's installation instructions.
2. Low voltage wiring for overrides and sensors is completed.
3. Accurate 'as-built' load schedules have been prepared for each lighting control panel.
4. Proper notification of the impending start-up has been provided to the owner's representative.
5. Programming of all wallstations/switches, relays, groups of relays and interfaces with building automation shall be completed by factory authorized technician, prior to final and training.

B. Factory support: Factory telephone support shall be available at no cost to the owner during the warranty period. Factory assistance shall consist of assistance in solving programming or other application issues pertaining to the control equipment. The factory shall provide a toll free number for technical support.

3.4 PROGRAMMING:

A. Program of all lighting control systems as directed by the electrical engineer and/or owner. Meet with the electrical engineer at their office prior to preparation of shop drawings to discuss specific programming and zoning requirements of system(s). Each networked or standalone system shall be programmed to revert back to its normal "ON" position one hour after selecting a scene or raising or lowering a lighting zone.

B. All lighting programing shall meet the requirements of the IECC 2021 or current energy code applied to the project.

C. Integrate lighting controls into classroom or room AV touch Screen and Shade Controller. Provide interface as required. Coordinate with AV integrator to integrate with Touch Panel and GUI within the room. Lighting shall provide multiple presets and slider control options.

1. Sensors can be used to trigger automated settings for shades and projector screens based on room occupancy, ambient light level, etc.

2. Program lighting and shades, per owner's requirements, to operate in accordance with the defined lighting presets within the space.

3.5 COMMISSIONING:

A. A lighting control system requires at least one site visit for proper commissioning. If multiple site visits are required, the first ensures that the contractor is trained to install the system correctly. On the second, the factory trained engineer will start up the system, ensure that it is operating according to specification, and perform initial programming. The third visit is for the purposes of refining the programming, and training the owner/end user on the system.

B. Provide factory-certified field service engineer to ensure proper system installation and operation under following parameters:

1. Certified by the equipment manufacturer on the system installed.

2. Site visit activities:

a. Verify connection of power feeds and load circuits.

b. Verify connection of controls.

c. Verify system operation control by control, circuit by circuit.

d. Obtain sign-off on system functions.

e. Demonstrate system capabilities, operation and maintenance and educate Owner's representative on the foregoing.

3. At least three site visits to accomplish the following tasks:

a. Prior to wiring:

i. Review and provide installer with instructions to correct any errors in the following areas:

1. Low voltage wiring requirements

2. Separation of high and low voltage wiring runs

3. Wire labeling

4. Load schedule information

5. Switching cabinet locations and installation

6. Physical locations and network addresses of controls
7. Ethernet connectivity
8. Computer-to-network connections
9. Load circuit wiring
10. Connections to other systems and equipment
11. Placement and adjustment of Occupancy Sensors
12. Placement and adjustment of Photocells

b. After system installation:

i. Check and approve or provide correction instructions on the following:

1. Connections of power feeds and load circuits
2. Connections and locations of controls
3. Connections of low voltage inputs
4. Connections of the data network

ii. Turn on system control processor and upload any pre-programmed system configuration

iii. Verify cabinet address(es)

iv. Upload pre-programmed system configuration and information to switching and/or dimming cabinets

v. Check load currents and remove bypass jumpers

vi. Verify that each system control is operating to specification

vii. Verify that each system circuit is operational according to specification

viii. Verify that manufacturers' interfacing equipment is operating to specification

ix. Verify that any computers and software supplied by the manufacturer are performing to specifications

x. Verify that any remote WAN (Wide Area Network) connections are operating properly

xi. Have an owner's representative sign off on the above-listed system functions

c. Before project completion and hand-off:

i. Demonstrate system capabilities and functions to owner's representative

ii. Train owner's representative on the proper operation, adjustment, and maintenance of the system.

C. Notification: Upon completion of the installation, the contractor shall notify the manufacturer that the system is ready for formal checkout. Notification shall be given in writing a minimum of 21 days prior to the time factory-trained personnel are required on site. Each field installed RJ45 connection must be tested prior to system interconnection. A test report must be furnished to manufacturer prior to scheduling commissioning activity. Manufacturer shall have the option to waive formal turn-on.

D. Turn-On: Upon completion of all line, load and interconnection wiring, and after all fixtures are installed and lamped, Manufacturer's Certified Technician shall completely check the installation prior to energizing the system. Each installed relay system shall be tested for proper ON/OFF operations, and proper LED illumination. Each installed control cabinet shall be tested verifying that each controlled load adjusts to the selected setting and that all switch LED's illuminate properly.

E. Provide written commissioning report including space/room names and numbers indicating list of all lighting equipment and devices tested and verifying proper operation of the system. Report shall include corrections, programming information/file, warranties, and owner's representative sign off on the above-listed system functions.

F. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

3.6 RETRO-COMMISSIONING:

A. During the one year warranty period, provide retro-commissioning services at three month, six month, nine month, and one year marks. Provide at least 4 hours of commissioning service for each of the four retro-commissioning periods. This will include meeting with the Owner to receive feedback on the system and making changes to the system including programming, task tuning.

3.7 MAINTENANCE:

A. Enable the end user to order new equipment for system expansion, replacements, and spare parts.

B. Make new replacement parts available for a minimum of ten years from the date of manufacture.

C. Manufacturing shall provide telephone technical support by factory personnel 24 hours a day, 7 days a week. Project cost overruns and delays can occur without this service. Answering services can add to frustration and delay the resolution of any problems or issues. Manufacturers who do not offer factory-direct technical support on a 24/7 basis should not be acceptable on this project.

D. Provide factory-direct technical support hotline 24 hours per day, 7 days per week.

E. Offer renewable annual service contracts, to include parts, factory labor, and annual training visits. Make service contracts available up to ten years after date of system commissioning.

3.8 WARRANTY:

A. Manufacturer shall provide a one (1) year limited warranty on lighting control system. A ten (10) year limited warranty shall be provided on the lighting control relays.

3.9 RECORD DRAWINGS:

A. Refer to Section 26 0502 for electrical O & M requirements.

3.10 TRAINING:

A. Provide four (4) hours of recorded training in two 2 hour sessions on the operation and use of the lighting control equipment, at job site, at no cost to the Owner.

B. Provide a USB Flash device to the owner containing the information specified below. The media shall include all information required to allow the Owner to change the schedules themselves. The media shall contain a minimum of following:

1. CAD drawing files of ‘as-built’ lighting control components and point to point connections.

2. General configuration programming.

3. Job specific configuration programming to include schedule.

C. Tutorial file on complete programming of lighting control system

END OF SECTION 260943

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SECTION 26 1010

ENERGY & POWER METERING SYSTEM

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 work of this section.

B. Division-26 Basic Materials and methods sections apply to work of this section except as otherwise indicated. See Section 26 2713 Service Entrance, Section 26 2413 Switchgear and Switchboards, and Section 26 2416 Panelboards.

1.2 DESCRIPTION OF WORK:

A. Provide equipment to measure, monitor, acquire and store electrical metering data, and to communicate energy and power data to the building BAS/BMS (Building Automation System/Building Management System). Communication of data to the BAS/BMS system shall use the BACnet protocol.

B. System shall include, but not be limited to, electronic primary meters and sub-meters, meter/monitor devices, current and voltage transformers as required, microprocessors, communications network, communications modules and network equipment, and all ancillary equipment to provide a complete and operating Energy and Power Metering System.

C. System shall measure kWh energy use, kW power, power factor, frequency, voltage and current data, and shall store and communicate this data separately for the following individual load categories: Total HVAC System; Interior Lighting; Exterior Lighting; Plug Loads; Process Load; and Building Operations and Other Miscellaneous Loads.

TABLE C405.12.2
ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.

D. System shall also comply with 2021 IECC C405.12 Energy Monitoring Measurement Requirements and Energy Monitoring Credit 406.10.

E. System shall store all meter data for at least 36 months.

F. PRIMARY METERING: Primary metering equipment shall be utility-grade equipment. Functions provided by the Energy and Power Metering System equipment and components in this section include the following:

1. Data acquisition, data storage and communication to the the building BAS/BMS system
2. Overall building electrical energy use data in kWh stored and communicated to the BAS/BMS at 15-minute intervals
3. Overall building electrical power demand data in kW stored and communicated to the BAS/BMS at 15-minute intervals
4. Overall building electrical power factor data stored and communicated to the BAS/BMS at 15-minute intervals.
5. Building voltage data stored and communicated to the BAS/BMS at 15-minute intervals
6. Building current data in amperes stored and communicated to the BAS/BMS at 15-minute intervals

G. SUBMETERING: Submetering equipment shall be revenue-grade equipment. Functions provided by the Energy and Power Metering System equipment and components in this section include the following:

1. **Total HVAC System** equipment electrical energy in kWh, power demand in kW, voltage and current data stored and communicated to the BAS/BMS at 15-minute intervals
2. **Interior Lighting** energy in kWh, power demand in kW, voltage and current data stored and communicated to the BAS/BMS at 15-minute intervals
3. **Exterior Lighting** energy in kWh, power demand in kW, voltage and current data stored and communicated to the BAS/BMS at 15-minute intervals
4. **Plug Load** energy in kWh, power demand in kW, voltage and current data stored and communicated to the BAS/BMS at 15-minute intervals
5. **Process Load** energy in kWh, power demand in kW, voltage and current data stored and communicated to the BAS/BMS at 15-minute intervals
6. **Building Operations and Other Miscellaneous Loads** energy in kWh, power demand in kW, voltage and current data stored and communicated to the BAS/BMS at 15-minute intervals

H. Any additional equipment and accessories required for a fully functional metering system to meet the intent of the specifications shall be provided whether or not specifically listed herein.

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable pertaining to construction and installation of electrical/electronic metering systems and equipment.

B. Comply with applicable requirements of UL safety standards pertaining to electrical/electronic metering systems and equipment. Provide equipment that has been UL listed and labeled.

C. All work shall be done by expert technicians qualified in the field with knowledge of metering systems and experience installing similar systems.

D. The manufacturer's qualified technician shall calibrate, test and adjust the metering system and make all final connections to the metering equipment

1.4 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. The acceptable manufacturers listed below shall provide Energy and Power Metering System equipment and install the necessary equipment within their electrical switchboards and panelboards.

B. Subject to compliance with requirements, provide products of one of the following:

1. Leviton Manufacturing Co. Inc. (Basis of Design)
2. Cutler-Hammer Products, Eaton Corp.
3. General Electric Co.
4. Siemens Energy & Automation, Inc.
5. Square D Co.

2.2 EQUIPMENT AND COMPONENTS:

A. GENERAL: Energy and Power Metering system:

1. Shall measure, meter, record and store electrical energy and power data.
2. Shall automatically communicate electrical energy and power data.
3. The system shall utilize multiple submeters and power monitor devices throughout the electrical distribution system, located in multiple switchboards and panelboards that serve lighting, plugloads, hvac equipment and laboratories. The system shall acquire and store energy and power data from the primary meter and from each of the submeters/power monitor devices over a network, with the result that the data shall is centralized in the Central Energy & Power Display/Processor. The Central Energy & Power Display/Process shall communicate the data to the BAS/BMS systems.
4. All set-up parameters shall be stored in non-volatile memory and retained in the event of a control power failure.

B. PRIMARY METER equipment shall be a utility-grade device, located within manufacturer's switchboard. Meter equipment monitor devices shall:

1. be designed for use with current inputs from standard instrument current transformers.
2. shall measure line-to-line voltage each phase, line-to-neutral voltage each phase, line current each phase, frequency, power in kW of each phase (and total), apparent power each phase (and total).
3. shall calculate line-to-line average 3-phase voltage, average current, total power demand in kW, power factor, and accumulated energy in kWh.

C. SUBMETER equipment shall be revenue-grade devices,. located within manufacturer's switchboards and panelboards. Meter equipment monitor devices shall:

1. be designed for use with integral current sensors or external current transformers
2. shall measure line-to-line voltage each phase, line-to-neutral voltage each phase, line current each phase, frequency, power in kW of each phase (and total), apparent power each phase (and total).
3. shall calculate line-to-line average 3-phase voltage, average current, total

power demand in kW and accumulated energy in kWh.

D. POWER MONITOR DEVICES:

1. similar to Leviton "Leviton VerifEye Metering System"
2. integral built-in current transformers up to 400 amperes
3. monitors watts, watt-hours, watt demand, currents, voltages, frequency, reactive power, apparent power factor and displacement power factor

E. CURRENT TRANSFORMERS:

1. Solid-core transformers, with ratings corresponding to the feeder breaker current rating.
2. plus or minus 2% accuracy
3. UL listed

F. CENTRAL ENERGY & POWER DISPLAY/PROCESSOR:

1. Microprocessor-based.
2. Shall acquire and store energy and power data from primary meter, submeters and power monitor devices.
3. Shall communicate data to the BAS/BMS. Shall report data at 15-minute intervals as specified and described in paragraphs 1.2.F and 1.2.G.
4. Shall store all metering data for at least 36 months.
5. Shall report hourly, daily, monthly and annual energy use for each primary meter, submeter and power monitor device to comply with 2021 IECC 405.12/406 Energy Metering requirements.

G. COMMUNICATION COMPONENTS AND NETWORKS:

1. Provide communications and control network, network hardware, software to effect acquisition of energy and power data between the Central Energy & Power/Display Processor and primary meter, submeters and power monitor devices. Include all interconnection connectivity, active equipment, communication interfaces, wires and cables as required.
2. Provide communications modules, hardware, interface cards, etc. and software to communicate between the Central Energy & Power Display Processor and the building BAS/BMS system.

H. CABLE SYSTEMS:

1. RS-485 Cable: PVC jacketed, paired, 2 pairs, twisted, No. 22 gauge minimum, stranded.
2. Unshielded Twisted Pair - Category 6 minimum, as specified in Telecom cabling section.
3. Other cables: as recommended by Energy & Power Metering system manufacturer.
4. Certified for use at data speeds up to at least 100 Mbps.

I. FACTORY REQUIREMENTS:

1. Energy and Power meters, submeters, power monitoring devices and ancillary components shall be factory-installed, wired and tested prior to shipment to the jobsite.
2. All control power, CT, PT and data communications wire shall be factory-wired, harnessed and terminated within the switchboards, panelboards and equipment enclosures.

3. Where external connections are required, terminal blocks shall be provided and the manufacturer's drawings shall clearly identify the interconnection requirements for external wiring, including wire type to be used.

PART 3 - EXECUTION

3.1 INSTALLATION OF ENERGY AND POWER METERING SYSTEM:

A. Install equipment and components in accordance with manufacturer's written instructions with recognized industry practices to ensure that installation complies with requirements of NEMA and NEC standards, and applicable portions of NECA's "Standard of Installation".

B. Energy and Power monitoring components shall be factory installed, wired and tested prior to shipment to the jobsite.

C. Network hardware shall be installed in accordance with the manufacturer's instructions.

D. Software (as applicable) shall be designed specifically for energy, power monitoring and control. The software shall be a standard product offering with no customization required. The software shall be configured by the manufacturer's qualified technician.

E. Electrical Identification: As required by the manufacturer, and as specified in Section 260553 Electrical Identification for requirements.

3.2 WIRING:

A. All wiring external to metering equipment, switchboards and panelboards shall be installed in metallic conduit and provided with necessary junction and pull boxes. The electrical contractor shall provide all wiring and conduit, boxes, and rough-in. Wiring types and characteristics shall comply with equipment manufacturer recommendations. Care shall be exercised in wiring installation to avoid damage to the cables. Cables shall be pulled continuous without splicing, leaving ends in lengths as directed by the manufacturer's qualified technician.

B. After all wiring, circuits and cables have been pulled and completed from one extremity to the other, the electrical contractor shall check all wiring free of opens, shorts and grounds.

C. Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground.

D. The manufacturer's qualified technician shall calibrate, test and adjust the metering system and make all final connections to the metering equipment.

3.3 FIELD QUALITY CONTROL:

A. Prior to system energization, check all power and control wiring for electrical continuity and communications wiring for signal integrity.

B. EQUIPMENT CHECK-OUT: Provide equipment check-out by manufacturer's trained and authorized technician.

C. TESTNG: Upon completion of installation of system, demonstrate system operation, capability and compliance with requirements. Where possible, correct malfunctioning equipment at site, then retest to demonstrate compliance. Otherwise, remove and replace with new equipment, and proceed with retesting.

D. Subsequent to wire and cable connections, energize electrical system and demonstrate functioning in accordance with requirements.

3.4 TRAINING:

A. Provide a minimum of four hours of in-service training with owner personnel.

END OF SECTION 26 1010

SECTION 26 2200

TRANSFORMERS

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 work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Extent of transformer work is indicated by drawings and schedules. Work includes complete installation and electrical connections.

B. Types of transformers in this section include the following:

1. Dry-type Distribution Transformers

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to installation and construction of electrical power/distribution transformers; with applicable portions of NEMA Std. Pub. Nos. TR1 and TR27; and with applicable ANSI/IEEE standards pertaining to power/distribution transformers.

B. Comply with applicable portions of ANSI/UL 506; "Safety Standard for Specialty Transformers". Provide distribution transformers that have been UL listed and labeled.

C. All characteristics, definitions, and terminology, except as specifically covered in this specification, shall be in accordance with the latest revision of the following ANSI/IEEE, NEMA, and Department of Energy standards.

1. C57.12.00 – IEEE Standard for Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
2. C57.12.28 – Pad-Mounted Equipment - Enclosure Integrity.
3. C57.12.34 – IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers (2500 kVA and Smaller) - High Voltage: 34500GrdY/19920 Volts and Below; Low-Voltage: 480 Volt 2500 kVA and Smaller (issued in March 2005 - combines C57.12.22 and C57.12.26).
4. C57.12.90 – IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and IEEE Guide for Short-Circuit Testing of Distribution and Power Transformers.
5. C57.12.91 – Guide for Loading Mineral-Oil-Immersed Transformers.
6. NEMA TR 1-1993 (R2000) – Transformers, Regulators and Reactors, Table 0-2 Audible Sound Levels for Liquid-Immersed Power Transformers.
7. NEMA 260-1996 (2004) – Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas.
8. 10 CFR Part 431 – Department of Energy – Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.
9. NEMA ST-20 - Dry-Type Transformers for General Applications

10. NEMA TP-1-2002 – Standards for transformer energy efficiency.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 - PRODUCTS

2.1 DRY -TYPE DISTRIBUTION TRANSFORMERS:

A. GENERAL: Except as otherwise indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.

B. MANUFACTURER: Subject to compliance with requirements, provide products of one of the following (for each type of transformer):

1. Acme Transformer Company
2. GE/ABB
3. Cutler Hammer Products, Eaton Corp.
4. Federal Pacific
5. Hevi-Duty Electric Div., General Signal Corp.
6. Jefferson Electric
7. Schneider Electric/Square D Co.
8. Hammond Power Solutions
9. Siemens Energy & Automation, Inc.

C. DRY-TYPE DISTRIBUTION TRANSFORMERS (GENERAL PURPOSE):

1. Provide factory-assembled, general-purpose, air-cooled, aluminum wound dry-type distribution transformers where shown; of sizes, characteristics, and rated capacities indicated. Provide primary winding with minimum of 4 full capacity taps; each 2-1/2 percent, two above and two below full-rated voltage for de-energized tap-changing operation.
2. Insulate with 220 degree C. UL recognized insulation system for 150° degree C rise above 40o ambient at full load.
3. Limit sound levels to the following (as determined by ANSI/NEMA standards):
    a. 30-50 KVA 45 dB
    b. 51-150 KVA 50 dB
    c. 151-300 KVA 55 dB
    d. 301-500 KVA 60 dB
    e. 501-1000 KVA 64 dB
4. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections. Equip terminal leads with connectors installed, suitable for copper or aluminum wiring. Cushion-mount transformer with vibration isolation supports. Provide transformers with ventilated, heavy gauge sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for wall and floor mounting as indicated.
5. The percent impedance voltage, as measured on the rated voltage connection, shall be per Table 2.

Table 2 Percent Impedance Voltage (Dry-Type)	
KVA Rating (Secondary Voltage < 700 V)	Impedance
0 - 75	3.00 – 5.75%
112.5 - 225	4.00 - 5.75%
300 and above	5.00 - 5.75%

D. DRY-TYPE DISTRIBUTION TRANSFORMERS (K-RATED):

1. Provide factory-assembled, air-cooled, copper wound dry-type distribution transformers where shown; of sizes, characteristics, and capacities indicated, and UL listed for non-sinusoidal current loads of K-factor 13 (shown on drawings). See ANSI/IEEE C57.110-1986 for K-factor and UL Std 1561. Provide primary windings with a minimum of 4 full capacity taps; each 2-1/2 percent, two above and two below full-rated voltage for de-energized tap changing operator.

2. Insulate with 220 degree C UL recognized insulation system for 150° degree C rise above 40oC ambient at full load.

3. Include an electrostatic shield for attenuation of spikes, line noise, and transients. Wind coils with foil wrap to minimize effects caused by harmonic currents above the fundamental frequency. Provide transformer with neutral conductor and lugs sized at two times rated phase current.

4. Limit sound levels to the following:

   a. 30-50 KVA 45 dB

   b. 51-150 KVA 50 dB

   c. 151-300 KVA 55 dB

   d. 301-500 KVA 60 dB

   e. 501-1000 KVA 64 dB

5. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections. Equip terminal leads with connectors installed, suitable for copper or aluminum wiring. Cushion-mount transformer with vibration isolation supports. Provide transformers with ventilated, heavy gauge sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Provide transformers suitable for wall and floor mounting as indicated.

6. The percent impedance voltage, as measured on the rated voltage connection, shall be per Table 3.

Table 3 Percent Impedance Voltage (Dry-Type, K-rated)	
KVA Rating (Secondary Voltage < 700 V)	Impedance
0 - 75	3.00 – 5.75%
112.5 - 225	4.00 - 5.75%
300 and above	5.00 - 5.75%

PART 2 – EXECUTION

2.1 INSTALLATION OF TRANSFORMERS

A. Install transformers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate transformer installation work with electrical raceway and wire/cable work, as

necessary for proper interface.

C. Connect transformer units to electrical wiring system; comply with requirements of other Division-26 sections.

D. MOUNTING: Provide concrete pad under all floor mounted equipment and equipment mounted at grade. Anchor transformer to pad with 3/8" expansion anchors at each corner of enclosure. Provide vertical and lateral support systems for all transformers that are supported from overhead structure. See drawings for support and attachment details. Provide neoprene vibration isolators at each anchor point.

E. GROUNDING: Provide tightly fastened equipment grounding and bonding connections for transformers.

F. TESTING: Upon completion of installation of transformers, energize primary circuit at rated voltage and frequency from normal power source and test transformers, including, but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.

END OF SECTION 26 2200

SECTION 26 2413

SWITCHGEAR AND SWITCHBOARDS

RESOLUT HAS PREVIOUSLY PROCURED THE CT/MS AND MDP SWITCHGEAR DUE TO PROJECT SCHEDULE CONSTRAINTS. DIVISION 26 SHALL INCLUDE WITHIN THEIR BID PACKAGE THE RECEIVING AND INSTALLATION OF THE PREVIOUSLY PROCURED CT/MS AND MDP ALONG WITH THE ENTIRETY OF THE REMAINING GEAR, EQUIPMENT, FEEDERS, AND THE COMPREHENSIVE INSTALLATION OF THE ENTIRE ONE-LINE AND ELECTRICAL INFRASTRUCTURE WITHIN THEIR BID. DIVISION 26 WILL SHOULDER THE RESPONSIBILITY OF BOTH RECEIVING THE ITEMS AND ENSURING THE COMPLETE INSTALLATION OF THE ELECTRICAL SYSTEM, ALONG WITH ALL OTHER NECESSARY PREREQUISITES TO ESTABLISH A FULLY FUNCTIONAL ELECTRICAL SYSTEM. COORDINATE WITH CODALE ELECTRICAL SUPPLY AS REQUIRED.

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 work of this section.

B. Division-26 Basic Materials and methods sections apply to work of this section except as otherwise indicated. See Section 262713 Service Entrance, for metering requirements. See Section 264313 for SPD requirements.

1.2 DESCRIPTION OF WORK:

A. Extent of switchgear and switchboards is indicated by drawings and schedules.

B. Types of switchgear and switchboards in this section include the following:

1. AC Dead Front Switchboards (600V)

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to construction and installation of electrical switchgear and switchboards. Provide switchgear and switchboards that have been UL listed and labeled.

1.4 SUBMITTALS:

A. Refer to Section 26 0502 for electrical submittal requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide products of one of the following (for each type of switchgear and switchboard):

B. AC DEAD FRONT SWITCHBOARDS (600V):

1. Square D Co. (Basis of Design)
2. Cutler-Hammer Products, Eaton Corp.
3. GE/ABB
4. Siemens Energy & Automation, Inc.

2.2 EQUIPMENT SECTIONS AND COMPONENTS:

A. GENERAL: Except as otherwise indicated, provide switchgear and switchboards of types, sizes, characteristics, and ratings indicated, that comply with manufacturer's standard design, materials, components, and construction in accordance with published product information, and as required for a complete installation. See drawings and Section 262815. Series rated systems are not accepted.

B. Overcurrent Protection Devices, for main and branch devices. Provide switchgear, switchboards, and overcurrent devices of one manufacturer.

C. Provide each service entrance switchboard with surge protective device (SPD) mounted in a separate enclosure adjacent to the switchboard/switchgear. See Section 264313 for SPD unit requirements. Provide in-line fusing for each phase of the device, and wire in accordance with manufacturer's instructions, with conductor length not exceeding 18".

2.3 AC DEAD-FRONT SWITCHBOARDS (600V):

A. Provide factory assembled, dead front, metal enclosed, floor standing, self supporting, group mounted, secondary power switch boards, of sizes, electrical ratings and characteristics indicated consisting of panel (vertical) units, and containing circuit breaker and fusible switch assemblies of quantities, ratings and types indicated. Provide aluminum main bus and connections to switching devices of sufficient capacity to limit rated continuous current operating temperature rise to UL standard; with main bus and tap connections silver-surfaced or tin-plated and tightly bolted for maximum interrupting capacity. Provide accessibility of line and load terminations from front of switchboard. Prime and paint switchboard with manufacturer's standard finish and color. Equip units with built-in lifting eyes and yokes; provide individual panel (vertical) units, suitable for bolting together at project site, and constructed for the following environment:

1. Installation: Indoors, NEMA Type 1.

B. Limit height of upper most overcurrent device handle to 6'-2" to accommodate 4" curb.

PART 3 - EXECUTION

3.1 INSTALLATION OF SWITCHGEAR AND SWITCHBOARDS:

A. Install switchgear and switchboards where shown, in accordance with manufacturer's written instructions with recognized industry practices to ensure that switchgear and switchboards comply with requirements of NEMA and NEC standards, and applicable portions of NECA's "Standard of Installation".

B. Install all switchgear and switchboards on 4" high concrete curb and bolt equipment to curb with 5/8" anchors at each corner and at intervals not to exceed 4 feet along perimeter. Install concrete wiring trench under switchgear and switchboards; 18" deep, and 4" smaller in length and width than equipment base. Install grounding bushings on conduits penetrating trench.

C. Arrange conductors within switchgear and switchboards in neat fashion, and secure with suitable ties.

D. Tighten fuses, if any, in each switchgear and switchboard.

E. Provide and install spare fuse cabinet in main electrical room.

F. Electrical Identification: Refer to Section 260553 for requirements.

G. Provide a surge protective device on each switchboard located on the emergency distribution system. Refer to Section 26 4313 for requirements.

3.2 ADJUST AND CLEAN:

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL:

A. Prior to energization of switchgear and switchboards, check with ground resistance tester phase to phase and phase to ground insulation resistance levels to ensue requirements are fulfilled.

B. Prior to energization, check switchgear and switchboards for electrical continuity of circuits, and for short circuits.

C. Subsequent to wire and cable connections, energize switchgear and switchboard and demonstrate functioning in accordance with requirements.

END OF SECTION 26 2413

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SECTION 26 2416

PANELBOARDS

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 work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to panelboards specified herein.

1.2 DESCRIPTION OF WORK:

A. The extent of panelboard and enclosure work, is indicated by drawings and schedules.

B. Types of panelboards and enclosures in this section include lighting and appliance panelboards, and power distribution panelboards.

1.3 QUALITY ASSURANCE:

A. Provide units that have been UL listed and labeled. Comply with NEC as applicable to installation of panelboards, cabinets, and cutout boxes. Comply with NEC pertaining to installation of wiring and equipment in hazardous locations. Comply with NEMA Stds. Pub No. 250, "Enclosures for Electrical Equipment (1000 volt maximum). Pub No. 1, "Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less".

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

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

1. Square D Company (Basis of Design)
2. Cutler Hammer Products, Eaton Corp.
3. GE/ABB
4. Siemens Energy & Automation, Inc.

2.2 PANELBOARDS:

A. GENERAL:

1. Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated. Equip with number of unit panelboard devices as required for complete installation. Fully equip "spaces" with hardware to receive breaker or switch of size indicated. Provide CU/AL rated lugs of proper size to accommodate conductors specified.

B. POWER DISTRIBUTION PANELBOARDS:

1. Provide dead-front safety type power distribution panelboards as indicated, with switching and protective devices in quantities, ratings, types and with arrangement shown. Equip with aluminum bus bars, full-sized neutral bus and ground bus. Provide fusible or circuit breaker branch and main devices as

indicated. Series rated systems are not acceptable. See Section 262815, Overcurrent Protection Devices.

C. LIGHTING AND APPLIANCE PANELBOARDS:

1. Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types, and arrangement shown. Provide bolt-on thermal magnetic type branch breakers. Where multiple breakers are indicated, provide with common trip handle. Series rated systems are not acceptable. Equip with aluminum bus bars, full-sized neutral bus, and ground bus.

D. PANELBOARD ENCLOSURES:

1. Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage minimum 16-gage thickness. Provide door-in-door hinged fronts. Provide fronts with adjustable indicating trim clamps, and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed door hinges and door swings as indicated. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor. Provide enclosures fabricated by same manufacturer as overcurrent devices contained therein Bolt engraved plastic laminate labels indicating panel name and voltage on the interior and exterior of panelboards.
2. Provide floor to ceiling panel extensions for all surface mounted panels located outside of mechanical and electrical rooms.

E. FINISH:

1. Coat interior and exterior of surface with manufacturer's standard color; baked on enamel finish.

F. ELECTRICAL IDENTIFICATION:

1. Refer to Section 260553 for requirements.

PART 3 – EXECUTION

3.1 INSTALLATION OF PANELBOARDS:

A. GENERAL:

1. Install panelboards and enclosures where indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", in compliance with recognized industry practices to ensure products fulfill requirements.
2. Provide a surge protective device on each panelboard located on the emergency distribution system. Refer to section 26 4313 for requirements.

B. MOUNTING:

1. Provide 4" high concrete curb under floor standing distribution panelboards.
2. Coordinate installation of panelboards and enclosures with cable and raceway installation work. Anchor enclosures firmly to walls and structural surfaces, ensuring they are permanently and mechanically secure. Arrange conductors neatly within enclosure, and secure with suitable nylon ties. Fill out panelboard's circuit directory card upon completion of installation work. Utilize actual final building room numbers, not architectural numbers used on drawings. Identify individual lighting circuits and individual receptacle circuits by room served. Label circuit breakers to identify location of subpanel or equipment supplied using room numbers and equipment names. Include room number with equipment circuit designations. All directories to be typewritten.

END OF SECTION 26 2416

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SECTION 26 2713

SERVICE ENTRANCE

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 work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Extent of service-entrance work is indicated by drawings and schedules.

B. Switchboards, panels, disconnects, transformers, etc., used for service-entrance equipment are specified in applicable Division-26 sections, and are included as work of this section.

C. Consult local utility relative to all costs for line extensions, connections, etc., and include all costs for bringing service to the facility in base bid. Confirm location of point of service before bidding.

D. Provide labor and materials as required to accomplish power company metering in accordance with power company standards and requirements.

E. Provide concrete vaults and concrete pads of size and type required for service transformers. Verify location, size, openings, reinforcing requirements with Murray City Power (MCP/Local Utility) before beginning work. Comply with MCP clearance requirements.

1.3 QUALITY ASSURANCE:

A. Comply with NEC and NEMA standards as applicable to construction and installation of service-entrance equipment and accessories. Provide service-entrance equipment and accessories that are UL-listed and labeled, and equipment marked, "Suitable for use as Service Equipment".

B. Provide and locate properly sized concrete padsvaults for power company furnished pad/vault mounted transformers in accordance with power company clearance requirements.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 – PRODUCTS

2.1 SERVICE - ENTRANCE EQUIPMENT:

A. GENERAL: Provide service-entrance equipment and accessories, of types, sizes, ratings and electrical characteristics indicated, that comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation, and as herein specified.

B. Provide each service entrance switchboard with Surge Protective Devices as required by Section 264313.

2.2 OVERCURRENT PROTECTIVE DEVICES:

A. GENERAL: Provide overcurrent protective devices complying with Division-26 section "Overcurrent Protective Devices", and as indicated on drawings.

2.3 METERING:

A. METER SOCKETS: Provide meter sockets that comply with requirements of local utility company supplying electrical power to service-entrance equipment of building project.

B. METERS: Provide meters, current and potential transformers, selector switches, wiring, etc. for a complete metering system. Provide meter of same manufacturer as switchboard (equal to Square D Power Logic Circuit Monitor, Class 3020, Model CM-3250), integrally mounted in service equipment, completely wired with control power input. Provide capability for metering the following data:

INSTANTANEOUS READINGS	DEMAND READINGS
RMS Current Values	Current Values
Phase A Current	Average Demand Current Phase A
Phase B Current	Average Demand Current Phase B
Phase C Current	Average Demand current Phase C
3-Phase Average Current	Peak Demand Current Phase A
Apparent RMS Current	Peak Demand Current Phase B
RMS Voltage Values	Peak Demand Current Phase C
Phase A-B Voltage	Real Power Values
Phase B-C Voltage	Average Demand Real Power
Phase C-A Voltage	Predicted Demand Real Power
Phase A-N Voltage	Peak Demand Real Power
Phase B-N Voltage	Phase C-N Voltage
Power Factor Values	Energy Readings
Phase A Power Factor	-
Phase B Power Factor	Energy Accumulated
Phase C Power Factor	Reactive Energy Accumulated
3-Phase Total Power Factor	-
3-Phase Total Power Values	-
Real Power, 3-Phase Total	-
Reactive Power, 3-Phase Total	-
Apparent Power, 3-Phase Total	-
Frequency	-
Temperature	-

C. Provide with integral display, selection keys, and indicting LEDs. For each instantaneous reading, provide a running maximum and minimum history in non-volatile memory, capable of externally operated reset. Provide "waveform capture" feature to allow subsequent analysis of actual current and voltage profile for harmonic distortion.

2.4 RACEWAYS AND CONDUCTORS:

A. GENERAL: Provide raceways and conductors complying with applicable Division-26 Basic Materials and Methods sections.

B. WALL AND FLOOR SEALS: Provide wall and floor seals complying with Division-26 Basic Materials and Methods section "Raceways".

C. Fluidized thermal backfill (FTB): Provide fluidized thermal backfill (FTB) around service lateral conduits (Service Lateral: Conductors/conduits between RMP transformer and meter. See NEC Article 230) when there are seven or more conduits specified. FTB shall comply with requirements of MCP Electrical Service Requirements.

PART 3 – EXECUTION

3.1 INSTALLATION OF SERVICE-ENTRANCE EQUIPMENT:

A. Install service-entrance equipment as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that service-entrance equipment fulfills requirements. Comply with applicable installation requirements of NEC and NEMA standards.

B. Coordinate with other work, including utility company wiring, as necessary to interface installation of service-entrance equipment work with other work.

C. Install all floor standing service equipment on 4" high concrete curb and bolt equipment to curb with 3/8" anchors at each corner and at intervals not to exceed 8' along perimeter. Install concrete wiring trench under floor standing equipment; 12" deep, and 4" smaller in length and width than equipment base. Install grounding bushings on conduits penetrating trench.

3.2 GROUNDING:

A. Provide system and equipment grounding and bonding connections for service-entrance equipment and conductors, as required.

3.3 ADJUST AND CLEAN:

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred enclosure surfaces to match original finishes.

3.4 FIELD QUALITY CONTROL:

A. Upon completion of installation of service-entrance equipment and electrical circuitry, energize circuitry and demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

END OF SECTION 26 2713

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SECTION 26 2726

WIRING DEVICES

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 work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to wiring devices specified herein.

1.2 DESCRIPTION OF WORK:

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 that are intended to carry but not utilize electric energy.

B. Types of electrical wiring devices in this section include the following:

1. Receptacles
2. Switches
3. Timer Switches
4. 0-10V & ELV LED LAMP DIMMERS
5. Cord caps
6. Cord connectors
7. Flat Panel Display Wall Box

1.3 QUALITY ASSURANCE:

A. Comply with NEC and NEMA standards as applicable to construction and installation of electrical wiring devices. Provide electrical wiring devices that have been UL listed and labeled.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 - PRODUCTS

2.1 FABRICATED WIRING DEVICES:

A. GENERAL:

1. Provide factory-fabricated wiring devices, in types, and electrical ratings for applications indicated and complying with NEMA Stds. Pub No. WD 1.

B. Provide wiring devices (of proper voltage rating) as follows:

	RECEPTACLE	SWITCHES			
MFGR		1-POLE	3-WAY	4-WAY	W-PILOT
Hubbell	BR20XTR	HBL 1221	HBL 1223	HBL 1224	HBL 1221-PL

Bryant		1221	1223	1224	1221-PL
Pass Seymour	TR63X	20AC1	20AC3	20AC4	20AC1-RPL
Leviton	TWR20-X	1221	1223	1224	
Cooper	TR5362	1221	1273	1224	1221-PL

C. Provide devices in colors selected by Architect. Provide red devices on all emergency circuits.

D. SURGE PROTECTIVE (SPD) RECEPTACLES:

1. Provide SPD receptacles having 4 series parallel 130V MOV's capable of a minimum of 140 joules suppression. Provide units with visual (and audible) surge status indicators to monitor condition of surge circuit; visual indicator to be "on" when power present and suppression circuit is fully functional. (Audible indicator shall sound a "beep" alarm approximately every 30 seconds if suppression circuit has been damaged.) Provide NEMA 5-20R, 20 amp, 125V receptacle of one of the following manufacturers:

	MANUFACTURER	
SPECIFICATION GRADE	HUBBELL	PASS SEYMOUR
Duplex Recept-Visual only	5350	5352 XXXSP
Duplex Recept-Visual/Audible	5352	5362 XXXSP
Single Recept-Visual only	5351	N/A
Duplex Recept-Isol Gnd, Visual/Audible	IG5352S	IG5362 XXXSP
Single Recept-Isol Gnd, Visual only	IG5351S	N/A
HOSPITAL GRADE	HUBBELL	PASS SEYMOUR
Duplex Recept-Visual/Audible	8300HS	8300 XXXSP
Single Recept-Visual only	8310HS	N/A
Duplex Recept-Isol Gnd, Visual/Audible	IG8300HS	IG8300 XXXSP
Single Recept-Isol Gnd, Visual only	IG8310HS	N/A

2. Provide (1) SPD receptacle in all Flat Panel Display Wall Boxes (‘DP’ symbol)

3. Color of devices selected by Architect. Provide red devices on all emergency circuits.

E. GROUND-FAULT INTERRUPTER:

1. Provide general-duty, duplex receptacle, ground-fault circuit interrupters; feed-thru types, capable of protecting connected downstream receptacles on single circuit; grounding type UL-rated Class A, Group A, 20-amperes rating; 120-volts, 60 Hz; with solid-state ground-fault sensing and signaling; with 5 milliamperes ground-fault trip level; color as selected by Architect. Provide Hospital grade where required elsewhere by specification or drawings. Provide units of one of the following:

a. P&S/Sierra

b. Hubbell

c. Leviton

d. Square D

F. USB RECEPTACLE

1. Provide duplex receptacle with two (2) USB 3.0 amps, 5VDC, 2.0 Type A charging ports.

2. Provide products of one of the following:

a. Bryant – USB20-X
b. Cooper – TR7736-X
c. Hubbell – USB20X2-X
d. Legrand – TR5362USB-X
e. Leviton – T5832-X

G. TAMPER RESISTANT RECEPTACLES:

1. All receptacles throughout the project shall be tamper resistant as required by the NEC.

2. Provide products of one of the following:

a. Leviton-TWR20-X
b. Hubbell – BR20XTR
c. Pass Seymour – TR63X
d. Cooper – TR5362

H. WEATHER-RESISTANT RECEPTACLES

1. Provide weather-resistant receptacles in outdoor locations such as under roofed open porches, canopies, marquees, etc.

2. Provide products of one of the following:

a. Pass & Seymour 2095TRWRXXX.
b. Hubbell GFTR20XX

I. CORD CAPS AND CONNECTORS:

1. Provide 3, 4 and 5-wire grounding, cap plugs, and connectors of ampere and voltage rating required, for final equipment, and as indicated otherwise on drawings.

2. Provide products of one of the following:

a. Cooper
b. General Electric
c. Hubbell
d. Leviton
e. P&S

J. TIMER SWITCH:

1. Provide a timer switch with the following features and functionalities. Provide switch that mounts in a standard wall box. Provide a Decora style cover plate that matches the other switches on the project. Provide color of switch chosen by Architect.

a. Provide Digital time switches that automatically turn lights off after a preset time. User programmable wall switch for astronomical and scheduled control. Electroluminescent back-lit LCD shows timer countdown. Compatible with all electronic ballasts, ELV, MLV, LED, and motor loads.

i. Wattstopper TS-400: 120/277VAC; 50/60 Hz

ii. Greengate

b. Provide Astronomical time switches that automatically turns lighting or other loads on and off according to user programming. Time-out settings range shall range from 5 minutes to 12 hours for flexibility. Electroluminescent back-lit LCD shows timer countdown. Compatible with all electronic ballasts, ELV, MLV, LED, and motor loads. Program schedule per the owner's requirements.

i. Wattstopper RT-200: 120/277VAC; 50/60 Hz

K. 0-10V & ELV LED LAMP DIMMERS:

1. Provide single-pole, semi-conductor modular type 0-10V control for 0-10V fluorescent ballasts/LED drivers & 3-wire fluorescent ballast/LED driver dimmers for fixtures; 60 hertz, with wattage and voltage as indicated, continuously adjustable slider control, and with electromagnetic filters to reduce noise and interference to minimum. Construct with continuously adjustable trim potentiometer for adjustment of low end dimming. Dimmer shall match lamp/ballast combination. Color as selected by Architect. Provide devices manufactured by one of the following:

a. Pass & Seymour (Titan Series)

b. Lutron (Nova Series)

c. Lutron (Diva Series)

2.2 WIRING DEVICE ACCESSORIES:

A. WALL PLATES:

1. Provide stainless steel cover plates in all finished areas. Provide galvanized steel plates in unfinished areas. Provide blank coverplates for all empty outlet boxes.

B. WEATHER-PROTECTING DEVICE ENCLOSURES:

1. Where required for compliance with NEC 406-8 (receptacles installed outdoors for use other than with portable tools or equipment), provide weather-tight device covers that provide complete protection with the cord and cap inserted into the wiring device. Provide units that mount on either single or double gang devices.

2. Provide products of one of the following extra-duty low-profile expandable in-use weatherproof covers for exterior mounted installations:

a. Intermatic:

i.	WP7000W	Single-Gang/White Cover
ii.	WP7000G	Single-Gang/Gray Cover
iii.	WP7000BR	Single-Gang/Brown Cover
iv.	WP7200W	Double-Gang/White Cover

v. WP7200G Double-Gang/Gray Cover

vi. WP7200BR Double-Gang/Brown Cover

b. TayMac:

i. ML500W Single-Gang/White Cover

ii. ML500G Single-Gang/Gray Cover

iii. ML500Z Double-Gang/Brown Cover

iv. ML2500G Single-Gang/Gray Cover

c. Color chosen by architect.

3. Provide products of one of the following for roof mounted installations:

a. Intermatic WP1020 or WP1030

b. P&S WIUC10C or WIUC20c

2.3 FLAT PANEL DISPLAY WALL BOX:

A. Provide a factory assembled display wall box made of 14 gauge steel. Wall box shall have provisions for a UL Listed single gang box for mounting of duplex receptacle and additional back box with a minimum of (1) 1 ¼" conduit opening to allow for low voltage terminations. Coordinate low voltage plate configuration with drawings. Provide device manufactured by one of the following:

1. Stud Walls:

a. FSR Metal Products – PWB-100

i. Provide additional PN: 54406 Low-Voltage Conduit Entry Box (as required for conduit entry from top/bottom)

b. FSR Metal Products – PWB-FR-450 (Use at fire rated walls)

2. Masonry Walls

a. FSR Metal Products – PWB-CMU8

PART 3 – EXECUTION

3.1 GENERAL

A. Install wiring devices as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation" and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other work, including painting, electrical box and wiring work, as necessary to interface installation of wiring devices with other work. Install devices in boxes such that front of device is flush and square with coverplate. Drawings are small scale and, unless dimensioned, indicate approximate locations only of outlets, devices, equipment, etc. Locate outlets and apparatus symmetrically on floors, walls and ceilings where not dimensioned and coordinate with other work. Verify all dimensioned items on job site. Consult architectural cabinet, millwork, and equipment shop drawings before beginning rough-in of electrical work. Adjust locations of all electrical outlets as required to accommodate work in area, and to avoid conflicts with wainscoat, back splash, tackboards, and other items.

C. Where stranded conductors have been utilized, provide solid pigtails to terminate at device.

D. Provide receptacles in surface raceway at 12" on center unless indicated otherwise.

E. Install wiring devices only in electrical boxes that are clean; free from excess building

materials, dirt, and debris.

F. Install blank plates on all boxes without devices.

G. Delay installation of wiring devices until wiring work and painting is completed. Provide separate neutral conductor from panel to each GFI receptacle.

H. Install GFI receptacles for all receptacles installed in the following locations:

1. Restrooms, locker rooms, kitchens, within 6 feet of any sink, or when serving vending machines and electric drinking fountains.

2. Indoor wet locations, non-dwelling garages, elevator rooms and pits.

3. Outdoors, and on rooftops.

4. Dwelling unit garages, crawlspaces and unfinished basements, accessory buildings, boathouses, and receptacles for boat hoists.

5. Label all receptacles (non-GFI), protected downstream of a GFI receptacle or protected by GFI circuit breaker, with an indication that it is protected.

I. Where light switches or wall box dimmers are specified, provide a separate neutral for each phase of the branch circuits that switches or dimmers are connected.

J. Electrical Identification: Refer to Section 260553 for requirements.

3.2 PROTECTION OF WALL PLATES AND RECEPTACLES:

A. At time of substantial completion, replace those items, that have been damaged, including those stained, burned and scored.

3.3 GROUNDING:

A. Provide electrically continuous, tight grounding connections for wiring devices, unless otherwise indicated.

3.4 TESTING:

A. Prior to energizing circuitry, test wiring devices for electrical continuity and proper polarity connections. After energizing circuitry, test wiring devices to demonstrate compliance with requirements.

END OF SECTION 26 2726

SECTION 26 2815

OVERCURRENT PROTECTIVE DEVICES

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 work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to overcurrent protective devices specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of overcurrent protective device work is indicated by drawings and schedules and specified herein. Overcurrent protective devices specified herein are for installation as individual components in separate enclosures; and for installation as integral components of switchboard and panelboards. See Section 262413, Switchgear and Switchboards, and Section 262416, Panelboards.

B. Types of overcurrent protective devices in this section include the following for operation at 600 Volts and below:

1. Molded case thermal circuit breakers
2. Molded case solid-state circuit breakers
3. Insulated case circuit breakers
4. Power circuit breakers
5. Fuses

C. Refer to other Division-26 sections for cable/wire and connector work required in conjunction with overcurrent protective devices.

1.3 QUALITY ASSURANCE:

A. Comply with NEC requirements and NEMA and ANSI standards as applicable to construction and installation of overcurrent devices.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide products of one of the following (main and branch device manufacturer must be same as panelboard and/or switchboard manufacturer):

B. CIRCUIT BREAKERS AND FUSIBLE SWITCHES:

1. Cutler Hammer Products, Eaton Corp.
2. General Electric Co.
3. Square D Co.
4. Siemens Energy and Automation

C. MOLDED CASE THERMAL TRIP CIRCUIT BREAKERS:

1. Provide factory-assembled, molded case circuit breaker for power distribution panelboards and switchboards; and for individual mounting, as indicated. Provide breakers of amperage, voltage, and RMS interrupting rating shown, with permanent thermal trip and adjustable instantaneous magnetic trip in each pole. Series rated systems are not acceptable. Construct with overcenter, trip-free, toggle type operating mechanisms with quick-make, quick-break action and positive handle indication. Construct breakers for mounting and operating in any physical position and in an ambient temperature of 40 degrees C. Provide with mechanical screw type removable connector lugs, AL/CU rated, of proper size to accommodate conductors specified.

2. Circuit breakers 15 amps through 399 amps shall be molded case thermal trip circuit breakers.

D. MOLDED CASE SOLID-STATE CIRCUIT BREAKERS:

1. Provide factory-assembled, molded case solid-state circuit breakers for power distribution switchgear and switchboards. Provide breakers of amperage, voltage and RMS interrupting rating shown, and with solid-state trip mechanisms. Breakers shall be UL listed for application at 100% of their continuous ampere rating.

2. Circuit breakers 400 amps through 1199 amps shall be molded case solid-state circuit breakers.

3. Solid-state trip mechanisms shall have the following functions: Adjustable long time ampere rating; adjustable long time delay; adjustable short time pick up; adjustable short time delay and adjustable instantaneous pick up.

E. INSULATED CASE CIRCUIT BREAKERS

1. Provide factory-assembled, insulated case circuit breakers for power distribution switchgear and switchboards. Provide breakers of amperage, voltage and RMS interrupting rating shown, with solid-state trip mechanisms and with manual spring charging mechanism. Breakers shall be UL listed for application at 100% of their continuous ampere rating.

2. Circuit breakers 1200 amps and larger shall be insulated case circuit breakers.

3. Solid-state trip mechanisms shall have the following functions: Adjustable long time ampere rating; adjustable long time delay; adjustable short time pick up; adjustable short time delay and adjustable instantaneous pick up.

4. On service disconnect breakers where phase to ground voltage exceeds 150V and the breaker is capable of being set at or over 1000A (and also where GFP protection is indicated on the one line diagram for downstream breakers), the solid-state trip mechanism shall also include the following:

   a. Adjustable ground fault pick up and adjustable ground fault time delay, and ground fault test button.

   b. Over/under voltage trip

   c. Current imbalance trip

5. Provide an energy-reducing maintenance switch with local, lit status indicator to allow for a reduction of the instantaneous pickup and instantaneous delay settings for use during maintenance. Device shall mount in face of dead-front. The switch shall be provided by the same manufacturer as the circuit breaker.

6. Include integral phase failure (single-phasing) protection where phase failure (PF) is indicated on the one line diagram

F. PHASE FAILURE PROTECTION:

1. Provide phase failure protection on overcurrent protective devices as indicated, by means of a single-phase, dead phase, reverse phase relay (Taylor Electronics Md1 PNDR). Provide relay to operate shunt trip or capacitor trip as required to open overcurrent protective device upon malfunction. Provide relay with adjustable time delay.

G. GROUND FAULT PROTECTION:

1. Provide ground fault sensing and relaying equipment on all overcurrent protective devices where phase to ground voltage is in excess of 150 volts and the overcurrent protection device is capable of being set at or over 1000 amps. Provide ground fault sensing and relaying equipment on other devices as indicated.
2. Provide zero sequence current sensors for overcurrent protective devices; inputs compatible with relay. Construct sensor frame so it can be opened to prevent removal or installation around conductors without disturbing conductors. Provide test winding in sensor for testing operation of GFP unit including sensor pick-up relay, and circuit protection device operation.
3. Provide solid-state ground-fault relay, that requires no external source of electrical power, drawing energy to operate GFP system directly from output of current sensor. Construct with adjustable pick-up current sensitivity for GF current from 200 to 1200 amperes, with calibrated dial to show pick-up point settings. Provide factory-set time delay of 1.5 seconds and protection that precludes tampering with setting after installation.
4. Provide monitor panel capable of indicating relay operation, and provide means for testing system with or without interruption of service. Construct so GF system can not be left in an inactive or OFF state. Provide indicator lamps and TEST and RESET control switches.
5. MANUFACTURER: Subject to compliance with requirements, provide ground-fault sensing and relaying equipment of one of the following:
   a. General Electric Co.
   b. Brown Boveri Electric, Inc.
   c. HI-Z Corporation
   d. Pringle Electric Mfg. Co.
   e. Square D Co.

2.2 FUSES:

A. GENERAL: Except as otherwise indicated, provided fuses of type, sizes and ratings and electrical characteristics of a single manufacturer as follows. Provide fuses labeled UL Class L or UL Class R, current limiting and rated for up to 200,000 amperes. Provide Buss KAZ signal activating fuses where required elsewhere in specification.

B. Where fuses are shown feeding individual or groups of equipment items, comply with manufacturer's recommendation for fusing; adjust fuse size and type as necessary to comply with manufacturer's recommendation.

C. Provide and install spare fuse cabinet in main electrical room.

D. MAIN SERVICE AND FEEDER CIRCUITS: For fuse ratings over 600 amperes provide UL Class L Fuses (KRP-C, or A4BQ or LCL or KLPC). For fuse ratings up to 600 amperes, provide UL Class RK1 (KTN-R, KTS-R or A2K-R, A6K-R or NCCR, SCLR or KLN-R, KLS-R). If fuse directly feeds motors, transformers or other inductive load provide UL RK5 time delay (FRN-R, FRS-R or TR-R, TRS-R or ECN-R, ECS-R or FLN-R, FLS-R).

E. BRANCH CIRCUITS: For motor circuits, transformer circuits, or other inductive loads, provide UL Class RK5 (FRN-R, FRS-R or TR-R, TRS-R or ECN-R, ECN-S or FLN-R, FLS-A). For other circuits, provide UL Class RK1, (KTN-R, KTS-R OR A2K-R, A6K-R or NCLR, SCLR OR KLNR, KLSR).

F. MANUFACTURER: Subject to compliance with requirements, provide fuses of one of the following:

1. Bussman Mfg. Co.
2. Mersen (Ferraz Shawmut)
3. Reliance Fuse Div./Brush Fuse Inc.
4. Littlefuse, Inc.

PART 3 – EXECUTION

3.1 INSTALLATION OF OVERCURRENT PROTECTIVE DEVICES:

A. Install overcurrent protective devices as indicated, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.

B. Coordinate with work as necessary to interface installations of overcurrent protective devices with other work.

C. Install fuses in overcurrent protective devices. For motor circuits, fuse sizes shown on drawings are for general guidance only. Size fuses in accordance with fuse manufacturer's recommendation for given motor nameplate ampere rating. Test operation. If nuisance tripping occurs, increase fuse size and disconnect device (if necessary) as required to provide nuisance free tripping. Adjust fuse size properly for ambient temperature, frequent starting and stopping of motor loads, and for loads with long start times. Include all costs in bid.

D. After the switchgear is energized and just prior to Substantial Completion, the contractor shall ensure that the field-adjustable circuit breakers and solid-state circuit breakers and associated trip mechanisms have been set to the appropriate settings as recommended by the equipment Manufacturer (or as recommended by the electrical contractor's Protective Device Study if section 260573 has been included in the project). Time-current trip curves and trip setting information as was required in the Submittal portion of this specification shall be made available by the contractor at this time. Provide adjustments to circuit breakers and switchboard AIC ratings as deemed necessary by the analysis/report, with no additional cost to the Owner. Provide over current protection devices with larger frame sizes to ensure coordination has been achieved.

E. Field test all ground fault protective devices for proper operation; test to be performed by representative of the manufacturer. Include verification of complete time current trip characteristics.

F. Electrical Identification: Refer to Section 260553 for requirements.

3.2 FIELD QUALITY CONTROL

A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short-circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

END OF SECTION 26 2815

SECTION 26 2816

MOTOR AND CIRCUIT DISCONNECTS

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 work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to motor and circuit disconnect switches specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of motor and circuit disconnect switch work is indicated by drawings and schedule. Work includes complete installations and electrical connections.

1.3 QUALITY ASSURANCE:

A. Provide motor and circuit disconnect switches that have been UL listed and labeled. Comply with applicable requirements of NEMA Standards Pub. No. KS 1, and NEC.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. MANUFACTURER: Subject to compliance with requirements, provide products of one of the following (for each type of switch):

1. Cutler Hammer Products, Eaton Corp.
2. Square D Company
3. General Electric Company
4. Siemens Energy & Automation, Inc.
5. Cooper Bussmann

2.2 FABRICATED SWITCHES:

A. GENERAL: Provide disconnect and safety switches as indicated herein. Provide:

1. General duty switches on 240 Volt rated circuits.
2. Heavy duty switches on 480 volt rated circuits.
3. HP rated switches on all motor circuits.

B. GENERAL DUTY SWITCHES: Provide general-duty type, sheet-steel enclosed switches, fusible or non-fusible as indicated of types, sizes and electrical characteristics indicated; rated 240 volts, 60 hertz; incorporating spring assisted, quick-make, quick-break mechanisms. Provide single phase or three phase and with solid neutral as required by application. Equip with operating handle that is capable of being padlocked in OFF position. Provide NEMA 1 or NEMA 3R as required by application, unless noted. Provide

fusible switches with Class R rejection fuse clip kits.

C. HEAVY-DUTY SWITCHES: Provide heavy-duty type, sheet-steel enclosed safety switches, fusible or non-fusible as indicated, of types, sizes and electrical characteristics indicated; rated 600 volts, 60 hertz; incorporating quick-make, quick-break type mechanisms. Provide single phase or 3 phase, and with solid neutral as required by application, Equip with operating handle that is capable of being padlocked in OFF position. Provide NEMA 1 or NEMA 3R as required by application unless noted. Provide fusible switches with Class R rejection fuse clip kits.

D. FUSES: Provide fuses for switches, as required of classes, types and ratings needed to fulfill electrical requirements for service indicated. Provide spare fuses amounting to one spare fuse for each 10 installed but not less than three of any one type and size. See Section 262815 Overcurrent Protective Devices for fuse types.

E. Electrical Identification: Refer to Section 260553 for requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR AND CIRCUIT DISCONNECT SWITCHES:

A. Install motor and circuit disconnect switches where indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation" and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Coordinate motor and circuit disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.

C. Install disconnect switches used with motor driven appliances, and motors and controllers within sight of controller position.

D. For disconnect switches serving motors controlled by variable frequency drives, provide late-make, early-break auxiliary contacts on each disconnect switch. Provide Heavy-Duty switch. Wire auxiliary contact to VFD safety contact, such that disconnecting the motor will shut down the drive first, and closing the switch will start the drive only after power is applied to the motor.

E. For all disconnect switches serving single elevator applications, provide a Cooper Bussman Quik-Spec™ Power Module™ Switch.

1. Elevator Shutdown
2. Shunt Trip Voltage Monitoring
3. Selective Coordination
4. Fire safety signal interface
5. Auxiliary Contact (Hydraulic Elevator)
    a. Wire auxiliary contact to auxiliary power such that disconnecting the motor will disconnect the auxiliary power.

END OF SECTION 26 2816

SECTION 26 2913

MOTOR STARTERS

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 work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of Division-26 sections making reference to motor starters specified herein.

1.2 DESCRIPTION OF WORK:

A. Extent of motor starter work is indicated by drawings and schedules.

B. Types of motor starters in this section include the following:

1. AC Fraction Horsepower Manual Starters
2. AC Line Voltage Manual Starters
3. AC Non-Reversing Magnetic Starters
4. AC Combination Non-Reversing Magnetic Starters

1.3 QUALITY ASSURANCE:

A. Comply with NEC and NEMA Standards as applicable to wiring methods, construction and installation of motor starters. Comply with applicable requirements of UL 508, "Electric Industrial Control Equipment", pertaining to electrical motor starters. Provide units that have been UL-listed and labeled.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

A. Subject to compliance with requirements, provide products of one of the following (for each type and rating of motor starter):

1. Allen-Bradley Co.
2. Appleton Electric Co.
3. Crouse-Hinds Co.
4. Eaton Corp., Cutler Hammer Products
5. General Electric Co.
6. Siemens Energy & Automation, Inc.
7. Square D Co.

B. MAINTENANCE STOCK, FUSES: For types and ratings required, furnish additional fuses, amounting to one unit for every 10 installed units, but not less than 5 units of each, for both power and control circuit fuses.

2.2 MOTOR STARTERS:

A. GENERAL: Except as otherwise indicated, provide motor starters and ancillary components; of types, sizes, ratings and electrical characteristics indicated that comply with manufacturer's standard materials, design and construction in accordance with published information and as required for complete installations.

B. THERMAL OVERLOAD UNITS: Provide thermal overload units, sized to actual running full load current, not to motor plate current. Size heaters for mechanical equipment after air and water balancing have been completed.

C. AC FRACTIONAL HP MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide manual, single-phase, 1 and 2 pole, 300 volt AC max, fractional HP motor starters, of types, ratings and electrical characteristics indicated; equip with one piece thermal overload relay with field adjustment capability of plus or minus 10 percent of nominal overload heater rating; for protection of AC motors of 1 HP and less. (For manually controlled motors in excess of 1 HP, see Line Voltage Manual Starters specified herein). Provide starter with quick-make, quick-break trip free toggle mechanisms, green pilot lights, and with lock-off toggle operated handle. Mount surface units in NEMA 1 enclosures, unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location unless noted otherwise. Provide flush mounted units with coverplate to match wiring device coverplates.

D. AC LINE VOLTAGE MANUAL STARTERS (EQUAL TO SQUARE D CLASS 2510): Provide line voltage manual starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt AC max; equip with pushbutton operator, low voltage protection feature, and green pilot light. Provide starters with trip free mechanism such that contacts will open under load and remain open until thermal element has cooled, and unit is reset. Mount surface units in NEMA 1 enclosure, unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location, unless noted otherwise. Provide overlapping trim for flush mounted units.

E. AC NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8536): Provide line voltage magnetic starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volt max, with thermal overload protection in all phases and inherent under voltage release. Equip units with holding contact, 2 normally open, and 2 normally closed auxiliary contacts, unless noted otherwise. Provide fused control transformer in each starter and 120V control coil. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide NEMA 1 enclosure unless noted otherwise. Provide NEMA 3R enclosure in exterior or damp location, unless noted otherwise. Equip all spare starters complete with items as specified herein.

F. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8539): Provide line voltage combination starters, of types, ratings and electrical characteristics indicated; 2 or 3 pole, 600 volts max with non-reversing magnetic starters as specified herein; in common cubicle or enclosure with motor circuit protector. Provide motor circuit protector, instantaneous trip circuit breaker as indicated and adjust to comply with manufacturer's recommendations. Mount hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide combination starters for individual mounting, or for group mounting in motor control center as indicated. Provide NEMA 3R enclosure in exterior or damp locations, unless noted otherwise. Provide NEMA 1 enclosures unless otherwise indicated.

G. AC COMBINATION NON-REVERSING MAGNETIC STARTERS (EQUAL TO SQUARE D CLASS 8538): Provide line voltage combination starters, of types, ratings, and electrical characteristics; 2 or 3 pole, 600 volt maximum with non-reversing magnetic starters as specified herein; in common cubicle or enclosure with fusible disconnect switch. Provide quick-make, quick-break, disconnect for NEMA sizes 1, 2, 3, and 4; and visible blade, automatic circuit interrupters with push-to-trip feature and separate fuse clips for larger NEMA sizes. Fuse all starters with dual-element (time-delay) fuses equal to Bussman FRN/FRS-R. Equip disconnect switch with Class R rejection fuse kits. Mount

hand-off-auto switch, red pilot light, and reset button in face of enclosure. Provide combination starters for individual mounting, or for group mounting in motor control centers as indicated. Provide NEMA 1 enclosures unless otherwise indicated. Provide NEMA 3R enclosure in exterior or damp locations, unless noted otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION OF MOTOR STARTERS:

A. Install motor starters as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NEMA standards, and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.

B. Install fuses in fusible disconnects, if any. Mount chart inside each starter indicating heater type, size, and ampere ratings available.

C. Electrical Identification: Refer to Section 260553 for requirements.

3.2 ADJUST AND CLEAN:

A. Inspect operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finish.

3.3 FIELD QUALITY CONTROL:

A. Subsequent to wire/cable hook-up, energize motor starters and demonstrate functioning of equipment in accordance with requirements.

END OF SECTION 26 2913

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SECTION 26 3213

EMERGENCY ELECTRICAL SYSTEMS

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 work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Extent of emergency electrical system work is indicated by drawings and schedules.

B. Types of emergency system components specified in this section include the following:

1. Automatic Transfer Switches (ATS)
2. Emergency Generators (Diesel)
3. Exhaust and Fuel Systems
4. Remote Annunciator Panels

C. CONDUCTORS/CABLES, RACEWAYS, AND ELECTRICAL BOXES AND FITTINGS are specified in applicable Division-26 Basic Materials and Methods sections.

D. Refer to other Division-26 sections as applicable for work required in connection with emergency electrical systems.

E. Refer to Division-23 sections for fuel tanks, piping and accessories required in conjunction with engine-generator units; not work of this section.

1.3 QUALITY ASSURANCE:

A. Comply with NEC as applicable to wiring methods, materials, construction and installation of emergency electrical systems. Comply with applicable requirements of UL 924, "Emergency Lighting and Power Equipment" and UL 1008, "Automatic Transfer Switches". Provide system components, that are UL-listed and labeled.

B. Comply with applicable requirements of NFPA Nos. 37, (99), 101, and 110 pertaining to stationary combustion engines, (health care facilities), life safety code, and emergency and standby power supplies.

C. Comply with ANSI/NEMA Std. Pub. No. ICS 2, pertaining to AC automatic transfer switches. Comply with applicable requirements of ANSI/NEMA MG 1, "Motors and Generators", and MG 2, "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators". Comply with applicable portions of IEEE Std. 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to standby power.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 – PRODUCTS

2.1 GENERAL:

A. Provide emergency electrical systems and components, of types, ratings, and electrical characteristics indicated. Provide all system components thru one supplier to guarantee

total system responsibility. Provide system and components capable of start and load transfer within 10 seconds of power outage.

2.2 ENVIRONMENTAL CONDITIONS:

A. Provide system components and accessories as required to ensure proper system operation at rated capacities under the following environmental conditions:

1. Altitude: 4800 feet above sea level
2. Maximum ambient temperature: 50 degrees C.
3. Minimum ambient temperature: 0 degrees C.
4. Seismic Zone as indicated in General Structural Notes.

2.3 AUTOMATIC TRANSFER SWITCHES:

A. Provide contactor type automatic transfer switches compatible with electric sets, and of continuous ampere rating sufficient to meet requirements of both maximum set output and normal power service. Switches that employ interlocking handles and circuit breakers to affect transfer are not acceptable. Provide 4 pole switches where distribution system is provided with ground fault protective relaying, or where indicated on drawings. Provide switches of voltage and phase indicated, and with the following features and characteristics:

1. Provide precision calibrated voltage sensors to monitor the normal power source and signal the electric set to start on a partial loss of power on any phase or where feedback voltages exist. Provide adjustability to signal start-up when line voltage drops 5 percent to 20 percent below pick-up voltage setting, and to signal shutdown when line voltage returns to 75% to 100% of normal.
2. Provide a time delay relay, adjustable from 1 to 10 seconds, to delay the signal to start to avoid nuisance start ups on momentary voltage dips or power outages.
3. Provide voltage sensors to sense return of normal power; and a time delay, adjustable 2 to 60 minutes, to delay the retransfer of load to normal to avoid short term fluctuations in normal power restoration.
4. Provide an engine cool-down timer, adjustable from 0 to 5 minutes, for unloaded engine cool-down time. Timer shall engage after retransfer to normal.
5. Provide pilot light to indicate switch in normal position and pilot light to indicate switch in emergency position. Mount pilot lights in front face of enclosure.
6. Obtain operating current for transfer and retransfer from the source that the load is to be transferred. Provide automatic bypass to retransfer the load from the electric set to the normal source if the electrical set output interrupts after normal source restores voltage.
7. Provide switch to simulate an interruption of power from the normal source.
8. Provide manual operator with removable handle for manual operation of the switch.
9. Provide clock exerciser to automatically start the electrical set at regular intervals and allow it to run for a preset time period; minimum of 30 minutes per week. Equip with selector switch to permit selection of "without load" or "with load" operation.
10. Provide means to electrically disconnect the control section from the transfer switch for maintenance service during normal operation.
11. Provide a battery charger mounted inside the transfer switch enclosure.

12. Provide time delay neutral position transfer in both directions to allow transfer switch to be disconnected from both sources during transfer from one source to another. Time delay shall be adjustable from 0 to 5 seconds.

13. Provide (3) sets of N.O./N.C. auxiliary contacts (in addition to those for remote Ann. panel) that operate when the transfer switch is in the normal position.

14. Provide (3) sets of N.O./N.C. auxiliary contacts (in addition to those for remote Ann. panel) that operate when the transfer switch is in the emergency position.

15. Provide ammeter with 4-position selector switch marked “Off”, “1", “2",and “3" to read current in all three phases of the load circuit.]

B. RATING AND PERFORMANCE: Rate automatic transfer switch for continuous duty when enclosed in a non-ventilated NEMA 1 enclosure. Rate switch for all classes of load, both inductive and non-inductive, at 600 volts; and tungsten lamp load at 205 volts.

C. Switch must be capable of closing into and withstanding fault current of 65,000 amperes RMS symmetrical at 600 volts, for units 225 amps and larger and 30,000 amperes RMS symmetrical on units 200 amps and less.

D. CONSTRUCTION: Provide operating mechanism with sufficient mechanical and electrical interlocks to prevent simultaneous energizing both normal and standby service. Provide main contacts with arc suppression and heat dissipation devices to provide dependable transfer of highly inductive loads. Equip switch with terminal lugs for either copper or aluminum conductor.

E. ENCLOSURE: Enclose switch in heavy gauge, welded seam construction, NEMA 1 enclosure.

F. MANUFACTURERS: Subject to compliance with requirements, provide automatic transfer switches of one of the following:

1. ASCO, Inc.

2. Onan Corp.

3. Russelectric Co.

4. Zenith Controls, Inc.

5. Kohler Power System

6. Generac

2.4 ENGINE GENERATOR UNITS:

A. Provide 60 hertz alternating-current standby-diesel engine-driven generator units of voltage, phase and capacities indicated. Base rating of electric sets upon operation after deducting power required for output for all necessary operating accessories, (including remote or direct drive radiator fans, fuel pumps, etc.) and under environmental conditions specified. Provide electric sets rated and capable of producing KW specified at 0.8 power factor for continuous standby duty. Certify performance of the electric set series by means of independent testing laboratory tests for full power rating stability, and voltage and frequency regulation.

B. Provide stationary, water cooled, full diesel, compression ignition, four stroke cycle, multi-cylinder, in-line or V-type engine. Arrange engine for direct connection to an alternator current generator; do not exceed engine speed of 1800 RPM at full rated load. Completely assemble engine, alternator, and components on a single base before shipping.

C. OVERCURRENT PROTECTIVE DEVICES: Provide overcurrent protective devices mounted in generator enclosure to match ratings of overcurrent protective devices providing service to normal power side of transfer switches.

D. LUBRICATION SYSTEM: Equip engine with a pressure lubricating system. Provide spin-

on type full flow lubricating oil filters. Equip filter with bypass valve to insure oil circulation if filters are clogged. Include dipstick oil level indicator. Provide lube oil heater for engine generator units located outdoors or where ambient temperature requires lube oil heating.

E. ENGINE COOLING SYSTEM: Provide engine cooling system that operates fully automatically while the engine is running. The cooling system coolant shall use a combination of water and ethylene-glycol sufficient for freeze protection at the minimum winter outdoor ambient temperature of the application. All coolant pumps shall be centrifugal type. Each engine shall have an engine-driven primary pump.

F. The engine cooling radiator shall be:

1. Engine/skid mounted at the front of the mounting base. Provide coolant in accordance with manufacturer's recommendation.

G. Equip engine with thermostatically controlled water jacket heater on all water cooled units. On air-cooled engines provide an oil base heater. The heater voltage shall match available voltage at the site. Make all necessary connections of jacket and oil base heaters.

H. AIR CLEANER: Provide reusable element air cleaner of size and type recommended by the engine manufacturer.

I. STARTING: Equip engine with a 12 volt electric starting motor of sufficient capacity to crank the engine at a speed that will allow full diesel starting of the engine. Disengage starter automatically when engine starts.

J. Provide engine start-stop switch with functions including reset, run/start, stop and automatic mode. Provide adjustable cycle cranking and cool down operation.

K. Provide rack mounted lead-acid battery set mounted integrally with electric set base. Provide sufficient capacity for cranking the engine a minimum of 4 cranking periods with 2-minute intervals between cranks. Each cranking period shall have a maximum duration of 15 seconds. Provide capacity and voltage recommended by engine manufacturer. Equip with all necessary interconnecting cables. Provide suitable float type battery charger to maintain the batteries in charged condition.

L. BATTERY CHARGER: Provide suitable automatic SCR voltage regulated battery charger with a maximum charge rate, as recommended by the manufacturer, to maintain batteries at full capacity during standby conditions. Equip with ammeter to indicate charge rate and protect circuit by either fuses or circuit breakers. Design charger such that it will not be damaged during engine cranking.

M. ENGINE INSTRUMENTS: Provide a unit mounted console with the following items:

1. Lubricating oil pressure gauge
2. Lubricating oil temperature display
3. Coolant fluid inlet/outlet temperature display
4. Coolant temperature gauge
5. Run time meter
6. Fuel meter display
7. Tachometer display
8. Battery charge rate ammeter
9. Engine Start-stop switch

N. EXHAUST SYSTEM: Provide a critical type exhaust silencer, flexible exhaust connector, and all exhaust piping and insulation as required. Flexible sections shall be made of convoluted seamless tube without joints or packing. Expansion joints shall be the bellow type. Expansion and flexible elements shall be stainless steel suitable for diesel-engine exhaust gas at 1000 degrees F.

O. Comply with manufacturer's recommendations. Wrap the entire exhaust system, from manifold to roof or wall penetration with exhaust insulation blankets as manufactured by Advanced Thermal Products, Inc., Santa Ana, California. Install per manufacturer's instructions.

P. ENGINE PROTECTION DEVICES: Provide the following engine protection devices with indicating light annunciation for each device:

1. Low-oil pressure cut-out
2. High air temperature cut-out
3. Overspeed cut-out

Q. MOUNTING: Equip electric set with a suitable base for mounting on a level surface. Provide vibration isolators, rated for seismic zone specified herein, between the electric set and base. Concrete base shall be designed by a Structural Engineer. All costs arising from design shall be paid by Manufacturer.

R. FUEL: Provide engine capable of satisfactory performance on commercial grade diesel fuel as recommended by manufacturer.

S. GOVERNOR: Equip engine with a high performance isochronous electronic governor to maintain frequency within the limits, as specified below by controlling engine and alternator speed.

1. Stability: + or - 0.33 percent at rated load
2. Speed Regulation: 5 percent maximum load to rated load

T. The governor shall be configured for safe manual adjustment during operation of the engine-generator from 90 to 110 percent of rated frequency.

2.5 FUEL SYSTEM:

A. Equip engine with primary and secondary fuel filters with replaceable elements, and an engine driven fuel pump, all mounted on the engine. Provide fuel system piping of size and type recommended by the engine manufacturer. Provide fuel tank(s) as follow(s):

1. Provide fuel tank, sufficient for 24 hours operation at full load, mounted between generator support rails. Provide a secondary containment tank.

2.6 ELECTRIC ALTERNATOR:

A. Provide direct connected, engine driven, single bearing, synchronous type alternator with electrical characteristics indicated.

B. INSTANTANEOUS VOLTAGE DIP: Limit voltage dip of engine generator set to less than 30 percent upon application of full rated power. Accomplish voltage regulation by means of a solid state voltage regulator. Inherently regulated machines are acceptable in sizes under 6KW.

C. Stability: 1 percent of its mean value at any constant load from no load to full load for solid state regulators.

D. Regulation: Plus or minus 2 percent maximum no load to full load for solid state regulators.

E. Where more than 40 percent of the load is comprised of rectifiers and/or thyristors, provide power to voltage regulator by means of ceramic type permanent magnet pilot excitor, capable of 80 percent automatic controlled SCR/Thyristor loading.

F. Provide instrument panel and console with the following:

1. Manual reset circuit breaker
2. A.C. voltmeter

3. A.C. ammeter
4. Voltmeter-ammeter phase selector switch with "off" position
5. Frequency meter
6. Start-Stop switch
7. Remote start terminals
8. Solid state cycle cranking control
9. Engine safety alarm lights and contact
10. Provide automatic solid state overload protection, under frequency protection, and volts/hertz characteristics.

2.7 EMERGENCY POWER OFF (EPO):

A. The emergency generator shall be provided with a remote EPO (similar to a break glass station) located outside of the room housing the generator.

2.8 WEATHERPROOF ENCLOSURE:

A. Provide weatherproof enclosure for engine generator unit. Enclosure shall house all components including engine, alternator, batteries, battery charger, fuel tank and controls. Provide one piece roof with drip edge on all four sides and with formed roof stiffeners to support silencer. Provide angle iron frame around the entire bottom of the enclosure to attach to mounting surface. Provide doors on each side for access to engine, alternator and all components. Provide all doors with continuous piano type hinges with stainless steel pins. Provide lockable 2-point latches on all doors, keyed alike. Provide a welded fixed open air intake louver panel on each side to accomplish air intake. Provide a framed expanded metal core guard to accomplish air discharge. Assemble all components with plated bolts and nuts. Caulk all seams to prevent rust bleed through. Clean and paint all components with manufacturer's standard rust inhibiting primer. Provide finish coat paint color to match pad mounted transformer. All openings shall be provided with screen material to exclude entrance of rodents.

2.9 SAFETY SYSTEM AND REMOTE ANNUNCIATOR:

A. Provide all wiring, devices, equipment, and components to automatically activate the appropriate signals and initiate the appropriate annunciation as specified herein.

B. Provide remote annunciator panel in flush enclosure (locate as directed by Owner/Architect or as indicated on drawings) with the features specified and with audible and visual alarm indication of the following conditions:

1. Low engine temperature (engine heater not functioning).
2. High temperature prealarm - engine temperature approaching shut down.
3. Low oil pressure prealarm - engine oil pressure approaching shut down.
4. Unit shut down due to low oil pressure.
5. Unit shut down due to high temperature.
6. Unit shut down due to overcrank.
7. Unit shut down due to overspeed.
8. Emergency (or normal) power source supplying load.
9. Battery charger malfunction.
10. Low fuel - main tank contains less than a 3 hour supply.
11. Low battery voltage.

12. System ready no alarm conditions present, all controls in "automatic".
13. Audible alarm silence push button.

C. MANUFACTURER: Subject to compliance with requirements, provide engine-driven generator sets of one of the following:

1. Caterpillar Tractor Co.
2. Cummins Engine Co.
3. Kohler Co.
4. Generac

PART 3 – EXECUTION

3.1 INSTALLATION OF ENGINE-GENERATOR SYSTEMS:

A. Install standby engine-generator sets as indicated, in accordance with the equipment manufacturer's written instructions, and with recognized industry practices, to ensure that engine-generator sets fulfill requirements. Comply with NFPA and NEMA standards pertaining to installation of standby engine-generator systems and accessories.

B. Provide vibration isolation mounting and anchoring of generator set to concrete slab.

C. Install fuel oil and piping to standby generator equipment. Comply with manufacturer's instructions and recommendations.

D. Electrical Identification: Refer to Section 260553 for requirements.

3.2 GROUNDING:

A. Provide equipment grounding connections for system components.

3.3 TESTING:

A. Upon completion of installation of engine-generator system and after building circuitry has been energized with normal power source, (including all VFD’s and other motor starters), test engine-generator to demonstrate standby capability and compliance with requirements. Provide start-up and testing by factory authorized representative in accordance with manufacturer’s recommendations. Perform each of the following tests (as a minimum) and submit written report of results of each as part of the Operation and Maintenance Manuals required herein:

1. Mimic a normal power outage by de-energizing normal power source to the facility. Verify engine start, transfer, and operation of all loads satisfactorily. Re-energize normal power, and verify proper performance of load retransfer, engine cool down, and engine shut down. Record and report all results.
2. Mimic a generator test by operating the “test mode” switch (with facility still energized by normal power). Verify engine start, transfer, and operation of all loads satisfactorily. Return “test” switch to normal, and monitor performance of load retransfer, engine cool down, and engine shut down. Record and report all results.
3. Perform a safety run test in accordance with the following:
    a. Provide all fluids, equipment, and test instrumentation to perform complete tests.
    b. Perform and record all engine manufacturer’s recommended pre-starting checks and inspections.
    c. Verify the proper operation of all controls, gauges, instruments, and set points.

d. Verify the proper operation of the emergency stop switch, the over-speed limit switch, oil overfill limit, oil low limit, and the over- and under-frequency limits. Where digital controls prevent direct access to safety switches, the manufacturer's representative shall utilize a field service computer and manufacturer's field service software to demonstrate the control's monitoring of engine speed, oil pressure and coolant temperature.

e. Perform an engine load run test. Provide all fluids, equipment, load banks, and test instrumentation to perform complete tests.

4. Perform and record all engine manufacturer's recommended prestarting checks and inspections.

5. Tests:

a. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection, except those indicated to be optional, for "AC Generators and for Emergency Systems" specified in NETA acceptance testing specification. Certify compliance with specification parameters.

b. Continuous engine load run test:

i. Provide a resistance load bank and make temporary connections for full load test.

ii. Readings shall be taken at 15 minute intervals shall include the following:

1. Output amperes, voltage, real and reactive power, power factor and frequency.

2. Lube-oil pressure.

3. Coolant, lube-oil, exhaust, and ambient temperatures.

iii. Operative the engine generator set for 4 hours at 100% of rated load.

iv. Remove load from the engine generator set. Shut down the engine generator set.

6. Perform tests required by NFPA 110 acceptance tests that are additional to those specified here including, but not limited to, a "cold start" test and a one step rated load pickup test. The AHJ (Authority Having Jurisdiction) shall be notified in advance and shall have the option to witness the tests.

7. Inspect lube oil filter for excessive metal, abrasive foreign particles, etc. If corrective action is necessary, perform all above run tests again after corrections have been made. Check all engine and mounting bolts for tightness and/or visible damage. Inspect and verify engine-generator shaft alignment by means of dial indicator.

B. After completion of all tests, provide engine fluid and diesel fuel to refill all engine fluids and refill diesel fuel tank to capacity.

3.4 SURGE PROTECTIVE DEVICES:

A. Provide a surge protective device on each switchboard and panelboard located on the emergency distribution system. Refer to section 26 4313 for requirements.

3.5 ON SITE TRAINING:

A. Conduct a training course for operating staff as designated by the Owner. The training period shall consist of a total of 8 hours of normal working time distributed between two shifts, and shall start after the system is functionally complete but prior to final

acceptance. The course instruction shall cover pertinent points involved in operating, starting, stopping, servicing the equipment as well as all major elements of the operation and maintenance manuals. Additionally, the course instruction shall demonstrate all routine maintenance operations such as oil change, oil filter change, air filter change, etc.

3.6 FIELD ENGINEER:

A. Provide a qualified field engineer to supervise the installation of the engine generator set, transfer, etc., assist in the performance of the on-site tests, and instruct personnel as to the operational and maintenance features of the equipment.

3.7 SERVICE AND SUPPORT

A. The manufacturer of the generator set shall maintain service parts inventory at a central location that is accessible to the service location 24 hours per day, 365 days per year.

B. The generator set shall be serviced by the local service organization (during the warranty period) that is trained and factory certified in generator set service the supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

END OF SECTION 26 3213

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SECTION 26 4119

DEMOLITION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Special Provisions, Division 1 and Division-2 Specification sections, apply to work of this section.

B. This section is a Division-26 Basic Materials and Methods section, and is part of each Division-26 section making reference to demolition.

1.2 DESCRIPTION OF WORK:

A. Extent of major items of demolition work is indicated by drawings. Other demolition work shall be performed as required to maintain system operation.

B. The intent of the drawings is to indicate major items affected and not to show every device, outlet, fixture, etc. affected by demolition work.

C. The drawings do not necessarily reflect as-built conditions. The contractor shall visit the jobsite prior to bidding to determine the overall scope of demolition work.

D. Refer to sections of other Divisions for applicable requirements affecting demolition work.

E. Refer to Section 260500 for requirements with regard to power outages affecting the operation of existing electrical systems.

1.3 QUALITY ASSURANCE:

A. NEC COMPLIANCE:

1. Comply with applicable portions of NEC as to methods used for demolition work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL:

A. Demolition work shall be laid out in advance to eliminate unnecessary cutting, drilling, channeling, etc. Where such cutting, drilling, or channeling becomes necessary, perform with care, use skilled mechanics of the trades involved. Repair damage to building and equipment. Cutting work of other Contractors shall be done only with the consent of that Contractor. Cutting of structural members shall not be permitted.

3.2 PATCHING AND REPAIR

A. The Contractor is responsible for all demolition, patching and repair of all finished interior surfaces pertaining to the installation of this particular phase of work. All surfaces shall be finished (painted, etc.) to match the adjacent materials, finishes and colors.

B. Hard surfaces: Whenever demolition or excavation is required for the installation of the electrical system, it shall be the responsibility of this contractor to make repairs and/or replacements of hard finish surfaces such as concrete, asphalt, roofing, etc.

C. The method of patching and repair shall follow good construction practices and all finished surfaces shall match materials and finish wherein the demolition occurred.

3.3 EXISTING EQUIPMENT

A. The following is a part of this project and all costs pertaining thereto shall be included in

the base bid.

B. The new electrical equipment and apparatus shall be coordinated and connected into the existing system as required. Auxiliary systems shall comply, unless otherwise specified.

C. The existing electrical devices, conduit and/or equipment that for any reason obstructs construction shall be relocated. Provide conduit, wiring, junction boxes, etc. as required to extend existing circuits and systems to relocated devices or equipment.

D. The new fixtures indicated for existing outlets shall be installed in accordance with the fixture specifications.

E. When installing equipment in the existing building, it shall be concealed.

F. All existing electrical equipment and systems in portions of the building not being remodeled shall be kept operational, in service and in working condition throughout the entire construction period. Restore any circuits and systems interrupted. Provide temporary panels, temporary wiring and conduit, etc. as required.

G. Maintain circuit integrity and continuity of all existing circuits and systems that interfere with or are interrupted by remodel work unless those circuits are to be abandoned completely. Maintain all circuits and systems in operation during construction. Provide temporary panels, temporary wiring and conduit, etc. as required.

H. Existing raceways may be used where possible in place, except as noted. All circuits, conduit and wire that are not used in the remodeled area shall be removed back to the panelboard, where it shall be labeled a spare with circuit number indicated. Re-used raceway shall meet all requirements for new installations.

I. Obtain permission from the Architect and Owner's representative before penetrating any ceiling, floor, and wall surfaces.

J. Any and all equipment having electrical connections that require disconnecting and reconnection at the same or another location throughout the course of construction shall be included as part of this contract.

END OF SECTION 26 4119

SECTION 26 4313

SURGE PROTECTIVE DEVICES (SPD)

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 work of this section.

B. Division 26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Extent of SPD's work is indicated by drawings, schedules and specified herein. Work includes complete installation, electrical connections, testing, and commissioning.

1.3 QUALITY ASSURANCE:

A. Comply with NEC, NEMA and IEEE Standards as applicable to wiring methods, construction and installation of SPD's. Comply with applicable requirements of ANSI/IEEE C62.11, C62.41.2 and C62.45; NFPA 70 285 (Type 2), 75, and 78; and ANSI/UL 1449 4th edition. Provide complete packaged units that have been listed and labeled by Underwriters Laboratory. UL surge ratings (UL 1449) must be permanently affixed to the SPS's device.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 - PRODUCTS:

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide products manufactured by one of the following as indicated by "Location Category" herein.

1. Advanced Protection Technologies Inc.
2. Current Technology Inc.
3. Cutler Hammer, Inc.
4. L.E.A. International
5. Emerson Network Power Surge Protection Inc.
6. United Power Corporation
7. GE
8. Eaton
9. Surgelogic (Square D)

2.2 GENERAL:

A. Except as otherwise indicated, provide high energy surge protective devices, with high frequency line noise filtering, suitable for application in Category A, B, and C environments as indicated. Provide types, sizes, ratings and electrical characteristics indicated that comply with manufacturer's standard materials, design, and construction in accordance with published information and as required for a complete installation.

B. Provide externally mounted SPD units only.

2.3 VOLTAGE SURGE SUPPRESSION – GENERAL:

A. Electrical Requirements

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.

2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.

3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

5. Nominal Discharge Current (In) – All SPDs applied to the distribution system shall have a 20kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20kA shall be rejected.

6. ANSI/UL 1449 4th Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:

B. SPD Design

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.

4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:

a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.

i. For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.

ii. For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.

iii. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

b. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.

c. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

d. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

i. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

6. Overcurrent Protection

a. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from

the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

7. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

8. Safety Requirements

   a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

   b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

   c. Sidemount SPDs shall be factory sealed in order to prevent access to the inside of the unit. Sidemount SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

2.4 SYSTEM APPLICATION

A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

B. Provide a surge protective device on each switchboard and panelboard located on the emergency distribution system. Refer to table below for category type.

Minimum surge current capacity based on ANSI / IEEE C62.41 location category			
CATEGORY	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCCs, Busway)	120 kA	60 kA

C. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

D. SPD Type – all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.5 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.

1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.

2. SPDs shall be installed following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
3. The panelboard shall be capable of re-energizing upon removal of the SPD.
4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
5. The SPD shall be included and mounted external of the panelboard.
6. The SPD shall be of the same manufacturer as the panelboard.
7. The complete panelboard including the SPD shall be UL67 listed.

B. Sidemount Mounting Applications Installation (SPD mounted external to electrical assembly)

1. Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

C. Switchgear, Switchboard, MCC and Busway Requirements

1. The SPD application covered under this section is for switchgear, switchboard, MCC, and busway locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
2. The SPD shall be of the same manufacturer as the switchgear, switchboard, MCC, and busway
3. The SPD shall be factory installed outside the switchgear, switchboard, MCC, and/or bus plug at the assembly point by the original equipment manufacturer
4. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
5. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
6. The SPD shall be external to switchgear, switchboard, MCC, and/or bus plug as a factory standardized design.
7. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.6 ENCLOSURES

A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:

1. NEMA 1 – Constructed of a polymer (units integrated within electrical assemblies) or steel (sidemount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
2. NEMA 4 – Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of

solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure. (sidemount units only)

3. NEMA 4X – Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection. (sidemount units only)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install SPD's as indicated in accordance with manufacturers recommendations and as necessary to meet requirements. Install with conductors of minimum length practicable, but in no case exceeding 30" in length; minimum conductor size - #6 AWG copper.

B. Install conductors in straight runs with a minimum of turns or bends (minimum bend radius to be 90 degrees). Do not splice phase or ground conductors in SPD's circuit. Torque all conductor terminations in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL:

A. Upon completion of installation of equipment, energize and demonstrate capability and compliance with requirements. Remove malfunctioning units, replace with new units and proceed with retesting.

END OF SECTION 26 4313

SECTION 26 5100

INTERIOR AND EXTERIOR BUILDING LIGHTING

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 work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Types of lighting fixtures in this section are indicated by schedule and include the following:

1. LED (Light Emitting Diode)

1.3 QUALITY ASSURANCE:

A. Comply with NEC, NEMA and ANSI 132,1 as applicable to installation and construction of lighting fixtures. Provide lighting fixtures that have been UL-listed and labeled.

B. Components and fixtures shall be listed and approved for the intended use by a National Recognized Testing Laboratory (NRTL) including: UL, ETL, and CSA or equivalent

C. All led products shall comply with the latest version of Illuminating Engineer Society (IES) publications LM-79 and LM-80.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements, provide products of one of the following (for each type of fixture):

1. LED:
    a. Cree
    b. Nichia
    c. Samsung
    d. Philips Lumiled
    e. Osram
    f. Xicato

2.2 INTERIOR AND EXTERIOR LIGHTING FIXTURES:

A. GENERAL:

1. Provide lighting fixtures, of sizes, types and ratings indicated complete with, but not necessarily limited to, housings, lamps, lamp holders, reflectors, ballasts, LED drivers, starters, and wiring. Label each fixture with manufacturer's name and catalog number. Provide all enclosed fixtures with positive latch mechanisms; spring tension clips not acceptable. Provide all exterior fixtures with

damp or wet location label as required by application.

B. SUPPORT REQUIREMENTS:

1. Provide all pendant and stem hung fixtures with flexible ball joint hangers at all points of support. Equip hooks used to hang fixtures with safety latches. Provide all detachable fixture parts, luminous ceiling accessories, louvers, diffusers, lenses, and reflectors with locking catches, screws, safety chain, or safety cable.

C. LIGHT EMITTING DIODE (LED) LUMINAIRES:

1. LED luminaires that can be serviced in place shall have a disconnecting means internal to the luminaries to disconnect simultaneously from the source of supply all conductors of the driver, including the grounded conductor. Disconnects shall not be required under the following exceptions:

a. Luminaries located in hazardous locations.

b. Luminaries used for egress lighting.

c. Cord-and-plug luminaries.

d. In industrial establishments with restricted public access where conditions of maintenance and supervision ensure that only qualified persons service the installation.

e. Where more than one luminaire is installed in a space and where disconnecting the supply conductors to the luminaire will not leave the space in total darkness.

f. Provide LED luminaires which are tested in accordance with IES LM-79, diodes tested in accordance with IES LM-80, and provide a minimum R9 rating of ≥ 50 (unless specified differently), a CRI rating of ≥ than 80 and L70 (6K) = 50,000 hours (IES TM-21). Provide with 0-10V dimming drivers as standard.

g. The fixture manufacturer(s) shall warrant the luminaires, in their entirety, to be free from defects in material or workmanship for at least 5 years from date of manufacture. Provide warranty in accordance with other sections of this specification and include a certificate of warranty from the fixture manufacturer with extended warranty information and proper forms and procedure description.

D. DIFFUSERS:

1. Where plastic diffusers are specified, provide 100 percent virgin acrylic compound; minimum thickness, .125 inches.

PART 3 - EXECUTION

3.1 INSTALLATION OF LIGHTING FIXTURES

A. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standards of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. Coordinate with other work as appropriate to properly interface installation of lighting fixtures with other work. Consult architectural reflected ceiling plan for exact location of all lighting fixtures.

C. Provide all necessary supports, brackets, and miscellaneous equipment for mounting of fixtures. Support all ceiling mounted fixtures from the building structure; independent of the ceiling system, unless noted. Support each recessed fixture (fluorescent incandescent, and/or HID) from the building structure with #12 ga. steel wire attached to

each corner (in addition to supports normally provided for attachment to the ceiling system). Provide backing supports above (or behind) sheetrock, plaster and similar ceiling and wall materials. Support surface mounted ceiling fixtures from channel. Support ceiling mounted outlet boxes independent of the raceway system, and capable of supporting 200 pounds. Feed each recessed fixture directly from an outlet box with flex conduit as required; do not loop from fixture to fixture. See plans for additional details.

D. FIXTURE WHIPS:

1. Provide each lay-in light fixture with at least 36" (Not to exceed 72") of 3/8" steel flexible conduit.

2. With-in spaces utilizing 0-10v control schemes ie: Room Controllers, the fixture whip shall be comprised of a MC-PCS Cable (see Section 26 0532 Conduit raceways) with at least 36” and not to exceed 72” in length located above removable grid ceilings.

E. Coordinate lighting in mechanical room with duct and equipment locations to avoid obstruction of illumination.

F. Provide gypsum board protection as required, (acceptable to fire official having jurisdiction) to ensure fire rating of each ceiling that the fixtures are installed in.

G. COORDINATION MEETINGS:

1. Meet at least twice with the architect and ceiling installer. Hold first meeting before submittal of shop drawings to coordinate each light fixture mounting condition with ceiling type. During second meeting, coordinate fixture layout in each area.

   a. Coordinate mounting height of pendant and wall mounted fixtures.

   b. Coordinate conduit layout in all open ceiling spaces e.g. Gym, Commons, Auditorium, etc. with architect prior to rough-in.

2. Meet at least twice with the AV/Intercom systems Installer. Hold first meeting before submittal of shop drawings to coordinate each AV equipment, speaker mounting condition with ceiling type. During second meeting, coordinate AV equipment, speaker layout in each area.

3. Meet at least once with the mechanical installer prior to fabrication and installation of duct work. Coordinate depth and location of all fixtures and duct work in all areas.

H. ADJUST AND CLEAN:

1. Clean lighting fixtures of dirt and debris upon completion of installation.

2. Protect installed fixtures from damage during remainder of construction period. Repair all nicks and scratches to appearance of original finish.

3.2 FIELD QUALITY CONTROL:

A. Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements.

B. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with retesting.

C. At the time of Substantial Completion, replace lamps in interior lighting fixtures that are observed to be noticeably dimmed after the Contractor's use and testing, as judged by Architect/Engineer.

D. GROUNDING:

1. Provide equipment grounding connections for each lighting fixture.

END OF SECTION 26 5100

SECTION 26 5600

EXTERIOR AREA LIGHTING

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 work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Types of lighting fixtures in this section are indicated by schedule and include the following:

1. LED (Light Emitting Diode)

B. Excavation and backfilling for exterior area lighting poles, standards and foundations are specified in applicable Division-26 general provision sections.

C. Concrete for embedding poles, and for pole foundations and footings is specified in other sections of specification. Provide pole bases under this section of the specification.

D. Refer to other Division-26 sections for cable, wire and connectors required in connection with exterior area lighting poles and standards.

1.3 QUALITY ASSURANCE:

A. Comply with NEC, NEMA and ANSI/IES requirements as applicable to location and installation of lighting poles and standards. Provide lighting components and fittings that are UL-listed and labeled.

B. Comply with other portions of specification as applicable for forming, splicing, and curing of concrete bases provided under this section.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 - PRODUCTS

2.1 **MANUFACTURER**: Subject to compliance with requirements, provide products as scheduled on drawings.

A. CONCRETE: 3000 psi Class.

B. LIGHT FIXTURE POLES: Provide light fixture poles that comply with the following minimum requirements.

1. The pole shaft constructed of seamless aluminum alloy per requirements of ASTM B221. Include a flush covered hand hole in each pole with finish hardware. Provide a permanent marking with the manufacturer name inside the hand hole for easy recognition.

2. Provide aluminum alloy anchor base welded to the pole shaft. Welding must comply with AWS Specification D1.2, Structural Welding Code – Aluminum. The complete assembly must be heat-treated to a T6 temper.

3. Provide super durable thermosetting polyester power coat paint, a minimum of

1.5 mils thick along the entire length of the pole.

4. Include aluminum nut covers for a “Shoe Base” trim.

5. Provide a 10-year minimum guarantee, which covers the pole structure and paint.

6. Provide vibration dampening in poles.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install area lighting units as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC, NESC and NEMA standards and with recognized industry practices to ensure that lighting units fulfill requirements.

B. Coordinate with other work as necessary to properly interface installation of roadway and parking area lighting with other work.

C. Comply with NEC 300-5 (or State of Utah requirement, whichever is most stringent), for raceway burial depth.

D. Mount lighting units on concrete bases as indicated, complete with anchor bolts and reinforcing bars. Coordinate proper size and location of all bases as required to ensure proper installation. Provide 3000 psi class concrete; hand rub all exposed concrete to uniform, smooth finish.

E. Deliver poles to job site with factory finish paint.

F. Set poles and standards plumb. Support adequately during backfilling, or anchoring to foundations.

G. Provide sufficient space encompassing hand access and cable entrance holes for installation of underground cabling.

3.2 GROUNDING:

A. Provide equipment grounding connections for each lighting unit installation.

END OF SECTION 26 5600

SECTION 27 1500

TELEPHONE/DATA SYSTEMS

PART 1 – GENERAL

1.1 SCOPE OF DOCUMENT:

A. The following are project specifications that all cabling systems must adhere to. These specifications apply to all installers (hereinafter referred to as “the Contractor”) for all sites, that require, standards-compliant structured cabling systems and shall be used for all the installation, testing, and acceptance of the information transport systems as described in the attached specifications. Prices quoted of the installation facilities shall be all-inclusive and represent a complete installation at such sites as prescribed in this specification and contract documents. The Contractor shall be solely responsible for all parts, labor, testing, acceptance and all other associated processes and physical apparatus necessary to turn-over a completed system fully warranted and operational for acceptance by the Customer. Final acceptance of the installation shall be in writing by the Architect and Engineer.

B. In all instances where Standards are cited, it is assumed Installer will have familiarity with and implicitly follow the recommendations of the most current version of the Standard referenced at the time of installation. Compliance with most current Standards is the sole responsibility of the Contractor.

1.2 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Division-7 Firestopping, apply to work of this section.

C. Division-26 Basic Materials and Methods sections apply to work specified in this section.

D. Refer to and coordinate with 27 and 28 specifcations for any equipment requiring UTP based category and/or optical fiber cabling and connectivity. Division 27 1500 shall provide installation and execution requirements for all category and/or optical fiber cabling and connectivity required within the those system.

E. Refer to and coordinate with specification 27 4100 for any audiovisual equipment requiring UTP based category and/or optical fiber cabling and connectivity. Division 27 1500 shall provide installation and execution requirements for all category and/or optical fiber cabling and connectivity required within the audiovisual system.

1.3 SCOPE OF WORK:

A. The extent of telephone/data system work is indicated by drawings and is hereby defined to include, but not be limited to racks, cabinets, patch panels, cables, raceway, outlet boxes, device plates, backboard, and grounding. Contractor is responsible for installation of all specified and unspecified necessary and miscellaneous items required for delivery of a complete and functional data cabling and device system.

B. Provide pathway and demark for local telco fiber optic utility connection. Provide GPON breakout connections as required for POTS, etc.

1. GPON Requirements - Verify additional Requirements with owner Telco Service:

   a. 4x8 Fire Rated Plywood

   b. (2) Dedicated 4-Plex Receptacles

   c. (4) Category 6 Cables to Rack/Patch Panel

   d. 110 Block

e. Grounding To TMGB

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C. Contractor shall provide complete cable and outlet system as indicated on the drawings and described herein. Work shall include all associated infrastructure transmission components and support appliances including, but not be limited to cable, jacks, terminal blocks, racks, cabinets, wire management, labeling, transient voltage surge suppression, patch cords, telecommunications grounding system and all terminations as specified herein.

D. Contractor shall provide system testing as described herein using up-to-date and industry accepted Level IIIe, IV, V test equipment appropriate to the types of links being tested and in accordance with the latest edition of IEC 61935-1. All testers used shall be factory calibrated within one year of use with references set daily prior to testing.

E. All active equipment (electronics) will be owner furnished and owner installed.

F. Contractor shall be solely responsible for all parts, labor, testing, documentation and all other associated processes and physical apparatus necessary to turn-over the completed system fully warranted and operational for acceptance by Owner and Engineer.

G. Contractor shall provide all labor, materials, tools and equipment required for the complete installation of work called for in the Construction Documents.

H. Copper solution must match optical fiber solution and be provided by the same manufacturer. No two separate warranties are acceptable for the copper connectivity and optical fiber connectivity.

I. Contractor shall provide a minimum size of 1-1” EMT conduit from telecommunications outlet/connector to accessible ceiling space, then utilize non-continuous cable support devices to cable tray.

1.4 CONTRACTOR QUALIFICATIONS

A. The contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to voice and data network systems. The Contractor shall at a minimum possess the following qualifications:

1. Must have at a minimum (1) RCDD certified individual employed full time at the time of bidding and throughout entire project. **PROVIDE PROOF OF RCDD CERTIFICATION IMMEDIATELY UPON JOB AWARD**.

2. Approved and certified by connectivity manufacturer. Provide proof of certification immediately upon job award.

3. BICSI Certified Installers or equivalent.

4. Possess those licenses/permits required to perform telecommunications installations in the specified jurisdiction.

5. Have a minimum of 5 years in the communications structured cabling business and be able to provide three owner references for the type of installation described in this specification for projects within the last 18 months.

6. Personnel trained and certified in fiber optic cabling, splicing, termination and testing techniques. Personnel must own not rent a light meter or fiber test adapter head, and OTDR and shall be factory certified by the manufacturer of the products being installed.

7. Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.

8. Personnel knowledgeable in local, state, province and national codes, and regulations. All work shall comply with the latest revision of the codes or

regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall be followed.

9. Be factory certified by the manufacturer used in installation of all transmission components of all copper and fiber links and able to provide the manufacturer warranty.

1.5 QUALITY ASSURANCE

A. Required Pre-Telecommunications Construction Meeting with Communications Engineer: Electrical contractor/representative AND Communications Contractor will be required to attend a pre-communications construction meeting (approximately 30-60 minutes) with Communications representative in the electrical engineer's office prior to communications construction commencement. This meeting will address any questions on the part of the contractor and the expectations of the Engineer with regard to specifications, plans and site visits for both rough and finish electrical work.

B. Owner IT Contact:

1. **Jason Eyre; jeyre@murrayschools.org**

C. BNA IT Contact:

1. **Eric Skinkis; eskinkis@resolutgroup.com, 801-532-2196**
2. **Drayton Bailey; dbailey@resolutgroup.com, 801-532-2196**

1.6 APPLICABLE CODES AND STANDARDS

A. Contractor is responsible for compliance with all applicable portions of the NEC code as to type of products used and installation of components. All materials used shall be products and materials that have been UL-listed and labeled. All installed products shall comply with applicable NEMA standards for low loss extended frequency cable.

B. In addition, installation shall adhere to the following Standards:

1. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises, or most recent edition at the time of installation
2. ANSI/TIA-568-C.1 – Commercial Building Telecommunications Cabling Standards, or most recent edition at the time of installation
3. ANSI/TIA-568-C.2 - Balance Twisted Pair Communications and Components Standards, or most recent edition at the time of installation
4. ANSI/TIA –942 -Telecommunications Infrastructure for Data Centers, or most recent edition at the time of installation
5. TIA-569-B - Commercial Building Standard for Telecom Pathways and Spaces, or most recent edition at the time of installation
6. ANSI/TIA-606-A – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, or most recent edition at the time of installation
7. ANSI/NECA/BICSI-607 - Commercial Building Grounding/Bonding Requirements, or most recent edition at the time of installation
8. ANSI/TIA 1152 – Testing of Copper Links
9. BICSI Telecommunications Distribution Methods Manual, 13th edition or most recent edition at the time of installation.
10. TIA 758-A - Customer owned Outside Plant Telecommunications Infrastructure Standard (2004), including all applicable addenda and the most recent revision at the time of installation.

11. BICSI Information Transport Systems Installation Manual - 5th edition or most recent edition at the time of installation.
12. ANSI/NFPA-70 - 2017 National Electrical Code, revision, or most recent revision at the time of installation.
13. ANSI/IEEE C-2 - 2017 National Electrical Safety Code or most recent revision at the time of installation.
14. OSHA Standards and Regulations All applicable
15. Local Codes and Standards All applicable

C. Note: Anywhere cabling standards conflict with electrical or safety codes, Contractor shall defer to NEC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either. Knowledge and execution of applicable codes is the sole responsibility of the Installer. Any code violations shall be remedied at the Contractor's expense.

1.7 ACCEPTABLE MANUFACTURERS:

A. General:

1. Unapproved product substitutions are not allowed. Contractor wishing to substitute any products for those expressly specified shall submit three samples of the alternate product to Engineer no less than two weeks prior to the last addendum accompanied by all engineering documents, drawings and third party test data proving mechanical and transmission equivalency. Acceptance of substitutions shall be received from Engineer in writing. All unapproved substitutions installed shall be removed by Contractor who shall assume all costs for removal and replacement with approved products. Such costs shall include, but not be limited to labor, materials, as well as any penalties or fees for late completion.

B. APPROVED MANUFACTURERS:

1. Contractor shall select only one line item in the each section of Parts 2, 3, and 4. Contractor shall NOT utilize multiple line items for the project within each Part. For example, if Panduit / General Cable is selected to be used for the project, all copper cabling and connectivity shall be by Panduit or General Cable. No other manufacturer or combination of manufacturers may be used for the copper cabling or connectivity equipment.
2. Copper Cabling / Connectivity Approved Manufacturers:
    a. CommScope
    b. Panduit/General Cable
    c. Leviton / Berk-Tek
    d. Siemon
    e. Belden/ Mohawk
3. Fiber Cabling Approved Manufacturers
    a. Same manufacturer from Part 2.
    b. Corning
4. Non-Cabling / Connectivity Approved Manufacturers:
    a. Same manufacturer from Part 2.
    b. Chatsworth

1.8 SUBMITTALS: Refer to Section 26 0502 for requirements.

PART 2 - PRODUCTS

2.1 GENERAL:

A. All products shall be in new condition and UL listed.

B. Provide complete raceway, outlet boxes and miscellaneous items. All conduit utilized shall be EMT grade.

C. Provide 5” x 2.875" (or 4-11/16” x 3.25” square) deep square outlet box at each outlet location with single gang plaster or tile ring. Provide wall board adapters / accessories as necessary.

1. Approved solutions:

a. RANDL 5 Square Telecommunications Outlet Box Model TX-550-YY where “X” could be a bracket box and “YY” could be knockout arrangements.

b. Hubbell Large Capacity Wall Box Model HBL260. If a 2” knockout is required for installation purposes, provide this box.

D. Communication grounding and bonding shall be constructed and installed to meet or exceed the requirements of the National Electrical Code (NEC), IEC 1000-5-2 and ANSI/J-STD--607-A throughout the entire grounding system.

E. All termination hardware shall be rated to meet specified cabling specifications.

2.2 ENTRANCE FACILITY (EF) / EQUIPMENT ROOM (ER) / TELECOMMUNICATIONS ROOM (TR)

A. General:

1. Contractor shall be responsible for the adequate and appropriate design of all racking systems, paying particular attention to sizing of all cable management troughs and supports both horizontal and vertical installation of patch panels and wire management into rack.

2. Provide line surge suppressors at main telephone board in ER for all incoming phone lines if not provided by service provider. Provide ground connection to TMGB.

3. School District Specific Backbone Requirements:

a. Provide 12 Strand indoor/outdoor Multimode OM4 Fiber from the ER/MDF to each TR/IDF. Provide (2) Cat6A from the ER/MDF to each TR/IDF.

B. Provide the following, see specifications for each item in this document:

1. Wall Linings in each EF, ER, and TR:

a. In addition to the architectural walls, provide plywood wall lining that mounts at 8” A.F.F that shall:

i. Be fire-rated or treated on all sides with at least two coats of fire-resistant light-colored paint. Fire-retardant plywood is also acceptable. Leave fire rated stamp on plywood unpainted.

ii. Have walls lined with A/C grade or better, void-free plywood, 8 feet high with a minimum thickness of ¾”. See plans for additional wall locations.

iii. Install the plywood with grade A surface exposed. Plywood shall be securely fastened to wall-framing members to ensure that it can support attached equipment.

iv. Use flush hardware and supports to mount plywood.

v. Plywood shall be void free and kiln-dried to a maximum moisture content of 15 percent to avoid warping.

2. Main Cross Connect (MC) / Horizontal Cross Connects (HC):

a. Floor Mounted Racks (See Plans for Locations):

i. Four Post (All racks within the MDF to be 4-post racks):

1. Provide Four post 19” wide minimum 7’ tall EIA aluminum rack with ANSI/EIA 310-D rail size, 45RU capacity, painted black, top flanges, and mounting holes.

2. Provide paint-piercing washers to electrically bond racks.

3. Approved Equipment

a. Chatsworth 50120-703 Standard Rack
b. CommScope RK4P45-45A
c. Panduit R4PBelden XDR8419-3122836

ii. Two Post (All racks within IDF rooms to be 2-post racks):

1. Provide two post 19” wide minimum 7’ tall EIA aluminum rack with ANSI/EIA 310-D rail size, 45RU capacity, painted black, top flanges, and mounting holes.

2. Provide paint-piercing washers to electrically bond racks.

3. Approved Equipment

a. Chatsworth 55053-703 Standard Rack
b. CommScope RK3-45A
c. Panduit R2P
d. Belden BHRR194

b. Wall Mounted Cabinet (See Plans for Locations)

i. Provide black cabinet, with swing out cabinet body, perforated front door, and black color. Door shall be lockable.

ii. Size cabinet to accommodate all passive equipment necessary. Plan for 8RU minimum of active equipment.

iii. Provide horizontal slack manager and 3” cable bend radius posts.

iv. Provide cabinet fan kit.

v. Approved Equipment

1. Hubbell HLQ24 Quadcab
2. Chatsworth CUBE-iT Plus Cabinet System.
3. Belden XHW-4830-GD with XHWFANKIT115V

c. Flat Copper Patch Panels:

i. Provide flush mount flat patch panels of required number and size to accommodate shown telecommunications outlets on plans.

ii. Size panels to provide minimum 25% spare capacity. Fill all available space in remaining patch panels so that panels are fully populated.

iii. Support Category 6 or higher applications.

iv. Provide keystones or inserts to match School District specific cable system colors/identifiers.

v. Shall accommodate 8-Pin 8-Contact (8P8C) ports.

vi. Mount to standard EIA 19" rack.

vii. Each patch panel shall include mounted behind it one "towel rack" style cable support bar for each 24 connections that the Contractor shall dress cables using hook and loop type cable ties.

viii. Approved Equipment

48-Port Patch Panel Cat 6		
Manufacturer	**Model Name**	**Flat Patch Panel**
CommScope	Uniprise	UNP-6-DM-2U-48
Panduit	NetKey	NK6PPG48Y
Leviton	Leviton	69586-U48
Siemon	HD	HD6-48
Belden	Rev	RV6PPF2U48BK

48-Port Patch Panel Cat 6A		
Manufacturer	**Model Name**	**Flat Patch Panel**
CommScope	Uniprise	UNP-6A-DM-2U-48
Panduit	NetKey	NK6XPPG48Y
Leviton	Leviton	6A586-U48
Siemon	Z-Max	Z6A-PNL-U48K
Belden	Rev	RVAPPF2U48BK

d. Fiber Shelves and Cassettes

i. Provide fiber shelves and cassettes as required to complete project with a maximum of 36 strands in 1RU.

ii. Provide rack mounted, sliding type fiber trays as required to complete project.

iii. Provide OM4 fiber adapter patch panels that contain modular, dual LC adapter panels as required to complete project. Color for OM4 ports to be aqua.

iv. Provide minimum 25% spare capacity of fiber adapter panels. Provide additional rack mounted fiber trays/fiber adapter patch panels if necessary to meet 25% spare capacity requirement.

v. Approved Equipment

Manufacturer	**Model Name**	**Fiber Shelf**	**Cassette (OM4)**
CommScope	Systimax 360	SD-1U-FX	PNL-CS-12LCX-PT
Panduit	HD-FLEX	FLEX1U06	FHSZA-12-10P
Leviton	Opt-X	5R1UM-S03	SPLCS-124
Corning	CCH	CCH-01U	CCH-CS12-E4-P00QE
Siemon	FCP3	FPC3-DWR	FSM2-12-LC5V-01
Belden		ECX-01U	FC4X06LDFS + FT4LC900PR12

e. Vertical Cable Managers:

i. Provide a double sided vertical cable management panel on both sides of rack.

ii. Manager shall consist of a metal backbone with cable management fingers that align with EIA rack spacing. Provide cover for all cable management.

iii. Vertical panel shall be able to manage all the cable on the rack without the aid of horizontal cable managers.

iv. Size all vertical cable managers according to factory recommendations for the cable being installed. In no case shall design require more than 35% fill ratio when rack is fully populated.

v. Provide molded plastic slack spools in front to facilitate minimum bend radius compliance.

vi. Minimum width to be 6”.

vii. Approved Equipment

1. Chatsworth Velocity Double Sided 1391X-703
2. CommScope VCM-DS-84-xB (6”, 8”, 10”, 12”).
3. Panduit PatchRunner PRV6
4. Leviton 8980L-VFR (8”)
5. BHVHH06 with BHSK020

f. Horizontal Cable Management

i. Provide horizontal cable management capable of managing copper and fiber cables.

ii. Manager shall consist of bend radius control throughout the fingers, pass through holes, and transitions between horizontal and vertical pathways.

iii. Provide front hinged cover that shall open 180 degrees.

iv. Manager should mount to standard EIA 19” rack.

v. Size according to factory recommendations for the cable being installed. In no case shall design require more than 40% fill ratio when rack is fully populated.

vi. Approved Equipment

1. Panduit NMFX, where X refers to the number of rack units
2. CommScope HTK-19-SS-XU, where X refers to the size.
3. Leviton 492RU-HFR (2RU) or 491UR-HFR (1RU)
4. Chatsworth 13930-70X (X denotes 1-3 RU)
5. BHH191UR / BHH192UR

g. Power Distribution Units (PDUs)

i. Provide monitored vertical mount power outlet unit with amperage and voltage indicated on plans. Unit shall have (24) NEMA 5-20R receptacles per circuit and internal thermal breaker of power outlet unit's listed amperage. Provide data cable to each PDU for reporting.

ii. Approved Equipment

1. Chatsworth eConnect P3-1C0A5
2. 9PG2-241003 with XDRPDUK401

h. Uninterruptible Power Supply (UPS)

i. Provide 1500VA, 120V rack-mounted UPS for each rack/cabinet on project with capability of providing backup to the full connected load for a minimum of **20 minutes**, regardless of shown load on electrical panel schedules.

ii. Provide a minimum of (2) output receptacles.

iii. Provide submittal for each UPS showing run time graph that shows compliance with the specifications.

iv. Approved Manufacturers

1. APC

f. Cable Tray (only within the EF/ER/TR)

i. This cable tray section is only applicable within the EF/ER/TR and does not apply outside of those spaces. See specification 26 0536 Raceway Systems for any cable tray requirements outside of the EF/ER/TR (if applicable to the project.)

ii. Provide overhead ladder tray:

1. Tray shall have minimum 6" rung spacing.
2. Mount tray 18" above racks unless otherwise noted. Provide additional vertical tray as required to provide pathways between the tray above racks and the tray entering the communications room from outside.
3. Size tray according to quantity of cables entering space. However, in no case shall the tray be smaller than 4" high by 6" wide. Do not exceed 50% cable fill of tray.

4. For overhead installations, utilize profile supports to support tray every 5'-0".
5. For wall mounted installations, utilize shelf brackets to support tray every 5'-0".
6. Provide blind ends to provide closure for a dead-end tray.
7. Provide cable rollers, two at each 90-degree bend. A radius shield or horizontal bend radius may also be used in lieu of cable rollers.
8. Provide drop-out fittings, or waterfalls, over each cabinet of sufficient quantity to provide an acceptable path for cables to enter equipment. For single cables leaving the tray, utilize a cable drop-out in lieu of a waterfall.
9. Cables must enter the racks from the top.
10. Provide conduit to tray adapters for each conduit terminating to cable tray.

iii. Acceptable Manufacturers

1. Chatsworth Universal Cable Runway
2. Cooper B-Line Redi Rail Runway
3. Cablofil PW Ladder Tray
4. CommScope Cable Runway
5. Panduit WyrGrid Cable Tray
6. MonoSystems Series MR-16T

2.3 CABLING DISTRIBUTION SYSTEMS AND MISCELLANEOUS EQUIPMENT

A. General:

1. Provide plenum rated cable/connectors if required, cabling/connectors must be appropriate for the environment that it is installed in. Provide wet rated cable for all wet locations, including any conduit in or below slab on grade.
2. Contractor shall be responsible for sizing all pathways such that newly installed cable represents not more than a 35% fill as per manufacturer's directions. Overfilled pathways are the sole responsibility of the Contractor who shall remove and reinstall at Contractors expense.
3. Provide products rated for the environment that it is installed in (i.e. riser, plenum, outdoor). All cabling installed in wet locations (i.e. underground conduit, conduit in slab on grade) shall be listed for use in wet locations. Cabling rated for wet location/OSP to be ran entirely in conduit to within 50' of IDF/MDF room. OSP cabling may not be free-aired or utilize ventilated trough due to lack of plenum rating.

B. Backbone Cabling Distribution System – Optical Fiber

1. General:
   a. Provide an optical fiber backbone cabling distribution system between telecommunication spaces. Provide OFNR or OFNP as required. Provide 900μm tight-buffered optical fiber cable for premise cable and loose tube for outside plant cable.
   b. Provide fiber jumpers of appropriate length and cable type for each terminated optical fiber port to be connected.

2. Multi-Mode Fiber Optic Cable (OM4)

   a. All multimode optical fiber cabling shall be 50μm/125μm micron laser-optimized cable, designation OM4.

   b. Provide two strands between each EF/ER, ER/TR, and TR/TE for each 48-port patch panel. Provide a minimum of 12-strands of fiber between telecom rooms unless otherwise noted on plans. Provide 25% extra fiber pair strands if more than 12-strands are required. See riser diagram for additional information.

   c. Approved Equipment

Manufacturer	**Model**	**Indoor/Outdoor**
General Cable	NEXTGEN	BL###4M1D-DT
CommScope	LazrSPEED 550	P-###-OD-5K
Berk-Tek	GIGALite	LTPxxx-FB3010
Corning	MIC Cable	xxxTSP-T4190-D20
Siemon		9GD5(x)(xxx)-T501A
Belden		FD4DxxxR9

3. Connectors:

   a. Provide LC-Duplex Connectors.

   b. Mechanical connectors are acceptable. Do not utilize polish type connectors. Clean all preterm connectors, no exceptions.

   c. For all simplex connectors, provide duplex type clip.

   d. Approved Manufacturers:

Manufacturer	**Multi-Mode (OM3/4)**
CommScope	MDC-LCR-16-BG
Panduit	FLCDMx
Leviton	49990-LDL
Corning	95-051-98-SP-X
Siemon	FC1-LB-SC5-9AQ
Belden	FT3LC900FS01

C. Backbone Cabling Distribution System – Copper

1. General:

   a. Provide copper backbone distribution system between telecommunication spaces as shown on drawings.

   b. Provide Hitachi cable **(Drybit Category 6A Indoor/Outdoor Cable)** for the location requiring plenum indoor/outdoor cable or the conduit shall be

run all the way back to the data room with non-plenum indoor/outdoor cable. NO transition point is permitted from outdoor to indoor cabling.

2. Backbone Cabling Distribution System

   a. Provide Cat 6A cable with wire count as shown on drawings.

   b. Provide copper patch cables of appropriate length and cable type for each terminated patch panel port with an additional 25% spare.

   c. Acceptable Manufacturers:

      i. Copper backbone cabling shall be by same manufacturer as copper horizontal cabling.

3. Multipair Bundle Copper Termination Blocks:

   a. Provide termination blocks that support Category 6 applications and facilitate cross-connection using either cross- connect wire or patch cords.

   b. Provide termination blocks for voice and data as required for all building telecommunications needs. A minimum of two Category 6 termination blocks shall be provided at each back board location sized for incoming telecommunications needs.

   c. Connecting hardware block shall support all Category 3, 5e or 6 applications and facilitate cross-connection and/or inter-connection using either cross-connect wire or patch cords.

   d. Provide wiring spindles and channels as necessary to allow neat bundling of all wire and cable. Provide wiring channel (horizontal) above and/or below each termination block. Provide wiring channels by same manufacturer of termination block. Provide Velcro type ties for all cables at telephone backboard not run in conduit or channels. Provide wiring channel from demarcation point to termination block.

   e. Approved Equipment

      i. Panduit GPKBW24Y Punchdown Kit.

      ii. Leviton CAT6+ 110-style wiring block (96-pair) # 41AB6-1F4

      iii. Commscope

      iv. Belden Gigabix AX101470

4. Primary Protection (Surge Protection)

   a. General

      i. Provide surge protection for each pair of copper cabling between buildings and any end point devices that are located outside. For example, if a camera is mounted or located on the exterior of the building—surge protection is required.

      ii. Surge suppressions shall be achieved through 5-pin, solid state, plug-in type modules for each conductor pair.

      iii. Provide necessary grounding of equipment to building electrical ground. Size all grounding conductor based on distance to electrical ground according to the requirements of this section.

      iv. Provide 25% spare modules.

      v. Approved Equipment

         1. For data outlets where POE is present

a. ITWLinx 1Gb CAT6A-POE.

2. For outlets where no POE is present

a. ITWLinx 1Gb CAT6A-LAN

3. For copper multi-pair backbones

a. ITWLinx ML25-CAT5-75

4. If power is required on all four pairs. (Note: If Cisco switches are connected via a copper backbone, this product is required.)

a. ITWLinx 1Gb CAT6A-75

D. Horizontal Cabling Distribution System – Balanced Twisted Pair

1. General:

a. Provide appropriate number of Category 6 horizontal cables, patch cables, work area cables, for all terminated data drops, between switches, etc. so that building-wide networking will be operational once all installation is complete.

2. Horizontal Cabling

a. Provide Cat 6 UTP, min-compliant, 4-Pair 100Ω Balanced Twisted Pair Cable to all locations shown on plans with the following minimum quantities by space, regardless of what is shown on plans:

i. Offices; 4 cables each

ii. Classrooms/Workstations; 4 cables each

iii. Conference Rooms; 4 cables each

iv. Reception; 4 cables

v. Copy Rooms; 4 cables each

vi. Furniture Feeds; 2 cables each

b. Provide cabling rated for the environment that it is installed in (i.e underground conduit, conduit in slab on grade). All cabling installed in wet locations shall be listed for use in wet locations.

c. Provide a minimum of (2) cables, unless otherwise noted, to each location shown on plans.

i. Provide (2) Category 6A Shielded cables to each wireless access point (WAP).

a. Locate drops in near center of classroom in biscuit jack above ceiling grid, label on ceiling grid on locations that biscuit is used instead of faceplate.

b. WAPs should be provided at a minimum of the following locations: Lecture Hall, Cafeteria, Commons Office Areas, Counseling office, Reception Office Common Area where kids would be sitting. See plans for additional locations and provide accordingly.

c. Wireless access points to be owner furnished, owner installed (OFOI)

d. Horizontal cable colors (Verify with owner prior to ordering cable):

i. Telephone/Data = Blue

ii. Wireless Access Point (WAP) = Orange

iii. IP Surveillance Cameras = Yellow

iv. AV = White

v. Intercom = Purple

vi. Elevator = Black

vii. Access Control = Green

viii. Intrusion = Gray

e. Approved Equipment

Cat 6		
Manufacturer	**Model**	**Plenum**
General Cable	GenSPEED 6	7131800
CommScope	Uniprise	6504
Berk-Tek	LANmark-6	10136226 (Blue, CMP)
Siemon		9C6P4-E3-06-RXA
Belden		2413

Cat 6A			
Manufacturer	**Model**	**Plenum**	**WAP**
General Cable	GenSPEED 6 10,000	7131819	Shieled Cat 6A
CommScope	Uniprise	UN874035114/10	Shieled Cat 6A
Berk-Tek	LANMark-10G2	10130484 (Blue, CMP)	Shieled Cat 6A
Siemon		9C6P4-A5-06AR1A	Shieled Cat 6A
Belden		10GXS13	Shieled Cat 6A

f. Surface Box/Biscuit Box

i. Provide an 1 or 2-port surface/biscuit for each camera and WAP, and any other locations indicated or as required.

ii. Box shall match provided cabling manufacturer.

3. Patch and Work Area Cables:

a. Patch Cables shall match colors specified above.

b. Provide and install (1) 7-foot-long patch cable for each workstation, except for classroom locations where (1) 15-foot-long patch cable is to be provided, and (1) 5 foot or 7 foot patch cable for each patch panel port in the TR/TC. Provide half of the TR/TC patch cables in 5 foot lengths and the remaining half in 7 foot lengths. Verify final patch cable lengths with owner prior to ordering.

c. No patch or work area cords shall in any case exceed in total 10 meters as per TIA Standard unless design includes Standards compliant MUTOA (multi-user termination outlet) and work area cord adjustments are made according to recommendations for zone cabling contained within TIA 568-

C or most recent revision at the time of installation. Coordinate with owner for preferred patch cord lengths at patch panel and work area.

d. Copper patch cord and work area outlet cabling must be provided by the same manufacturer and meet the same performance standards as the horizontal cabling.

e. Patch cord and work area cables shall be blue.

f. Provide (1) 6 foot, 2-strand optical fiber patch cable for each patch panel, utilizing same performance standards and connector types as specified for the backbone. The cable shall be provided by the same manufacturer and meets the same performance standards as the backbone optical fiber. Verify final patch cable lengths with owner prior to ordering.

4. Telecommunications Outlets/Connectors (See Plans for Locations):

a. Sloped Faceplates:

i. Provide modular type information outlets with sloped telephone jack or data outlet. Provide single gang faceplate kits to allow up to six data or voice jacks as shown on plans. Provide faceplate kits for wall outlets in colors and materials that match power wiring device plates. Provide faceplate kits that allow labeling schemes described herein. Faceplates shall accept STP, UTP, fiber optic or audio/video modules as an option.

ii. Provide keystones or inserts to match School District specific cable system colors/identifiers.

iii. Blank off all unused ports.

iv. Color: Stainless Steel Faceplates

b. Angled Connector:

i. Color: Standard color as selected by owner/architect.

c. Approved equipment

Connector			
Manufacturer	**Model**	**Connector Cat 6**	**Connector Cat 6A**
CommScope	GigaSPEED XL	MGS400-xxx	MGS600-xxx
Panduit	NetKey	NK688Mxx	NK6X88Mxx
Leviton	QuickPort, eXtreme	61110-Rx6	6110G-Rx6
Siemon		MX6-(xx)	Z6A-(xx)
Belden		RV6MJKUxx-S1	RVAMJKUxx-S1

Angled Plate		
Manufacturer	**Model**	**Stainless Steel Faceplates**
CommScope	GigaSPEED XL	
Panduit	MiniCom	CFPSLxS

Leviton	QuickPort, eXtreme	43081-xLx
Siemon	Use angled version	mounted
Beldon		

PART 3 – EXECUTION

3.1 GENERAL

A. Prior to pathway rough-in, low voltage contractor shall meet with electrical contractor to review pathway installation requirements.

B. Pathway Requirements:

1. General:

   a. All pathways shall be designed, constructed, grounded and installed in accordance with all recommendations delineated within TIA 569-B and Standard TIA 942.

   b. Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. Field coordinate alternate pathway requirements with other trades onsite. New pathways shall not exceed distance limitations defined within this specification. Notify the Engineer of the changes for final approval prior to proceeding with the change.

   c. Paint all electrical boxes and their covers for the telephone and data system matte white. See specification 26 0553 for additional identification information.

2. Cable Tray Within EF/ER/TR:

   a. Wrapped around room (wall support is acceptable)

   b. Along equipment rows leading to cross-connects.

   c. Ground tray to TGB or TMGB (whichever is closer) utilizing #6CU bare wire.

   d. Coordinate tray locations with lighting, air-handling systems, and fire extinguishing systems so that fully loaded trays will not obstruct or impede their operation.

      i. Install cable tray under mechanical components for access for future cabling needs; coordinate the mounting height of the cable tray with Owner IT Representative prior to installation. Do not install cable tray at the top of a ceiling which is inaccessible due to the excessive height.

3. Racks / Cabinets:

   a. Racks shall be securely attached to the concrete floor using minimum 3/8” hardware or as required by local codes.

b. Racks shall be placed with a 36-inch (minimum) clearance from the walls on all sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.

4. Conduits:

   a. For any interior/exterior conduit 4” and larger, provide (3) 1.25” plenum-rated corrugated innerducts.

   b. Flexible conduit is not acceptable as cable tends to creep, shift, or have sheath damage.

   c. Achieve the best direct route parallel with building lines with no single bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.

   d. Conduit runs shall not have continuous sections longer than 100 feet without a pull box and may only be filled to 35% capacity.

   e. Ream all conduit ends and fit with an insulated throat nylon bushing with non-indenter type malleable steel fittings to eliminate sharp edges.

   f. Telecommunications conduits should not be routed over or adjacent to heat sources such as boilers, hot water lines, or steam lines. Neither should they be routed near large motors, generators, photocopy equipment, or electrical power cabling and transformers.

   g. Conduits that enter an EF/ER/TR must terminate near the corners to allow for proper cable racking. Terminate these conduits as close as possible to the wall where the backboard is mounted to minimize the cable route.

   h. Terminate conduits that protrude through the structural floor 1” to 3” above the surface within an EF/ER/TR.

   i. After installation, conduits shall be clean, dry, unobstructed, capped for protection, labeled for identification, reamed and fitted with bushings.

   j. A 200lb pull cord (nylon, 1/8” minimum) shall be installed in any empty conduit.

   k. When the number of conduits requires more than one row, restrict the number of rows to two wherever practicable.

5. Open Top Cable Support Requirements:

   a. Provide wide surface area open-top cable supports spaced 5 feet apart at the maximum to adequately support and distribute cable’s weight. Follow manufacturer specifications for cable loading. Provide supports that have a galvanized finish with wide base specifically for telecommunications cabling.

   b. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables

   c. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.

   d. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports.

   e. Approved Equipment

      i. Erico Caddy-Cat HP

6. Pull Box Requirements:
    a. NEC sized pull boxes are not acceptable. Follow BICSI and EIA/TIA 569-B guidelines for pull box sizing.
    b. Provide pull boxes in sections of conduit that are 100 feet or longer, contain more than two 90-degree bends, or contain a reverse bend.
    c. Conduits that enter the pull box from opposite ends should be aligned.
    d. Pull boxes shall have a length 12 times the diameter of the largest conduit.
    e. All pull boxes must be accessible.

C. Cabling System:
1. Follow T568B scheme for copper cabling terminations.
2. Life Safety Related Cabling:
    a. Provide the specified category cabling in 1” conduit from elevators and or lifts. Cabling shall terminate at telephone service demarcation point.
    b. Provide the specified category cabling in 1” conduit for two phone lines to the fire alarm control panel back to telephone service demarcation point.
    c. Provide the specified category cabling in 1” conduit for the two-way communication system Main Control Panel back to telephone service demarcation point.
3. Miscellaneous Related Cabling:
    a. Provide the specified category cabling in 1” conduit for two data connections to Intrusion Detection System head-end back to EF or demarcation room. Refer plans for exact locations.
    b. Provide the specified category cabling in 1” conduit for two data connections to Access Controls System head-end back to closest data rack. Refer to plans for exact locations.
    c. Provide the specified category cabling in 1” conduit for one data connection to Intercom head-end back to closest data rack. Refer to plans for exact locations. Provide specified category cabling and conduit between intercom head-end and access control panel.
    d. Provide the specified category cabling in 1” conduit for Main Building Management System (ATC Panels, etc) back to nearest ER/TR room. Refer to Mechanical plans for exact location.
    e. Provide the specified category cabling in 1” conduit for one data connection to each lighting controller/relay panel back to nearest ER/TR room. Refer to plans for exact locations.
    f. Provide the specified category cabling in 1” conduit for one data connection to each irrigation controller back to nearest ER/TR room. Refer to plans for exact locations.
    g. Provide the specified category cabling in 1” conduit for two data connections to Energy & Power Metering System back to Main Building Management System Panel. Mutliple locations throughout the school. Refer to plans for main switchboard location.
    h. Provide the specified category cabling in 1” conduit for one data connection to each classroom/building CSA system to nearest ER/TR room. Refer to plans for exact locations.

i. Provide the specified category cabling in 1" conduit for one data connection to each classroom/building POE Audio Enhancement camera to nearest ER/TR room. Refer to plans for exact locations.

4. Backbone cables shall be installed separately from horizontal distribution cables. Provide plenum rated innerduct if required, innerduct must be appropriate for the environment that it is installed in.

5. It is acceptable to install innerduct within ventilated trough as long as the fill ratio is not exceeded.

6. Fiber slack shall be neatly coiled within the fiber enclosure or ventilated trough . No slack loops shall be allowed external to the fiber panel. Each cable shall be individually attached to the respective fiber enclosure by mechanical means.

7. Provide a minimum of one balanced twisted pair cable to each voice outlet and one balanced twisted pair cable to each data outlet shown on the drawings unless noted otherwise on the drawings.

8. Service Loop Requirements

   a. Provide a minimum 6" service loop in each communications system junction box for balanced twisted pair. Cables shall be coiled in the in-wall boxes if adequate space is present to house the cable coil without exceeding manufacturers bend radius.

   b. Provide a minimum 10' service loop in each EF/ER/TR/TE.

   c. Provide a minimum 2' service loop at each stub-up or at each transition from conduit to ventilated trough .

   d. Provide a 5' service loop in the ceiling before the conduit travels down the wall and terminates into the communications junction box.

   e. Provide a 15' loop at all wireless access point (WAP) locations above the ceiling.

      i. Provide cable in biscuit box.

   f. Provide a 15' loop at all IP surveillance camera locations above the ceiling.

      i. Provide cable in biscuit box.

9. Provide modular jacks for each installed cable at outlets shown on drawings. Blank off all unused ports on faceplate.

10. Provide Velcro type ties for all cables and install in a neat and workmanlike manner. Where applicable, use plenum rated Velcro. Where cable is installed in ventilated trough , bundle a maximum of 25 cables in each Velcro tie. No zip ties are permitted whatsoever, even for temporarily hanging cables during the installation process

11. The bending radius and pulling strength requirements of all backbone and horizontal cables shall be observed during handling and after installation. Use pulling compound as recommended by manufacturer.

12. All horizontal cables, regardless of media type, shall not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the horizontal cross connect.

13. The combined length of all patch cords in the EF/ER/TR and the work area shall not exceed 10m (33 ft)

14. No splices are allowed.

15. In a false ceiling environment, a minimum of 3 inches shall be observed between cable supports and false ceiling. At no point shall cable(s) rest on acoustic ceiling grids or panels.

16. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

17. Cables shall not be attached to ceiling grid seismic support wires or lighting fixture seismic support wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.

18. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.

19. Pulling tension for balanced twisted pair shall not exceed 25lbf and for optical fiber shall not exceed 50lbf.

20. Pair untwist at the termination shall not exceed 0.125”. The cable jacket shall be maintained as close as possible to the termination point.

21. Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

22. Cable shall not be draped on, tied or otherwise secured to electrical conduit, plumbing, ventilation ductwork or any other equipment. Cable shall be secured to building supports or hangers or to additional blocks or anchors specifically installed for this purpose.

23. Copper Backbone Terminations:

    a. Terminate one single pair on pins 4, 5 at each patch panel port. Terminate all pairs on patch panel located on rack.

D. Grounding System:

1. All grounding and bonding shall be done according to ANSI J-STD-607-A, TIA 942, and NEC.

2. All cabinets/racks shall utilize paint piercing grounding washers, to be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.

3. All racks shall further utilize a full-length rack ground strip attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact. Similar to Panduit RGS.

4. All active equipment from owner shall be bonded to ground. If the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. All active equipment shall be bonded using the appropriate jumper for the equipment being installed using the thread-forming screws. Similar to Panduit RG.

5. Racks shall have individual, appropriately sized conductors bonded to the grounding backbone. Do not bond racks or cabinets serially – daisy-chained rack grounds will not be accepted.

6. Patch panels shall be bonded to racks using the appropriate bonding screws. Mounting rails may utilize cage nuts, threaded holes or thru hole mounting fasteners to secure patch panels to the rails.

7. Bond ventilated trough , raceway system, structural steel and all other metal

equipment located within EF/ER/TR to the grounding bus bar utilizing copper conductors per the following schedule:

a. ≤25' - #34

b. ≤50' - #2

c. ≤66' - #2/0

d. ≥67' - #3/0

8. Provide 4" X 12" X ¼" CU Telecommunication Main Grounding Bus Bar (TMGB) with bonding conductor per schedule above to Intersystem Bonding Terminal (IBT) in each telecommunication room (EF/ER/TR) with a main cross-connect (MC). Provide 20% spare termination spaces on bus bar, provide additional bus bars as necessary to accommodate spare.

9. Provide 2" X 12" X ¼" CU Telecommunication Grounding Bus Bar (TGB) with bonding conductor per schedule above to TMGB in each room with a horizontal cross-connect (HC).

10. Refer to electrical diagrams for additional ground connection requirements.

E. Electromagnetic Compatibility:

1. General:

a. Do not install power feeders above or within the telecommunications room. Do not install telecommunications conduits above electrical panelboards, switchboards, transformers, motor control centers, etc.

b. Where telecommunication cable is installed in grounded, metallic conduit near power cables, the power cables shall be kept physically separated from telecommunications cables:

i. Circuits Under 5kVA: 2" minimum separation.

ii. Circuits Over 5kVA: 6" minimum separation.

iii. Electrical motors/transformers: 48" minimum separation.

iv. Lighting ballasts: 6" minimum separation.

c. Where telecommunication cable is installed in ventilated trough or underground in non-metallic conduit near power cables, the power cables shall be kept physically separated from telecommunications cables by a minimum of 12"

F. EF/ER/TR Power Requirements:

1. General: Regardless of what is shown on drawings, the minimum requirements for providing power in the EF/ER/TR are as follows and shall be included in bid:

a. Provide (1) dedicated, nonswitched 120V/20A 4-plex receptacles, per each data rack, each on individual branch circuits. Outlet to be located near the top of the data rack.

b. 120V/20A Duplex receptacles located +18" A.F.F. placed at 6 foot intervals around perimeter walls. Up to 10 receptacles may be placed on a single circuit.

G. Firestopping and Smoke/Acoustical Pathways(See Also Division 7):

1. Provide firestop/smoke barrier solution equivalent to the wall/ceiling/floor rating.

2. Provide firestop labels next to each penetration with written date. Label both sides of the penetration.

3. Firestop systems shall be UL Classified to ASTM E814 (UL 1479). A drawing

showing the proposed firestop system shall be provided to the Engineer prior to installing the Firestop system(s).

4. Utilize firestop pass-through type devices for medium to large penetrations into fire walls/floors.

5. Provide a minimum of (4) 4" trade size Hilti Speedsleeves (or STI EZPath) with at least one spare for each and every firewall penetration where ventilated trough meets the wall.

6. Provide the following products:

   a. Fire Rated; STI EZ-Path Fire-Rated Pathways Series (or Hilti Speed Sleeve CP 653 BA)

   b. Smoke/Acoustical Rated; STI EZ-Path Smoke & Acoustical Pathway Series (or Hilti Smoke and Acoustic Sleeve CS-SL SA)

H. Miscellaneous Equipment:

1. Arrange all terminal blocks in a manner that allows natural wiring progression and minimizes crossing of wires.

2. Provide patch cords and cross connect cables as necessary for a complete operational telephone and data network system. Consult with owner to determine any special needs such as dedicated phone lines.

PART 4 – LABELING

4.1 GENERAL

A. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

B. All telecommunications spaces, pathways, cables, connecting hardware, equipment, racks, patch panels, outlet/connectors, and grounding system shall be labeled in accordance with TIA/EIA 606-A.

C. All labels shall meet UL 969 requirements for legibility, defacement and adhesion requirements. Handwritten, Ink, or Laser Printing labels are not allowed. Provide labels using thermal transfer print. Heat shrinking or wraparound labels are required, flag style labels are not allowed.

4.2 TELECOMMUNICATION PATHWAYS

A. Identify each dedicated pathway (including inner ducts) for the voice and data system.

B. Label pathways at regular intervals and wherever they are accessible.

4.3 TELECOMMUNICATION CABLES

A. Identify cables at each end with a permanent label or physical/electronic tag.

1. The same alphanumeric identifiers should be used at both ends of the cable.

2. Identify cables at regular intervals throughout and wherever they are accessible.

3. Cables shall be identified in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to

the cable behind the faceplate that can be accessed by removing the cover plate and to the cable behind the patch panel on a section of cable that can be viewed without removing the bundle support ties. Cables labeled within the bundle where the label is obscured from view shall not be acceptable.

4.4 CONNECTING HARDWARE

A. Identify connecting hardware items (termination blocks, cross-connects, racks, cabinets, patch panels, telecommunications outlet/connectors, ports) using alphanumeric identification such as the following three-level scheme:

1. First level—Termination field or patch panel. Color-coding or other labeling should be used to uniquely identify each termination field (e.g., voice and data) on a common mechanical assembly.
2. Second level—Terminal block within a given field or patch panel that could be a row of insulation displacement connectors (IDCs), optical fiber connectors, or modular jacks.
3. Third level—Defines the individual position within a given terminal block or patch panel.

4.5 TELECOMMUNICATIONS GROUNDING SYSTEM

A. Identify each telecommunications grounding bus bar (TGB) and telecommunications main grounding bus bar (TMGB).

B. Identify each grounding conductor relating to the telecommunications system, including those connecting building steel, grounding electrodes, water pipes, and telecommunications structural components.

PART 5 - MISCELLANEOUS

5.1 TESTING:

A. General

1. Provide testing within 10 days of completion for all copper and fiber optic cable according to TIA/EIA standards and any other requirements of the manufacturer who will provide warranty.
2. Submit copy of current calibration of all testing equipment. Submit all test reports electronically to architect/engineer and include in O&M manuals to include test reports. Meter shall have been calibrated within the past 12 months.
3. Correct any malfunctions. Contractor shall re-terminate/replace any cable, connection, or equipment found to be defective or non-compliant with these specifications and referenced standards.
4. Invite Owner IT representative and Engineer to witness and/or review field testing. Notify five business days prior to commencing testing.

B. Copper Cable

1. Utilize Level IIIe, IV, V Tester to test all equipment and each outlet, horizontal cable, termination block, patch cords, etc. to verify compliance with requirements. Testing shall consist of industry accepted verification tests for the Category of cable installed and shall meet latest requirements of EIA/TIA cabling Standards.
2. UTP Cable and Links: All UTP cabling channel must be tested at swept frequencies up to 250MHz for internal channel performance parameters as defined in IEEE 802.3an and ANSI/TIA/EIA-568C. Certifications shall include the following parameters for each pair of each cable installed:

a. Wire map (pin to pin connectivity)

b. Length

c. Insertion Loss

d. Near End Crosstalk (NEXT)

e. Attenuation to Crosstalk Ratio Far End (ACRF)

f. Return Loss

g. Propagation Delay

h. Delay Skew

i. DC Loop Resistance

j. DC Resistance Unbalance

k. Power Sum Near-End Crosstalk (PS-NEXT)

l. Attenuation to Crosstalk Ratio Near-End (ACR-N)

m. Power Sum Attenuation to Crosstalk Ratio Near-End (PS-ACR-N)

n. Attenuation to Crosstalk Ratio Far-End (ACR-F)

o. Power Sum Attenuation to Crosstalk Ratio Far-End (PS-ACR-F)

p. Transverse Conversion Loss (TCL)

q. Equal Level Transverse Conversion Transfer Loss (ELTCTL)

3. All channels that fail testing parameters will be replaced at the Contractor's expense until all channels pass the performance parameters.

4. Provide Modular Plug Terminated Link (MPTL) test for all field terminated plugs (standard for cameras and WAPs).

   a. All installed cabling modular plug terminated links (MPTL) shall comply with the permanent link transmission requirements of the ANSI/TIA-568-2.D standard.

   b. The MPTL shall be tested with a Permanent Link Adapter on the Main Unit and a Patch Cord Adapter Suitable for Category 6A testing on the Far End or Remote Test Equipment.

   c. Modular plug terminated link test results, including the individual frequency measurements from the tester, shall be recorded in the test instrument upon completion of each test for subsequent uploading for reports to be generated.

5. Sampling is not acceptable. MPTL testing shall be performed on each cabling segment (connector to connector).

C. Fiber Optic Cable

1. Provide test results using an OTDR of all installed fiber optic links to demonstrate compliance with requirements. Testing shall consist of industry accepted verification tests for the type of cable installed and shall meet the latest requirements of EIA/TIA 455-53A standards. Test setup and performance shall be conducted in accordance with ANSI/TIA/EIA 526-14 Standard Method B.

2. Provide inspection of fiber end faces by using scope and test according to IEC 61300-3-35 standards. Correct scratched, pitted, or dirty connectors.

3. Provide bi-directional testing of cable for both cable rated wavelengths. Results shall show compliance of cable and shall include the following parameters:

a. Attenuation

b. Length

c. Verification of Polarity

D. Owner reserves the right to hire an independent testing company to spot check the test results. If the results vary more than 10% from the results provided by the Contractor, the Contractor will be required to prove his results are correct or retest the entire system.

5.2 WARRANTY:

A. Register installation with cable/connectivity manufacturer.

B. Provide and submit all test results to owner, engineer, and manufacturer and meet all other manufacturer requirements in order to provide minimum 20-year extended product link warranty for complete cabling/connectivity installation, including all copper and optical fiber utilized on the entire channel. The channel warranty shall be provided by the connectivity manufacturer. Include replacement material and installation for any defective product.

5.3 OPERATING AND MAINTENANCE MANUALS: Refer to Section 26 0502 for requirements.

5.4 TRAINING:

A. Provide four hours training on the operation and installation of the structured cabling system at job site, at no cost to owner.

5.5 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.

END OF SECTION 27 1500

SECTION 27 3244

TWO-WAY COMMUNICATION SYSTEM

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 work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK

A. Extent of two-way communication system work is indicated by performance requirements after construction.

B. Provide all equipment associated with the installation of a Digital Area of Refuge/Area of Rescue Assistance Signal System designed for current edition of International Building Code (IBC) and ADA (Americans with Disabilities Act) requirements. This work shall include a main control panel, optional remote control panels, an internal modem, optional proprietary field switches for systems over 8 zones, remote call stations, power supply(s), outlet boxes, cables and wiring as shown on the drawings and as specified herein.

C. All requirements are hereby defined to include, but not be limited to equipment, raceway, outlets, coverplates, backboards, grounding and miscellaneous items required for complete system.

D. Refer to other Division-26 sections for requirements for raceways, trays, boxes and fittings, and supporting devices, and other sections, as applicable.

1.3 QUALITY ASSURANCE:

A. Comply with applicable portions of NEC as to type products used and installation of components. Provide products and materials that have been UL- 2525 listed and labeled.

B. The system shall be installed in accordance with the current edition of International Building Code (IBC) and ADA (Americans with Disabilities Act) requirements.

C. The completed system shall be in compliance with state and local electrical codes.

D. All wiring shall test free from grounds and shorts.

E. Install according to the manufacturer’s wiring diagrams.

F. The Digital Emergency Communications System requires installation by factory trained authorized dealers/distributors, in accordance with ANSI/NFPA 70 National Electrical Code and NFPA 72 Fire Alarm Code.

G. Properly trained personnel, familiar with Telecommunications Industry Associations 568 TIA/EIA standard, are required for proper installation. Failure to terminate the wiring correctly will cause damage to the system and void the warranty.

1.4 ACCEPTED MANUFACTURER:

Cornell Communications, Inc.

Milwaukee, Wisconsin

Phone 800 558-8957

www.cornell.com

sales@cornell.com

Jeron Electronic Systems, Inc.

Niles, Illinois

Phone 800 621-1903

Sales @jeron.com

1.5 SUBMITTALS: Refer to Section 26 0502 for requirements.

1.6 SYSTEM OPERATIONS:

A. Provide a Digital Rescue Assistance System (Two-Way Communication System) as indicated on the drawings and as specified herein.

1. A common base station shall be provided at the main building entrance or other location as authorized by local authority or the fire department where shown on the drawings to indicate light and tone signals from multiple remote call stations and allow voice communication. When the system is operational, a LED signals power on.

2. When the remote call station switch is activated, a one shot tone is made at the call station and a LED is lit that is steady. The call is displayed digitally on the base station with a tone along with a display of the call and its location on base station

3. When the alarm signal is answered by the control panel, the remote call station is signaled by the LED flashing that voice communication is initiated.

B. Voice communication with the remote call station can then be initiated from the control panel via a handset.

C. A POTS Network Adapter shall be provided to allow the system to call to an Off-Site Emergency Number after a programmable time delay.

D. The system shall poll (supervise) all the call stations, control panels and field switches on a continuous basis to identify line faults and defective equipment. Faults will be alerted and displayed at the control panel(s).

PART 2 – PRODUCTS

2.1 RESCUE ASSISTANCE-DIGITAL SYSTEM AND COMPONENTS

A. This system shall consist of multiple remote call stations, which will communicate with the control panel and have access to a public telephone system for external alarm notification and two-way voice communication.

B. The digital communication system is based on Ethernet technology. It consists of four primary components, a Control Panel, Base Station, Call Station(s),Expansion Module(s) and Power Supplies. In any given system there will be at least one Control Panel and between one and 255 Call Stations. For larger systems, Expansion Modules may be used. The Expansion Switch is based on the Control Panel hardware design. The Control Panel and/or Expansion Switches power the Remote Call Stations. The system interconnects using standard CAT-5E cable. The Ethernet restriction of 100m of cable between a Control Panel and/or Expansion Switch and endpoint applies.

C.

2.2 CONTROL PANEL:

A. When the system is operational, a LED signals power on. When the system is operating in battery power mode a different LED will be on.

B. The main control panel shall be a CORNELL Model SCM-4825 , with capacity for 500 zones utilizing Ethernet technology. The panel shall be rack mounted at the Main Telecommuncaitons Room .

C. An LCD display shall display the first three zones in alarm status. Up to 500 zones can be seen via a scroll button.

a. Each zone alarm will be identified by a building identifier, the floor location, and the description of the area.

b. In the case of an electrical fault: a system fault LED light on the control panel shall illuminate, the fault location will be shown on the LCD display and the alarm shall emit a repeating sound.

D. An audible alarm shall be mounted on the annunciator panel, which will emit a minimum sound level of 90 db at 30 cm when a remote zone station calls.

a. Depressing the select zone switch will answer a call and open the intercom line to the first zone displayed. You can talk to the zone via the handset, which operates in full duplex mode.

b. Depressing the select switch again will end the call, change the call status to answered, move the next call to the first line of the display, which allows you to repeat process answering the next call.

c. If you desire to review all calls: press the scroll button to step through the list of calls.

E. The control panel shall have operating directions as well as both alarm and voice mute buttons.

F. The power supply shall 120 volt with a dedicated circuit. A 24VDC emergency battery backup, CORNELL model B-4825-7 in back box mounted adjacent to Control Panel.

G. The system will be configured via a laptop computer.

H. Raw call data can be optionally logged via the RS-232 terminal interface to a device such as a laptop or desktop computer.

2.3 Base Station:

A. The Base Station shll be a Cornell Model A-4800BS to provide a fully supervised, full duplex voice communications between each Remote Call Station and the Base Station through the Control Panel.

B. Base Station shall initiate a ringtone and display a detailed description of where a call is coming from, call shall be answered by picking up the handset.

C. Provide CAT5e cabling for connection to Control Panel.

D. Provide a JL Industries “1427F12” cabinet for mounting the base station. Provide with clear acrylic window without graphics.

2.4 REMOTE CALL STATIONS:

A. The remote call station shall be CORNELL Model 4800VS, with a momentary switch, microphone, and loudspeaker utilizing Ethernet technology.

B. The station shall have hands free voice communication with the Base Station .

C. The station shall have silk-screened operating instructions.

D. The station shall mount in a 3 gang back box, minimum of 2 ½” deep..

2.5 EXPANSION MODULE:

A. The Expansion Module shall be CORNELL Model ES-4800S and shall allow for additional Call Stations to be installed into the system.

B. Mount Expansion Module in CORNELL Enclosure Model 7330-108.

C. Provide a 250 wall 24VDC plug-in transformer to power unit with 18/2 wiring.

D. Provide CAT6 cabling for connection between Control Panel and Remote Call Stations.

2.6 POTS NETWORK ADAPTER

A. The POTS Network Adapter shall be a CORNELL Model POTS-4800S and provide connection to a POTS telephone line to allow the system to call an offsite monitoring station.

B. Provide CAT5e cabling for connection between Network Adapter and Control Station.

2.7 WIRING REQUIREMENTS:

A. Wiring from the control panel to secondary control panels, field switches and the call stations shall per the specified 27 1500 CAT6 cable.

B. Power Supply – 120V ac, 1 phase, 20 amp. Power requires (1) Pair #16 AWG, stranded, non-shielded cable, from the PS to the Control Panels/Switches for power and (1) Pair #22 AWG, stranded, non-shielded cable, circulating from the PS to all of the Power Detect (J9) connections on the Control Panel.

C. Verify cable types with the Rescue Assistance System Manufacturer.

2.8 RESCUE ASSISTANCE SIGNAL SYSTEM - AUDIO/VISUAL INSTALLATION:

A. Complete system shall be installed in strict accordance with manufacturer's recommendations.

B. Wiring shall be installed in raceways throughout the building

PART 3 - EXECUTION

3.1 INSTALLATION:

A. GENERAL: Install raceway system as indicated to comply with NEC and recognized industry practices. Run 3/4" conduit minimum.

B. GROUNDING: Provide grounding per NEC.

C. POWER: Provide a minimum of one duplex receptacle on dedicated emergency powered circuit as specified.

D. Perform a complete functional test of the system upon completion of the installation.

3.2 WARRANTY:

A. Manufacturer shall provide a one (1) year limited warranty on two way communication system.

3.3 RECORD DRAWINGS:

A. Refer to Section 26 0502 for requirements.

3.4 OPERATION AND MAINTENANCE MANUALS

A. Refer to section 26 0502 for requirements.

3.5 TRAINING

A. Provide a minimum of two (2) hours of in-service training with the system.

1. These sessions shall be broken into segments that will facilitate the training of the system users in operating station equipment.

2. Operating manuals and user’s guides shall be provided at the time of training.

END OF SECTION 27 3244

END OF SECTION 27 3244

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SECTION 27 4100

AUDIOVISUAL SYSTEMS

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 work of this section.

B. Division-26, 27 & 28 basic materials and methods sections apply to work specified in this section.

C. Refer to specification 26 0553 for conduit and junction box color requirements.

D. Refer to specification 27 1500 for category and/or optical fiber cable and connectivity specifications.

E. All unshielded category 'UTP' and/or optical fiber cable, for AV equipment, used on this project shall match the horizontal cabling within the building.

1. Category cables used for transporting video, audio and controls simultaneously from transmitters to receivers and/or switchers shall follow the Manufacturer's recommend cabling specifications.

F. All equipment located in any outdoor location shall be weatherized. All hardware, cable, mounts, j-boxes, etc. shall be outdoor rated and resistant to corrosion

1.2 ADMINISTRATIVE REQUIREMENTS:

A. BNA Project Contact:

1. Eric Mangum, CTS-D
   a. Phone: 801-532-2196
   b. Email: emangum@resolutgroup.com
2. Jaime Verhaal, CTS-D, RCDD
   a. Phone: 801-532-2196
   b. Email: jverhaal@resolutgroup.com

B. Bid Submittal:

1. Equipment Costs: Breakout cost of material and labor as different line items.

C. Coordination:

1. Coordinate final inspection of the systems installed, with Audiovisual (AV) Consultant, three (3) weeks in advance.
2. Obtain GANTT chart for construction time frame from the General Contractor.
3. Coordinate with Electrical contractor to meet at least twice with the ceiling installer. Hold first meeting before submittal of shop drawings to coordinate the mounting condition of all ceiling-mounted AV equipment with ceiling type. During second meeting, coordinate the location of all ceiling-mounted AV equipment in each area.
4. Meet at least once with the mechanical installer prior to fabrication and installation of duct work. Coordinate depth and location of all loudspeaker and duct work in all areas.
5. Meet with Electrical contractor prior to pathway rough-in to coordinate AV system requirements in each area.
6. Meet at least once, prior to rough-in, with horizontal cabling installer to verify all AV network requirements. Coordinate cable color according to specification 26 0553.

7. Meet at least twice with owner and programmer to coordinate AV network requirements. Hold the first meeting after submittal of shop drawings to coordinate network protocols, including but not limited to: IP address schedules, MAC address schedules, patchbay schedules, security requirements, and VLANs. Hold the second meeting prior to AV system deployment.
8. Coordinate color and finish of all AV system components with Architect or Electrical contractor as appropriate.
9. Coordinate all AV system components within millwork/furniture with millwork shop drawings prior to rough-in.
10. Notify AV Consultant when rough-in is complete and ready to inspect. AV Consultant and Electrical Engineer to sign off on rough-in prior to rough-in resuming rough-in for typical rooms.

D. Contractor is responsible for coordinating with all other trades for equipment locations, mounting requirements, supports and plenum space requirements.

E. AV contractor shall attend the electrical pre-construction meeting per specification 26 0500.

1.3 DESCRIPTION OF WORK:

A. Provide the specified systems in a complete and operating condition with all necessary materials and labor to fulfill the requirements and the intent of the drawings and specifications. Except as otherwise indicated, provide manufacturer's standard system components. Contractor shall furnish all cables, materials and equipment, whether specifically mentioned herein or not, to ensure a complete and functional system.

B. Master quotes do not relieve contractor from preforming due diligence for equipment type, equipment quantity, and quantity of room types. Any errors, conflicts, or omissions between the drawings and/or specifications and master quotes shall be the responsibility of the contractor to resolve.

C. Bidders wishing to provide equipment other than the equipment specified shall submit proposed substitute equipment to AV Consultant eight (8) working days prior to bidding. Submittals for prior approval shall include description of equipment, design intent, complete riser diagrams for proposed equipment, equipment specifications, cut sheets of proposed equipment, reason for alternate equipment. AV Consultant may request physical equipment to test and demo. Acceptance of proposed equipment by AV Consultant shall not relieve AV contractor from responsibility to provide audio-visual systems equal to those specified in this Section. Contractor shall be ultimately responsible for providing complete and working audio-visual systems that function, control and operate in the same manner as the specified equipment. AV Consultant has final say if proposed equipment is equal to the specified equipment. Equipment that AV Consultant is not familiar with will require the contractor to provide manufacturer training at manufacturer's facility and have a manufacturer representative present at time of commissioning.

1. Refer to section 2.2 for approved equals of basis of design equipment.

D. Equipment submitted in the bid proposal that has not been approved by AV Consultant in writing will not be accepted and shall be replaced by approved equipment at contractor's expense. Equipment not listed within this specification, or contract documents, that is required for a complete and working system, shall be of professional grade, new and used in the same manner as needed for a complete and working system.

E. Input plates shall match the color and style being used throughout the project.

F. All control processors and controllers are to be on an unswitched power connection and connected to an uninterrupted power supply if indicated within the design.

1.4 DEFINITION OF TERMS:

A. Approve: The term "approved," where used in conjunction with the Engineer's action on

the Contractor's applications and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.

B. Configure: The term "Configures" or “Configuration” is used to describe set up of components which includes menu based settings, image alignment, dip switches, setup wizards, EDID, etc. required for standard functionality.

C. Contractor: the term “Contractor” refers to the company contracted to perform the work within this specification and associated documents.

D. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

E. Furnish, Install, and Provide: Refer to 26 0500 for definition.

F. General: Basic Contract definitions are included in the General Conditions.

G. Graphical User Interface (GUI): The term “Graphical User Interface (GUI)” is used to describe the user interface from a touch screen. This is a custom interface provided with the programming of the system.

H. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

I. Installer: An "Installer" is the Contractor, or an entity engaged by the Contractor, either as an employee, subcontractor, or sub-subcontractor, for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

J. Programming: The term “Programming” is used to describe writing computer code or a sequence of logic to perform an operation from a triggering event. Programming will be installed on a control processor or similar platform identified within the documents.

K. Programmer: the term “Programmer” is the company or entity engaged by the programming company, either as an employee, subcontractor, or sub-subcontractor, for providing the programming services.

L. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

M. Substitutions: Requests for changes in products, materials, equipment, and methods of construction required by Contract Documents proposed by the Contractor after award of the Contract are considered requests for "substitutions."

1.5 QUALITY ASSURANCE:

A. Installer:

1. Integrating firm shall have worked satisfactorily for a minimum of five (5) years of completing systems equal to this scope, quality, type and complexity.
2. Key personnel assigned to the project shall each have minimum of ten (10) years of experience in completing systems equal to this scope, quality, type and complexity.
3. Contractor shall be a factory authorized distributor of all equipment specified for the geographical area of the project.
4. Contractor shall maintain complete installation and service facilities for the duration of the project contract.

5. Contractor shall have current manufacturer certificates for all AV systems and equipment listed within this specification.
6. Contractor shall be in good standing with the owner.
7. Contractors that do not meet the above requirements cannot bid on this project.

B. Contractor must follow the standards described within:

1. BICSI/AVIXA AV Design Reference manual.
2. ANSI/AVIXA 2M-2010 Standard guide for Audiovisual Systems Design and Coordination Processes.
3. ANSI/AVIXA 10:2013 Audiovisual Systems Performance Verification Guide.

C. All work shall be done by expert technicians qualified in the field with knowledge of specified systems. Workmanship shall comply with industry best practices concerning grounding, shielding, cable dressing, cable termination and equipment mounting.

D. PRE-APPROVED INSTALLERS:

1. AVI-SPL
2. Cache Valley Electric
3. Ford AV
4. GenComm
5. IES
6. LINX
7. Marshall Industries
8. Performance Audio
9. Poll Sound
10. Summit Fire
11. Wasatch Electric
12. WEBB AV
13. Bids submitted by non-approved installers will not be accepted.
14. Bidders not pre-approved shall submit in writing the following for review at least eight (8) working days prior to bid:
    a. List of qualifications including:
        i. Industries certifications including manufacturers.
        ii. Approved resale manufacturers.
    b. Past and current projects within the last five (5) years similar in scope and size.
    c. Three (3) Different referrals from the owners of three (3) different projects within the last five (5) years.

1.6 SUBMITTALS: Refer to specification 26 0502 for shop drawing submittal requirements.

1.7 WARRANTY:

A. Systems shall be guaranteed for a period of one (1) year from the date of substantial completion against defective materials, inferior workmanship or improper installation adjustment. Guarantee shall cover all parts and labor, etc. required to maintain the functionality at the time of system completion.

1. System completion shall be signed off by the programmer, contractor, and the owner. At that time the system will be considered complete.

B. If system failure causes the audiovisual system to be inoperative or unusable for its intended purpose, contractor, when notified of the problem, shall repair the system to be operational and usable within three (3) business days. If defective components cannot be repaired in time, provide temporary equipment as required.

C. The contractor shall utilize their existing service department for warranty calls. Trouble shooting of system components shall be performed before adjustment to the programing is required.

1. Programming changes resulting in rewiring, modifying, or adding new system components will result in a charge, based on Time and Materials required for correcting the system changes.

2. Manufacturer defected equipment will be reprogrammed as needed. Prior to replacement of the equipment the contractor shall coordinate the installation date and time with the programmer. The programmer response time is indicated above.

a. If temporary equipment is needed in the interim, it will be programmed by the programmer. This may require additional time and coordination between the installer and programmer.

D. Contractor shall honor equipment warranties for term established by manufacturer if greater than warranty time frame mentioned above.

PART 2 – PRODUCTS

2.1 GENERAL:

A. All equipment shall be installed as shown on the drawings and in strict accordance with the specifications. Any errors, conflicts, or omissions discovered in the specifications or the drawings shall be submitted in writing to the AV Consultant for clarification.

B. Equipment lists are provided to identify quality and functional expectations. They may not be complete. Coordinate with devices shown on drawings, system risers and equipment lists for system intent. Provide a complete and functional system as described within the construction documents.

C. All equipment located in any outdoor location shall be weatherized and rated for outdoor use. All hardware, cable, mounts, j-boxes, etc. shall be outdoor rated and resistant to corrosion.

2.2 MANUFACTURER APPROVED EQUALS:

A. The Manufacturers listed below have the potential to be considered equals, as it relates to the system design intent and the equipment specified herein. Refer to section 1.3.C. for substitution requirements. Any equipment chosen as equal to what has been specified in section 2.4 will be the responsibilities of the AV Integrator to coordinate all resulting changes and guarantee a complete and functional system e.g. rough-in requirements, programming, etc. Please note that some components have been chosen over others for features and/or size limitations. Equipment listed below with an asterisk have feature and/or size limitations and may not be substituted.

1. Amplifiers – Crown, Extron, Lab Gruppen, LEA Professional, Powersoft, QSC and L`Acoustics

2. Assisted Listening Systems – Listen Technologies, Williams AV

3. Cables – Belden, Crestron, Extron, Gepco/General, Ice, Kramer, Liberty, and Westpenn cables

4. Controls – Crestron, QSC, and Extron

5. Displays – LG, NEC, Planar, Panasonic, Samsung, Sharp, and Sony

6. DSPs – Biamp, Extron, QSC and Symetrix
7. Equipment racks – AtlasIED, Chief, Lowell and Middle Atlantic
8. Loudspeakers – AtlasIED, Bose, Community, JBL, and QSC
9. Microphones – AKG, Audio Technica, Audix, Lectrosonics, Sennheiser and Shure
    a. Auditorium wireless microphones alternates are not acceptable.
10. Mounts – Chief and Premier mounts
11. Network equipment – Cisco, Luxell, and Netgear
12. Networked Audio – Attero tech (QSC), Extron, and RDL
13. Projection Screens – Da-Lite, Draper and Stewart Filmscreen
14. Video Equipment – AMX, Crestron, Extron, Hall Technologies, and Visionary Solutions
15. Wall plates – AtteroTech (QSC), Crestron, Extron, Hall Technologies, Visionary Solutions, RCI Custom, Liberty Panelcrafters and RDL

2.3 GENERAL EQUIPMENT REQUIREMENTS:

A. The equipment specified in this document aims to fulfill the intended functional requirements by precisely identifying the necessary equipment. Depending on the timing of component orders and the project timeline, there may be instances where certain equipment needs to be replaced with newer models. In the event that the indicated equipment is unavailable or has been replaced, the supplier or contractor shall provide a new model that offers comparable functionality.

B. Loudspeakers:

1. Provide applicable mounting equipment as needed, including but not limited to; back boxes, mounting hardware, safety equipment, and seismic restraints.

C. Video Signal:

1. The equipment listed below is considered to be equal replacement parts for a point-to-point video solution as it relates to the system design intent. Equipment listed in section 2.4 overrides the equipment listed below.
    a. Cable Equalizer for cable lengths exceeding 30’ but no more than 75’ or that has more than two (2) union connections. Connect to external power supply and do not use the 5 volts within the HDMI cable.
        i. Extron – HD 4K 101 Plus or Kramer – PT-3H2
    b. Point to point HDBaseT extension, 18 Gbps, 4k60 4:4:4 at 100 Meters:
        i. Crestron – DM-TX-4KZ-100-C-1G with DM-RMC-4KZ-100-C. or Extron – DTP2 T 211 with DTP2 R 211.
    c. HDMI cables intended for client device connection and that are less than 15’ shall be a flexible cable and support 18 Gbps, 4k60 4:4:4 for the entire length of the cable.
    d. Equipment that is not preapproved by the AV Consultant in writing will not be accepted and will be replaced with the approved equipment at no cost to the Owner.

D. Audio Signal:

1. The equipment listed below is considered to be equal replacement parts for a stereo to mono audio signal as it relates to the system design intent. Equipment listed in section 2.4 overrides the equipment listed below.
    a. Passive or Active audio summing adapter. Extron – ASA 131 or RDL –

STA-1

b. Isolation transformer: RDL – EZ-HK1

E. Cables grouped together shall be dressed in an expandable nylon loom, similar to Techflex - Flexo

F. Equipment Racks:

1. All AV equipment racks within this specification shall have the following accessories and/or features, either rack mountable or built into the rack, depending on the model of the rack. Refer to bid documents for all rack mounted equipment. Provide the following accessories as referred to in elevations. RUs are indicated in the elevations and noted with a # symbol in the part number.

2. General Equipment

a. Shelving: Middle Atlantic – SS; 1RU shelf.

b. Drawers:

i. Nonlocking: Middle Atlantic – D#

ii. Locking: Middle Atlantic – D#LK

c. Header panel, located at the top of the rack, AV contractor to submit their logo to RCI for inclusion in the Header panel. If AV contractor has another company that makes the Header panel, provide that information to the AV Consultant.

i. RCI Custom – BNA001-200120MM-01

d. Blank plates: Middle Atlantic – EB#

e. Surge protection for all devices located within the rack. Surge protector shall be: 20 AMPs, rack mountable or mount to a side rail and at least 1,000 joules of protection.

i. Recommended Surge protector is Middle Atlantic – PD-920R-SP. Additional acceptable manufacturers are: Furman, Juice Goose, Tripplite and SurgeX.

f. Horizontal, vertical, and entry cable management.

i. All cabling shall be straight off of the back of equipment to horizontal supports connected to equipment rack. Cabling shall follow support to vertical supports when going into other components and/or out of the equipment rack.

ii. Cabling secured to other cabling and supported from the connector is not acceptable.

iii. Separate AC power and other signal types from each other.

g. Provide 20 Amp rated power strips as necessary.

h. Sequencers

i. Provide a Middle Atlantic – PDS-620R or Furman – CN-2400S Sequencer.

ii. All equipment racks with the following equipment shall have a sequencer within the equipment rack. AV integrator to follow industry standards when using sequencers.

1. Amplifiers

2. Video processors without control processors

i. Passive Thermal Management

i. Vented rear door with no less than 60% open area.

ii. Solid blank panels on the front of the rack in all unused rack spaces.

iii. Stack power amplifiers without open rack space between.

iv. Top of equipment cabinet to be open or vented.

v. Provide passive thermal management in all racks unless noted above.

2.4 EQUIPMENT REQUIRED PER ROOM TYPE

V252-CLASSROOMS (TYPICAL) EQUIPMENT SCHEDULE			
TYPE	**DESCRIPTION**	**MANFR.**	**MODEL NO.**
HDU	HDMI, VGA, 3.5MM AUDIO AND USB PASS THROUGH SINGLE GANG WALL PLAT	AUDIO ENHANCEMENT	AV CONNECT 2
CSA	CLASSROOM RF MICROPHONE SYSTEM, RF RECEIVER, TEACHER & HANDHELD MICROPHONE, LOUDSPEAKERS (C4) INCLUDE WBA601 - INSTALLED	AUDIO ENHANCEMENT	OPTIMUM SYSTEM WITH INTEGRATED XD RECEIVER AND WBA-601
1H	POWER AMPLIFIER 2 CHANNEL X 15 WATTS, 4 Ohms	EXTRON	MPA 152 PLUS
D86	FLAT PANEL DISPLAY, 86" DIAGONAL, UHD	OFCI	OWNER FURNISHED
END OF SCHEDULE			

V258-CLASSROOMS FOODS LAB EQUIPMENT SCHEDULE			
TYPE	**DESCRIPTION**	**MANFR.**	**MODEL NO.**
R9	EQUIPMENT RACK, ABOVE CEILING 4 RU, RECESSED	FSR	CB-224S
Rx	VIDEO RECEIVER, DTP	EXTRON	DTP HDMI 4K 230 RX
HDU	HDMI, VGA, 3.5MM AUDIO AND USB PASS THROUGH SINGLE GANG WALL PLAT	AUDIO ENHANCEMENT	AV CONNECT 2
CSA	CLASSROOM RF MICROPHONE SYSTEM, RF RECEIVER, TEACHER & HANDHELD MICROPHONE, LOUDSPEAKERS (C4) INCLUDE WBA601 - INSTALLED	AUDIO ENHANCEMENT	OPTIMUM SYSTEM WITH INTEGRATED XD RECEIVER AND WBA-601
KP1	KEYPAD, 6 BUTTON WITH VOLUME BUTTONS & CONTROL PROCESSOR	EXTRON	MLC PLUS 100
	DTP HDMI DISTRIBUTION AMPLIFIER	EXTRON	DTP HD DA8 4K 230
	HDMI SWITCHER, 2 INPUT 1 OUTPUT	EXTRON	SW2 HD 4K PLUS
1M	POWER AMPLIFIER 2 CHANNEL X 100 WATTS, 4 Ohms	EXTRON	XPA 1002
D86	FLAT PANEL DISPLAY, 86" DIAGONAL, UHD	OFCI	OWNER FURNISHED
DOC	DOCUMENT CAMERA,4k UHD RESOLUTION, 30X OPTICAL ZOOM,70.2° HORIZONTAL FOV, SIMULTANEOUS HDBT AND H.264 STREAMING, PAIRS WITH ONE-LINK BRIDGE	VADDIO	DOCCAM 4K HDBT SKU: 999-99680-300
END OF SCHEDULE			

V319-GYMNASIUMS EQUIPMENT SCHEDULE (1 OF 2)			
TYPE	**DESCRIPTION**	**MANFR.**	**MODEL NO.**
R1	EQUIPMENT RACK, WALL MOUNT 42" TALL, 22" DEEP, 24 RU WITH PLEXI FRONT DOOR	MIDDLE ATLANTIC	DWR-24-22PD
	DRAWER, PULL OUT, RACK MOUNT LATCHING W/LOCK, 3RU	MIDDLE ATLANTIC	D3LK
	BLANK AND VENT PANELS AS REQUIRED	MIDDLE ATLANTIC	BL# SERIES VTP-# SERIES
	RESOLUT LOGO BLANK PANEL, 1RU WITH RJ45 KEYSTONE JACK FOR SERVICE PORT AND PATCH CABLE TO ETHERNET SWITCH	RCI CUSTOM	BNA001-200120MM-01
	SMART SEQUENCING POWER CONDITIONER, 20A, 9 OUTLETS	FURMAN	CN-2400S
	20A POWER CONDITIONER WITH LIGHTS & VOLT/AMMETTER	FURMAN	PL-PRO DMC
CD	CD PLAYER WITH BLUETOOTH, AM/FM TUNER, AND AUX INPUT	TASCAM	CD-400U
ALS	ASSISTED LISTENING PRIME LEVEL III STATIONARY RF SYSTEM- 72 MHZ INCLUDING: TRANSMITTER ANTENNA KIT RACK MOUNTING KIT RECEIVERS EAR SPEAKERS NECK LOOP LANYARDS 2M DUAL RCA CABLE 12-UNIT CHARGING TRAY NOTIFICIATION SIGNAGE KIT	LISTEN TECHNOLOGIES	LS-55-072 INCLUDING: (1) LT-800-072-01 W/RACK KIT (1) LA-122 (1) LPT-A107-B (1) LA-381-01 (1) LA-304 (#) LR-4200-072 (PER ADA REQ) (#) LA-401 (PER Rx QTY) (#) LA-430 (PER ADA REQ) (#) LA-423 (PER Rx QTY)
M2D	AES-67/DANTE, 1-GANG WALL PLATE, WITH 2 CH INPUT, 2-XLR, 1/4" COMBO	QSC	AXON D2i
BXT	AES-67/DANTE, 2-GANG WALL PLATE, WITH 4 CH INPUT, BLUETOOTH, L/R-RCA, L/R-3.5mm, 2 CH OUTPUT, L/R-3.5mm	QSC	unD6IO-BT
EN2	A/V ENCODER, 4K/60 4:2:0 UHD OVER IP, POE, 1 HDMI W/LOOPOUT, 1 RS-232, 1 STEREO IN, USB 2.0 EXTENSION, VIDEO SCALER	VISIONARY SOLUTIONS	E4100
DC1	A/V DECODER, 4K/60 4:2:0 UHD OVER IP, POE, 1 HDMI OUT, 1 RS-232, 1 STEREO OUT, 2 USB 2.0 EXTENSION, VIDEO SCALER	VISIONARY SOLUTIONS	D4100
EN1	A/V ENCODER (WALL PLATE), 4K UHD OVER IP, POE; DANTE HDMI ONLY	VISIONARY SOLUTIONS	DuetE-WP-H
	NETWORK SWITCH, MANAGED, PoE++, 1440W (24) 1GB AND 4SFP PORTS	NETGEAR	M4250-26G4F-POE++
TP5	TOUCH PANEL, 5.5" DIAGONAL, POE WALL MOUNT	QSC	TSC-50-G3
TP7	TOUCH PANEL, 7" DIAGONAL, POE WALL MOUNT	QSC	TSC-70-G3
END OF SCHEDULE			

V319-GYMNASIUMS EQUIPMENT SCHEDULE (2 OF 2)			
TYPE	**DESCRIPTION**	**MANFR.**	**MODEL NO.**
	UNIFIED CORE WITH 24 LOCAL AUDIO I/O CHANNELS, 128X128 TOTAL NETWORK I/O CHANNELS WITH 8X8 SOFTWARE-BASED DANTE LICENSE INCLUDED, USB AV BRIDGING, DUAL LAN PORTS, POTS AND VOIP TELEPHONY, NO GPIO, 16 NEXT-GENERATION AEC PROCESSORS, 1RU.	QSC	CORE 110F-V2 (INCLUDE UCI AND SCRIPTING LICENSES)
1A, 1B, 1C	POWER AMPLIFIER, w/ DSP & DANTE 4 CHANNEL X 1200 WATTS, 4 Ohms	POWERSOFT	QUATTROCANALI 4804 DSP+D
1D	1600W, 2-CHANNEL AMPLIFIER w/DSP	POWERSOFT	DUECANALI 1604 DSP
A1	LOUDSPEAKER, 15", 2-WAY, HIGH POWER W/ ROTATABLE HORN	JBL	AM7212 / 00
	PROJECTOR HEAVY DUTY LIFT WITH ENCLOSURE.	DRAPER	SLX14 PROVIDE UNIVERSAL MOUNTING BRACKET AND PROJECTOR ON SENSOR
P2	LCD, 13,000 lm, WUXGA, 3LCD LASER PROJECTOR W/4K ENHANCEMENT. PROVIDE PROTECTIVE CASE FOR PROJECTOR AND LENS COLOR BY ARCHITECT	EPSON	EB-PU2113W W/ELPLU04 LENS PROVIDE PROTECTIVE CASE
P3	LCD, 13,000 lm, WUXGA, 3LCD LASER PROJECTOR W/4K ENHANCEMENT. PROVIDE PROTECTIVE CASE FOR LENS AND PROJECTOR. LENS PROTRUDES BELOW THE BOTTOM OF PROJECTOR. COLOR BY ARCHITECT	EPSON	EB-PU2113W W/ELPX02 LENS PROVIDE CUSTOM PROTECTIVE CAGE
SC2	WALL MOUNTED, MOTORIZED, SCREEN W/MATTE WHITE MATERIAL, LVC CONTROLLED, 132.5" X 212"	DA-LITE	PROFESSIONAL ELECTROL
SC3	WALL MOUNTED, MOTORIZED, SCREEN W/MATTE WHITE MATERIAL, LVC CONTROLLED, 150" X 240"	DA-LITE	PROFESSIONAL ELECTROL
RP1	CUSTOM RACK PANEL - SEE ONE-LINE AND/OR PANEL DRAWINGS FOR REQUIREMENTS	RCI CUSTOM	CUSTOM ENGRAVED PANEL - SEE SIGNAL FLOW AND/OR PANEL DRAWINGS FOR REQUIREMENTS
END OF SCHEDULE			

V302-BAND / CHORAL EQUIPMENT SCHEDULE			
TYPE	**DESCRIPTION**	**MANFR.**	**MODEL NO.**
R6	EQUIPMENT RACK, WALL MOUNT, 24.5" TALL, 22" DEEP, 23.5" WIDE, 10RU. NO DOOR	MIDDLE ATLANTIC	EWR-10-22
	BLANK AND VENT PANELS AS REQUIRED	MIDDLE ATLANTIC	BL# SERIES VTP-# SERIES

	RESOLUT LOGO BLANK PANEL, 1RU WITH RJ45 KEYSTONE JACK FOR SERVICE PORT AND PATCH CABLE TO ETHERNET SWITCH	RCI CUSTOM	BNA001-200120MM-01
	POWER CONDITIONER	FURMAN	PL-8C
M2	DUAL MICROPHONE INPUT, WALL PLATE WITH SOLDER CONNECTIONS	RDL	D-XLR2F
AX	AUXILIARY INPUT, WALL PLATE 3.5 MM & DUAL RCA STEREO	RDL	D-CIJ3D
HDU	HDMI, VGA, 3.5MM AUDIO AND USB PASS THROUGH SINGLE GANG WALL PLAT	AUDIO ENHANCEMENT	AV CONNECT 2
CSA	CLASSROOM RF MICROPHONE SYSTEM, RF RECEIVER, TEACHER & HANDHELD MICROPHONE, LOUDSPEAKERS (C4) INCLUDE WBA601 - INSTALLED	AUDIO ENHANCEMENT	OPTIMUM SYSTEM WITH INTEGRATED XD RECEIVER AND WBA-601
MC	MICROFLEX, OVERHEAD MICROPHONE. COLOR BY ARCHITECT	SHURE	MX202
	16-CHANNEL DIGITAL MIXER WITH RACKMOUNT KIT. EFFECTS, 24 CHANNELS, USB INTERFACE, WI-FI / BLUETOOTH, RECORDING	ALLEN & HEATH	CQ-18T
1K	1200W, 2-CHANNEL AMPLIFIER w/DSP	POWERSOFT	DUECANALI 1204 DSP
W1	LOUDSPEAKER, CABINET, 90° X 50°, 93 dB, 117 dB MAX, 63 Hz - 19 KHz ±3dB, 8Ω, DRIVERS: 1x8" LF, 1x1.5" MHF COMPRESSION, PWR RATING: 250 LMHF WATTS	JBL	AC18/95
D86	FLAT PANEL DISPLAY, 86" DIAGONAL, UHD	OFCI	OWNER FURNISHED
END OF SCHEDULE			

V310-AUDITORIUM EQUIPMENT SCHEDULE (1 OF 3)			
TYPE	**DESCRIPTION**	**MANFR.**	**MODEL NO.**
R2	EQUIPMENT RACK, WALL MOUNT 38.5" TALL, 17" DEEP, 18 RU WITH PLEXI FRONT DOOR	MIDDLE ATLANTIC	DWR-18-17PD
R3	EQUIPMENT RACK, WALL MOUNT 42" TALL, 22" DEEP, 24 RU WITH PLEXI FRONT DOOR	MIDDLE ATLANTIC	DWR-24-22PD
	BLANK AND VENT PANELS AS REQUIRED	MIDDLE ATLANTIC	BL# SERIES VTP-# SERIES
	RESOLUT LOGO BLANK PANEL, 1RU WITH RJ45 KEYSTONE JACK FOR SERVICE PORT AND PATCH CABLE TO ETHERNET SWITCH	RCI CUSTOM	BNA001-200120MM-01
	SMART SEQUENCING POWER CONDITIONER, 20A, 9 OUTLETS	FURMAN	CN-2400S
	20A POWER CONDITIONER WITH LIGHTS & VOLT/AMMETTER	FURMAN	PL-PRO DMC
V	VOLUME CONTROL, 70V, DECORA WATTAGE TO EXCEED LINE LOAD BY 20%	ATLAS	ATXXXD
CD	CD PLAYER WITH BLUETOOTH, AM/FM TUNER, AND AUX INPUT	TASCAM	CD-400U

WMB	DIGITAL WIRELESS HANDHELD MICROPHONE BODYPACK TRANSMITTER	SHURE	ULXD1 (QTY: PROVIDE 16)
WMR	QUAD-CHANNEL DIGITAL WIRELESS RECEIVER, DANTE	SHURE	ULXD4Q
AT	POLARIZATION DIVERSITY ANTEANNA WITH PADDED COVER & WALL MOUNT BRACKET (BLACK)	RF VENUE	DIVERSITY FIN: DFINB WALL BRACKET PADDED COVER
AT	ANTENNA DISTRIBUTION SYSTEM	RF VENUE	DISTRO4 ANTENNA DISTRIBUTOR + CABLES
	HEADSET MICROPHONE, OMNI, BEIGE	POINT SOURCE	CO-8WD PROVIDE (4)
	EARWORN MICROPHONE, OMNI, BEIGE	POINT SOURCE	CO-8WS PROVIDE (12)
ALS	ASSISTED LISTENING WI-FI/ RF BASE SYSTEM- 72 MHZ INCLUDING: 2-CHANNEL WI-FI SERVER LE VENUE AWARENESS KIT STATIONARY 3-CHANNEL TRANSMITTER PACK DUAL RCA TO DUAL RCA CABLE BASIC DSP RECEIVER (72MHz) UNIVERSAL EAR SPEAKER INTELLIGENT EAR PHONE/NECK LOOP LANYARD, 4 PORT USB CHARGER	LISTEN TECHNOLOGIES	LCS-120-01 INCLUDING: (1) LW-100P-02 (1) LA-202 (1) LT-803-072-P1 (1) LPT-A107-B (#) LR-3200-072 (PER ADA REQ) (#) LA-401 (PER Rx QTY) (#) LA-430 (PER ADA REQ) (#) LA-423 (PER Rx QTY)
M2D	AES-67/DANTE, 1-GANG WALL PLATE, WITH 2 CH INPUT, 2-XLR, 1/4" COMBO	QSC	AXON D2i
BXT	AES-67/DANTE, 2-GANG WALL PLATE, WITH 4 CH INPUT, BLUETOOTH, L/R-RCA, L/R-3.5mm, 2 CH OUTPUT, L/R-3.5mm	QSC	unD6IO-BT

END OF SCHEDULE

V310-AUDITORIUM EQUIPMENT SCHEDULE (2 OF 3)

TYPE	DESCRIPTION	MANFR.	MODEL NO.
EN2	A/V ENCODER, 4K/60 4:2:0 UHD OVER IP, POE, 1 HDMI W/LOOPOUT, 1 RS-232, 1 STEREO IN, USB 2.0 EXTENSION, VIDEO SCALER	VISIONARY SOLUTIONS	E4100
DC1	A/V DECODER, 4K/60 4:2:0 UHD OVER IP, POE, 1 HDMI OUT, 1 RS-232, 1 STEREO OUT, 2 USB 2.0 EXTENSION, VIDEO SCALER	VISIONARY SOLUTIONS	D4100
EN1	A/V ENCODER (WALL PLATE), 4K UHD OVER IP, POE; DANTE HDMI ONLY	VISIONARY SOLUTIONS	DuetE-WP-H
	NETWORK SWITCH, MANAGED, PoE++, 1440W (24) 1GB AND 4SFP PORTS	NETGEAR	M4250-26G4F-POE++
	NETWORK SWITCH, MANAGED, PoE+, 250W (48) 10GB PORTS,	NETGEAR	M4300-48X
TP5	TOUCH PANEL, 5.5" DIAGONAL, POE WALL MOUNT	QSC	TSC-50-G3
TPT	TOUCH PANEL, 7" DIAGONAL, POE WITH TABLE MOUNT	QSC	TSC-70-G3 TABLETOP MOUNT

	UNIFIED CORE WITH 24 LOCAL AUDIO I/O CHANNELS, 128X128 TOTAL NETWORK I/O CHANNELS WITH 8X8 SOFTWARE-BASED DANTE LICENSE INCLUDED, USB AV BRIDGING, DUAL LAN PORTS, POTS AND VOIP TELEPHONY, NO GPIO, 16 NEXT-GENERATION AEC PROCESSORS, 1RU.	QSC	CORE 110F-V2 (INCLUDE UCI AND SCRIPTING LICENSES)
MIX	48 CHANNEL / 36 BUS DIGITAL MIXER, 24 ONBOARD MIC PREAMPS, 25 FADERS / 6 LAYERS 96kHz FPGA PROCESSING	ALLEN & HEATH	SQ-6
	DUST COVER FOR MIXING CONSOLE	ALLEN & HEATH	AP11333 - SQ-6 DUST COVER
1G	POWER AMPLIFIER, w/ DSP 4 CHANNEL X 600 WATTS, 4 Ohms	POWERSOFT	QUATTROCANALI 2404 DSP
1E, 1F	AMPLIFIED CONTROLLER WITH PFC 4X1000W /8Ω ETHERNET NETWORK AES/EBU	L'ACOUSTICS	LA4X US (QTY. PER DRAWINGS)
A5	LOUDSPEAKER, CABINET, 90° X 50°, 93 dB, 117 dB MAX, 63 Hz - 19 KHz ±3dB, 8Ω, DRIVERS: 1x8" LF, 1x1.5" MHF COMPRESSION, PWR RATING: 250 LMHF WATTS	JBL	AC18/95
	A10 RIGGING HARDWARE	L'ACOUSTICS	A10iWIDE-LINK (QTY.3) A10iWIDE-ENDLINK (QTY.1)
	A10 RIGGING HARDWARE	L'ACOUSTICS	A10-LIFT (QTY.2)
	A10 RIGGING HARDWARE	L'ACOUSTICS	LA-SLING2T
	SB18 RIGGING BAR	L'ACOUSTICS	KARAIIi-BUMP
	SB18 LINKS	L'ACOUSTICS	SB18IIi-LINK (QTY.2)
A3	2-WAY PASSIVE COAXIAL ENCLOSURE; 12" LF+3" HF DIAPHRAGM - STAGE WEDGE	L'ACOUSTICS	X12
S2	18" HIGH POWER SUBWOOFER	L'ACOUSTICS	SB18 Iii
A2	2-WAY PASSIVE CONSTANT CURVATURE 30° ENCLOSURE: 15: LF+3" HF DIAPHRAGM (INSTALLATION VERSION)	L'ACOUSTICS	A10i WIDE
END OF SCHEDULE			

V310-AUDITORIUM EQUIPMENT SCHEDULE (3 OF 3)

TYPE	DESCRIPTION	MANFR.	MODEL NO.
P1	LCD, 13,000 lm, WUXGA, 3LCD LASER PROJECTOR W/4K ENHANCEMENT. PROVIDE ELPLM10 LENS COLOR BY ARCHITECT	EPSON	EB-PU2113W W/ELPM10 LENS
SC1	WALL MOUNTED, MOTORIZED, SCREEN W/MATTE WHITE MATERIAL, LVC CONTROLLED, 177.5" X 284"	DA-LITE	PROFESSIONAL ELECTROL
RP1	CUSTOM RACK PANEL - SEE ONE-LINE AND/OR PANEL DRAWINGS FOR REQUIREMENTS	RCI CUSTOM	CUSTOM ENGRAVED PANEL - SEE SIGNAL FLOW AND/OR PANEL DRAWINGS FOR REQUIREMENTS
END OF SCHEDULE			

V252-MEDIA CENTER/FACULTY PRINT ROOM EQUIPMENT SCHEDULE			
TYPE	**DESCRIPTION**	**MANFR.**	**MODEL NO.**
HDU	HDMI, VGA, 3.5MM AUDIO AND USB PASS THROUGH SINGLE GANG WALL PLAT	AUDIO ENHANCEMENT	AV CONNECT 2
CSA	CLASSROOM RF MICROPHONE SYSTEM, RF RECEIVER, TEACHER & HANDHELD MICROPHONE, LOUDSPEAKERS (C4) INCLUDE WBA601 - INSTALLED	AUDIO ENHANCEMENT	OPTIMUM SYSTEM WITH INTEGRATED XD RECEIVER AND WBA-601
END OF SCHEDULE			

V351-LITTLE THEATER EQUIPMENT SCHEDULE (1 OF 2)			
TYPE	**DESCRIPTION**	**MANFR.**	**MODEL NO.**
R4	EQUIPMENT RACK, WALL MOUNT 28" TALL, 22" DEEP, 16 RU WITH PLEXI FRONT DOOR	MIDDLE ATLANTIC	DWR-16-17PD
	BLANK AND VENT PANELS AS REQUIRED	MIDDLE ATLANTIC	BL# SERIES VTP-# SERIES
	RESOLUT LOGO BLANK PANEL, 1RU WITH RJ45 KEYSTONE JACK FOR SERVICE PORT AND PATCH CABLE TO ETHERNET SWITCH	RCI CUSTOM	BNA001-200120MM-01
HDU	HDMI, VGA, 3.5MM AUDIO AND USB PASS THROUGH SINGLE GANG WALL PLAT	AUDIO ENHANCEMENT	AV CONNECT 2
CD	CD PLAYER WITH BLUETOOTH, AM/FM TUNER, AND AUX INPUT	TASCAM	CD-400U
WMH	WIRELESS HANDHELD MICROPHONE, WIRELESS RECEIVER KIT	SHURE	QLXD24/SM58 QTY: REFER TO PLANS
WMB	MICROPHONE, WIRELESS RECEIVER AND LAVALIER	SHURE	QLXD14/83 QTY: REFER TO PLANS
AT	ANTENNA DISTRIBUTION SYSTEM	RF VENUE	DISTRO4 ANTENNA DISTRIBUTOR + CABLES
	HEADSET MICROPHONE, OMNI, BEIGE	POINT SOURCE	CO-8WD PROVIDE (4)
	EARWORN MICROPHONE, OMNI, BEIGE	POINT SOURCE	CO-8WS PROVIDE (3)
M2D	AES-67/DANTE, 1-GANG WALL PLATE, WITH 2 CH INPUT, 2-XLR, 1/4" COMBO	QSC	AXON D2i
EN2	A/V ENCODER, 4K/60 4:2:0 UHD OVER IP, POE, 1 HDMI W/LOOPOUT, 1 RS-232, 1 STEREO IN, USB 2.0 EXTENSION, VIDEO SCALER	VISIONARY SOLUTIONS	E4100
DC1	A/V DECODER, 4K/60 4:2:0 UHD OVER IP, POE, 1 HDMI OUT, 1 RS-232, 1 STEREO OUT, 2 USB 2.0 EXTENSION, VIDEO SCALER	VISIONARY SOLUTIONS	D4100
EN1	A/V ENCODER (WALL PLATE), 4K UHD OVER IP, POE; DANTE HDMI ONLY	VISIONARY SOLUTIONS	DuetE-WP-H
	NETWORK SWITCH, MANAGED, PoE++, 1440W (24) 1GB AND 4SFP PORTS	NETGEAR	M4250-26G4F-POE++
TP7	TOUCH PANEL, 7" DIAGONAL, POE WALL MOUNT	QSC	TSC-70-G3

	UNIFIED CORE WITH 8 LOCAL AUDIO I/O CHANNELS, 64X64 NETWORK I/O CHANNELS WITH 8X8 SOFTWARE-BASED DANTE LICENSE INCLUDED, USB AV BRIDGING, DUAL LAN PORTS, VOIP, 8x8 GPIO AND 8 AEC PROCESSORS	QSC	CORE 8 FLEX (INCLUDE UCI AND SCRIPTING LICENSES)
1J, 1L	POWER AMPLIFIER, w/ DSP 4 CHANNEL X 600 WATTS, 4 Ohms	POWERSOFT	QUATTROCANALI 2404 DSP
A6	LOUDSPEAKER, CABINET, 120° X 60°, 93 dB, 117 dB MAX, 63 Hz - 19 KHz ±3dB, 8Ω, DRIVERS: 1x8" LF, 1x1.5" MHF COMPRESSION, PWR RATING: 250 LMHF WATTS	JBL	AC18/26
END OF SCHEDULE			

V351-LITTLE THEATER EQUIPMENT SCHEDULE (2 OF 2)

TYPE	DESCRIPTION	MANFR.	MODEL NO.
A8	LOUDSPEAKER, SUBWOOFER SINGLE 18"	JBL	ASB6118
	PROJECTOR CEILING MOUNT, LAY-IN ADJUSTABLE 9"-12" EXTENSION POLE COLOR BY ARCHITECT	CHIEF	CMA440 RPA CMS009012 CMA115
	COMPONENT POLE SHELF	CHIEF	PAC102B
D86	FLAT PANEL DISPLAY, 86" DIAGONAL, UHD	OFCI	OWNER FURNISHED
P4	LCD, 7,000 lm, WUXGA w/ENHANCED 4K, LASER, 1-DVI-D, 1-HDMI, 1-HDBaseT, 1-VGA, 3-USB, 1-COM, 1-LAN, 1-AUDIO OUT, 45° V / 30° H LENS SHIFT	EPSON	EB-PU1007X w/ LENS: ELPLM08 (1.44-2.32)
SC4	CEILING RECESSED, MOTORIZED, 16x10, 164" SCREEN W/TECVISION XH900X ALR MATERIAL	DRAPER	ACCESS/SERIES V WITH LVC-IV CONTROLLER
END OF SCHEDULE			

BUILDING EQUIPMENT SCHEDULE

TYPE	DESCRIPTION	MANFR.	MODEL NO.
HDU	HDMI, VGA, 3.5MM AUDIO AND USB PASS THROUGH SINGLE GANG WALL PLAT	AUDIO ENHANCEMENT	AV CONNECT 2
MW	WINDOW MOUNTED SPEECH SYSTEM, BENT WINDOW MIC	CONTACTA	STS-K058
D86	FLAT PANEL DISPLAY, 86" DIAGONAL, UHD	OFCI	OWNER FURNISHED
END OF SCHEDULE			

BASEBALL FIELD EQUIPMENT SCHEDULE

TYPE	DESCRIPTION	MANFR.	MODEL NO.
	BLANK AND VENT PANELS AS REQUIRED	MIDDLE ATLANTIC	BL# SERIES VTP-# SERIES

	RESOLUT LOGO BLANK PANEL, 1RU WITH RJ45 KEYSTONE JACK FOR SERVICE PORT AND PATCH CABLE TO ETHERNET SWITCH	RCI CUSTOM	BNA001-200120MM-01
CD	CD PLAYER WITH BLUETOOTH, AM/FM TUNER, AND AUX INPUT	TASCAM	CD-400U
	ANNOUNCER'S MICROPHONE W/BOOM ARM	SHURE	SM7B AND BOOM ARM
ALS	ASSISTED LISTENING PRIME LEVEL III STATIONARY RF SYSTEM- 72 MHZ INCLUDING: TRANSMITTER ANTENNA KIT RACK MOUNTING KIT RECEIVERS EAR SPEAKERS NECK LOOP LANYARDS 2M DUAL RCA CABLE 12-UNIT CHARGING TRAY NOTIFICIATION SIGNAGE KIT	LISTEN TECHNOLOGIES	LS-55-072 INCLUDING: (1) LT-800-072-01 W/RACK KIT (1) LA-122 (1) LPT-A107-B (1) LA-381-01 (1) LA-304 (#) LR-4200-072 (PER ADA REQ) (#) LA-401 (PER Rx QTY) (#) LA-430 (PER ADA REQ) (#) LA-423 (PER Rx QTY)
M2D	AES-67/DANTE, 1-GANG WALL PLATE, WITH 2 CH INPUT, 2-XLR, 1/4" COMBO	QSC	AXON D2i
BXT	AES-67/DANTE, 2-GANG WALL PLATE, WITH 4 CH INPUT, BLUETOOTH, L/R-RCA, L/R-3.5mm, 2 CH OUTPUT, L/R-3.5mm	QSC	unD6IO-BT
	NETWORK SWITCH, MANAGED, PoE+, 125W (8) 1GB POE+ AND 2X1G +2SFP PORTS	NETGEAR	M4250-10G2F-POE+
TPT	TOUCH PANEL, 7" DIAGONAL, POE WITH TABLE MOUNT	QSC	TSC-70-G3 TABLETOP MOUNT
	UNIFIED CORE WITH 8 LOCAL AUDIO I/O CHANNELS, 64X64 NETWORK I/O CHANNELS WITH 8X8 SOFTWARE-BASED DANTE LICENSE INCLUDED, USB AV BRIDGING, DUAL LAN PORTS, VOIP, 8x8 GPIO AND 8 AEC PROCESSORS	QSC	CORE 8 FLEX (INCLUDE UCI AND SCRIPTING LICENSES)
3A	1600W, 2-CHANNEL AMPLIFIER w/DSP	POWERSOFT	DUECANALI 1604 DSP
A9	ALL-WEATHER COMPACT 2-WAY COAXIAL, W/12"LF	JBL	AWC129
END OF SCHEDULE			

V102-COMMONS EQUIPMENT SCHEDULE			
TYPE	**DESCRIPTION**	**MANFR.**	**MODEL NO.**
R8	EQUIPMENT RACK, WALL MOUNT, 35" TALL, 22" DEEP, 23.5" WIDE, 16RU. SOLID FRONT DOOR	MIDDLE ATLANTIC	EWR-16-22SD
	RESOLUT LOGO BLANK PANEL, 1RU WITH RJ45 KEYSTONE JACK FOR SERVICE PORT AND PATCH CABLE TO ETHERNET SWITCH	RCI CUSTOM	BNA001-200120MM-01
CD	CD PLAYER WITH BLUETOOTH, AM/FM TUNER, AND AUX INPUT	TASCAM	CD-400U
WMH	WIRELESS HANDHELD MICROPHONE, WIRELESS RECEIVER KIT	SHURE	QLXD24/SM58 QTY: REFER TO PLANS

WM B	MICROPHONE, WIRELESS RECEIVER AND LAVALIER	SHURE	QLXD14/83 QTY: REFER TO PLANS
ALS	ASSISTED LISTENING PRIME LEVEL III STATIONARY RF SYSTEM- 72 MHZ INCLUDING: TRANSMITTER ANTENNA KIT RACK MOUNTING KIT RECEIVERS EAR SPEAKERS NECK LOOP LANYARDS 2M DUAL RCA CABLE 12-UNIT CHARGING TRAY NOTIFICIATION SIGNAGE KIT	LISTEN TECHNOLOGIES	LS-55-072 INCLUDING: (1) LT-800-072-01 W/RACK KIT (1) LA-122 (1) LPT-A107-B (1) LA-381-01 (1) LA-304 (#) LR-4200-072 (PER ADA REQ) (#) LA-401 (PER Rx QTY) (#) LA-430 (PER ADA REQ) (#) LA-423 (PER Rx QTY)
M2D	AES-67/DANTE, 1-GANG WALL PLATE, WITH 2 CH INPUT, 2-XLR, 1/4" COMBO	QSC	AXON D2i
BXT	AES-67/DANTE, 2-GANG WALL PLATE, WITH 4 CH INPUT, BLUETOOTH, L/R-RCA, L/R-3.5mm, 2 CH OUTPUT, L/R-3.5mm	QSC	unD6IO-BT
	NETWORK SWITCH, MANAGED, PoE+, 125W (8) 1GB POE+ AND 2X1G +2SFP PORTS	NETGEAR	M4250-10G2F-POE+
TP7	TOUCH PANEL, 7" DIAGONAL, POE WALL MOUNT	QSC	TSC-70-G3
	UNIFIED CORE WITH 8 LOCAL AUDIO I/O CHANNELS, 64X64 NETWORK I/O CHANNELS WITH 8X8 SOFTWARE-BASED DANTE LICENSE INCLUDED, USB AV BRIDGING, DUAL LAN PORTS, VOIP, 8x8 GPIO AND 8 AEC PROCESSORS	QSC	CORE 8 FLEX (INCLUDE UCI AND SCRIPTING LICENSES)
2A, 2B	1600W, 2-CHANNEL AMPLIFIER w/DSP	POWERSOFT	DUECANALI 1604 DSP
2C	1200W, 2-CHANNEL AMPLIFIER w/DSP	POWERSOFT	DUECANALI 1204 DSP
A4	LOUDSPEAKER, 12" TWO-WAY, 90 X 55,	EV	EVC-1122-95

END OF SCHEDULE

V305-DANCE ROOM EQUIPMENT SCHEDULE

TYPE	DESCRIPTION	MANFR.	MODEL NO.
R5	EQUIPMENT RACK, WALL MOUNT, 28" TALL, 17" DEEP, 23.5" WIDE, 12RU. NO DOOR	MIDDLE ATLANTIC	EWR-12-17SD
	DRAWER, PULL OUT, RACK MOUNT LATCHING W/LOCK, 3RU	MIDDLE ATLANTIC	D3LK
	BLANK AND VENT PANELS AS REQUIRED	MIDDLE ATLANTIC	BL# SERIES VTP-# SERIES
	RESOLUT LOGO BLANK PANEL, 1RU WITH RJ45 KEYSTONE JACK FOR SERVICE PORT AND PATCH CABLE TO ETHERNET SWITCH	RCI CUSTOM	BNA001-200120MM-01
	20A POWER CONDITIONER WITH LIGHTS & VOLT/AMMETTER	FURMAN	PL-PRO DMC
HDU	HDMI, VGA, 3.5MM AUDIO AND USB PASS THROUGH SINGLE GANG WALL PLAT	AUDIO ENHANCEMENT	AV CONNECT 2

CSA	CLASSROOM RF MICROPHONE SYSTEM, RF RECEIVER, TEACHER & HANDHELD MICROPHONE, LOUDSPEAKERS (C4) INCLUDE WBA601 - INSTALLED	AUDIO ENHANCEMENT	OPTIMUM SYSTEM WITH INTEGRATED XD RECEIVER AND WBA-601
CD	CD PLAYER WITH BLUETOOTH, AM/FM TUNER, AND AUX INPUT	TASCAM	CD-400U
WM B	MICROPHONE, WIRELESS RECEIVER AND HEADWORN	SHURE	QLXD14/SM35 QTY: REFER TO PLANS
	NETWORK SWITCH, MANAGED, PoE+, 125W (8) 1GB POE+ AND 2X1G +2SFP PORTS	NETGEAR	M4250-10G2F-POE+
	UNIFIED CORE WITH 8 LOCAL AUDIO I/O CHANNELS, 64X64 NETWORK I/O CHANNELS WITH 8X8 SOFTWARE-BASED DANTE LICENSE INCLUDED, USB AV BRIDGING, DUAL LAN PORTS, VOIP, 8x8 GPIO AND 8 AEC PROCESSORS	QSC	CORE 8 FLEX (INCLUDE UCI AND SCRIPTING LICENSES)
1J, 1L	POWER AMPLIFIER, w/ DSP 4 CHANNEL X 600 WATTS, 4 Ohms	POWERSOFT	QUATTROCANALI 2404 DSP
W1	LOUDSPEAKER, CABINET, 90° X 50°, 93 dB, 117 dB MAX, 63 Hz - 19 KHz ±3dB, 8Ω, DRIVERS: 1x8" LF, 1x1.5" MHF COMPRESSION, PWR RATING: 250 LMHF WATTS	JBL	AC18/95
A8	LOUDSPEAKER, SUBWOOFER SINGLE 18"	JBL	ASB6118
END OF SCHEDULE			

V259-CLASSROOMS (ART/SCIENCE) EQUIPMENT SCHEDULE			
TYPE	**DESCRIPTION**	**MANFR.**	**MODEL NO.**
HDU	HDMI, VGA, 3.5MM AUDIO AND USB PASS THROUGH SINGLE GANG WALL PLAT	AUDIO ENHANCEMENT	AV CONNECT 2
CSA	CLASSROOM RF MICROPHONE SYSTEM, RF RECEIVER, TEACHER & HANDHELD MICROPHONE, LOUDSPEAKERS (C4) INCLUDE WBA601 - INSTALLED	AUDIO ENHANCEMENT	OPTIMUM SYSTEM WITH INTEGRATED XD RECEIVER AND WBA-601
	HDMI SWITCHER, 2 INPUT 1 OUTPUT	EXTRON	SW2 HD 4K PLUS
D86	FLAT PANEL DISPLAY, 86" DIAGONAL, UHD	OFCI	OWNER FURNISHED
DOC	DOCUMENT CAMERA,4k UHD RESOLUTION, 30X OPTICAL ZOOM,70.2° HORIZONTAL FOV, SIMULTANEOUS HDBT AND H.264 STREAMING, PAIRS WITH ONE-LINK BRIDGE	VADDIO	DOCCAM 4K HDBT SKU: 999-99680-300
END OF SCHEDULE			

AV SYSTEMS PROGRAMMING			
TYPE	**DESCRIPTION**	**MANFR.**	**MODEL NO.**

	AV SYSTEMS PROGRAMMING ALLOWANCE REFER TO SECTION 3.3 FOR SCOPE OF PROGRAMMING	BNA CONSULTING	$36,800 SYSTEMS PROGRAMMING ALLOWANCE

END OF SCHEDULE

PART 3 – EXECUTION

3.1 INSTALLATION OF AV SYSTEMS:

A. Provide AV systems and ancillary equipment as indicated on drawings and in accordance with equipment manufacturer's written instructions, the NEC, and with industry best practices.

B. Coordinate all work performed by other contractors pertaining to the AV system, including raceways, electrical boxes and fittings.

C. Video systems.

1. HDCP:

a. All equipment within the signal path must be capable of processing HDCP-compliant material.

b. All switcher, scalers, transmitters, and receivers shall reflect the HDCP compliance of the endpoint/display(s).

c. HDCP shall be disabled in the switcher/scaler when a non-HDCP-compliant endpoint/display is used.

2. EDID Strategy:

a. Permanent video sources shall be set manually within the equipment to output their native resolution. Video properties shall not rely on EDID.

b. Portable video sources and wall plates shall use EDID tables within the switcher/scaler for preferred video properties

i. Audio: refer to control section for audio requirements. This will include mono, Stereo, Surround sound, etc.. All audio will be 44,100 Hz, 16 bit unless otherwise noted.

D. Pathway Requirements:

1. General:

a. All pathways shall be designed, constructed, grounded and installed in accordance with all recommendations delineated within TIA 569-B and Standard TIA 942.

b. Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. Field coordinate alternate pathway requirements with other trades onsite. New pathways shall not exceed distance limitations defined within this specification. Notify the Engineer of the changes for final approval prior to proceeding with the change.

2. Conduits:

a. Contractor shall provide a minimum of 1-1" EMT conduit from device to accessible ceiling space unless otherwise noted. Then utilize non-continuous cable support from devices to connecting device. Refer to AV symbol schedule for specific conduit requirements.

i. Provide non-continuous open top cable supports every 5' above accessible ceiling.

b. Provide conduit from device to device in open and/or exposed ceilings. Ceilings with clouds are considered open/exposed ceiling.

c. Achieve the best direct route parallel with building lines with no single bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.

d. Provide large radius elbows on all bends.

e. Conduit runs shall not have continuous sections longer than 100 feet without a pull box. Refer to rough-in schedule for conduit fill capacity.

f. AV conduits should not be routed over or adjacent to heat sources such as boilers, hot water lines, or steam lines. Neither should they be routed near large motors, generators, photocopy equipment, or electrical power cabling and transformers.

g. After installation, conduits shall be clean, dry, unobstructed, capped for protection, labeled for identification, reamed and fitted with bushings.

h. A 200lb pull cord (nylon, 1/8" minimum) shall be installed in any empty conduit.

3. Open Top Cable Support Requirements:

a. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables

b. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.

4. Pull Box Requirements:

a. NEC sized pull boxes are not acceptable. Follow BICSI and EIA/TIA 569-B guidelines for pull box sizing.

b. Provide pull boxes in sections of conduit that are 100 feet or longer, contain more than two 90 degree bends, or contain a reverse bend.

c. Conduits that enter a pull box from opposite ends should be aligned.

d. Pull boxes shall have a length 12 times the diameter of the largest conduit.

e. All pull boxes must be accessible.

E. Cabling System:

1. Follow T568B scheme for copper category cabling terminations.

2. Provide a minimum 6" service loop in each AV system junction box. Cables shall be coiled in the in-wall boxes if adequate space is present to house the cable coil without exceeding manufacturers bend radius.

3. In a false ceiling environment, a minimum of 3 inches shall be maintained between cable supports and false ceiling. At no point shall cable(s) rest on lay-in ceiling grids or panels.

4. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

5. Cables shall not be attached to ceiling grid seismic support wires or lighting fixture seismic support wires. Where support for AV cable is required, the contractor shall install appropriate carriers to support the cabling.
6. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.
7. Pulling tension for balanced twisted pair shall not exceed 25lbf and for optical fiber shall not exceed 50lbf.
8. Pair untwist at the termination shall not exceed 0.125”. The cable jacket shall be maintained as close as possible to the termination point.
9. Cable shall not be draped on, tied or otherwise secured to electrical conduit, plumbing, ventilation ductwork or any other equipment. Cable shall be secured to building supports or hangers or to additional blocks or anchors specifically installed for this purpose.
10. Group multiple cabling together with expandable nylon loom, similar to Techflex - Flexo, when cabling exists a cavity and connects to a device. Cabling within a lectern, podium or millwork shall have expandable nylon loom sleeve as well.

F. Grounding System:
1. All grounding and bonding shall be done according to ANSI J-STD-607-A, TIA 942, and NEC.
2. All cabinets/racks shall utilize paint piercing grounding washers, to be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.
3. All racks shall further utilize a full-length rack ground strip attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact. Similar to Panduit RGS.
4. All active equipment shall be bonded to ground. If the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. All active equipment shall be bonded using the appropriate jumper for the equipment being installed using the thread-forming screws. Similar to Panduit RG.
5. Racks shall have individual, appropriately sized conductors bonded to the grounding backbone. Do not bond racks or cabinets serially – daisy-chained rack grounds will not be accepted.
6. Refer to electrical diagrams for additional ground connection requirements.

G. Cabling groups and conduit separation:
1. Refer to “CABLING GROUPS AND CONDUIT SEPARATION SCHEDULE”, located on the drawings

H. Firmly secure all equipment in place that is not intended for portability.

I. Mount projectors permanently and provide mechanical index ensuring precise alignment of the projected image.

J. Provide adequate structural support for AV system components. Provide fastenings and supports with a safety load factor of at least five.

K. Digital Signage:
1. AV Contractor shall be responsible for installing the device(s) as indicated on the drawings and in the specifications.
2. AV Contractor shall be responsible for the following related to Digital Signage:

a. Submit an RFI asking for Color, Logo, IP scheme and other information related to setup and installation of digital signage players. Any passwords that are shared are to be changed immediately after setup is configured.

b. Verifying connection to owner's account

c. Training owner on connecting, setup and uploading content to device(s).

d. Create one (1) page of content for the owner per location indicated below. The page must include:

i. Owner's Logo in the top left corner and in their color scheme and fonts.

ii. A block that is 1/3 of the right side of the display for company announcements. This location should read "welcome to" building name.

3.2 LABELING

A. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and wall plates. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

B. All AV pathways, cables, connecting hardware, equipment, racks, patch panels, outlet/connectors, and grounding system shall be labeled in accordance with TIA/EIA 606-A.

C. All labels shall meet UL 969 requirements for legibility, defacement and adhesion requirements. Handwritten, Ink, or Laser Printing labels are not allowed. Labels shall be uniform in physical size and text height with minimal blank space. Provide labels using thermal transfer print. Heat shrinking or wraparound labels are required, flag style labels are not allowed.

D. Provide laminated plans (minimum size 11x17) of all AV as-built plans (including one-line diagrams) in each and every AV Rack.

E. Label each equipment with the date (month/year) that it was installed along with the IP address, if applicable, and equipment type.

3.3 CONTROL SYSTEM FUNCTIONALITY:

A. GENERAL:

1. The control processing and digital signal processing programming required for AV sub-systems as defined in section 2.4 of this specification shall be completed by BNA Consulting.

a. The General AV sub-systems require configuration and are not included in BNA's programming scope of work.

b. Configuring of system components will be part of the Contractors scope of work. Contractor shall provide IP address, MAC address, Serial numbers, etc to BNA for coordination with the program.

c. IP address will be coordinated by the programmer and shared with contractor for implementation into specific devices.

d. If the contractor chooses to provide their own programming services, it must match the functional intent as defined by BNA Consulting exactly. No exceptions.

2. The successful bidder for this specification section (27 4100) shall contract BNA Consulting for performance AV programming services.
    a. The allowance defined in section 2.4 for the performance AV systems programming services shall be included in the bid as a line item.
    b. Contracting shall take place once shop drawings are submitted. The Programming phase shall begin upon final review of AV contractor shop drawings.
3. Control programs & DSP configuration programs shall be designed to match the schematic system wiring as shown in approved shop drawings.
4. The AV contractor must field wire each system in accordance with the final reviewed shop drawings.
    a. Any deviations made to shop approved shop drawings will be subject to additional programming service fees.
5. Before programming services commence, the AV contractor shall confirm that all connections are complete, and all equipment is powered up and functional.
    a. Written documentation including site progress photos shall be provided to BNA Consulting prior to commencement of the programming phase.

B. The Programmer shall be responsible for providing programming services for the following systems. All other systems not specifically mentioned below shall be covered by the contractor.
1. V306 - Commons
2. V319 - Gymnasiums
3. V305 – Dance room
4. V351 – Little Theater
5. V310 - Auditorium
6. The Programmer check list shall be complete prior to the programmer arriving to the site, anything that is not completed when the Programmer arrives will result in an additional site charge covered by the AV Contractor.
7. Systems not identified in the list above shall be covered by the installation contractor.

C. Amplifiers shall be set to go to stand by after 30 minutes of no audio detection.

3.4 CYBER SECURITY

A. Contractor shall change all default username and passwords for all network devices provided. A Strong Password should include at a minimum the following:
1. Be at least 12 characters in length
2. Contain both upper and lowercase alphabetic characters (e.g. A-Z, a-z)
3. Have at least one numerical character (e.g. 0-9)
4. Have at least one special character (e.g. ~!@#$%^&*()_-+=)
5. Cannot contain full words

B. No written username or passwords shall be located in any areas of installation.

C. Network devices to be set up on a separate network other than owner’s LAN ensuring no internal or external users can access system without authorization.

D. Follow manufacturers hardening guide and use best industry practices to secure network

and devices provided by contractor and associated with system.

3.5 FIELD QUALITY CONTROL:

A. TESTING:

1. Refer To Section 27 4101 For Additional Requirements.

B. At the time of final commissioning, if the AV consultant determines that the systems are not sufficiently complete to do a final punch list, and was not notified at least three (3) days prior to the visit, then a return visit will be required. The AV Consultant's return visit will be paid for in advance by the AV integrator at a flat rate of $1,200 per person, at no cost to the owner.

3.6 OPERATING AND MAINTENANCE MANUALS: Refer to Section 26 0502 for requirements.

3.7 TRAINING:

A. Provide two (2) sessions of one (1) hours each of training on the operation of each system, except the Auditorium at job site, at no cost to owner. Provide two (2) sessions of one (1) hour on the operation of the Auditorium system. Systems shall be complete and have been finalized by the AV Consultant prior to training.

1. Training shall be covered by the AV Contractor, the PM performing the training will walk through the system with the Program at final sign off and prior to training.

B. Training shall be recorded using a video recording device that support a minimum resolution of 1080P/60 with an integrated microphone connection for an external microphone and a camera tri-pod mount. Presenter shall be wearing a lapel microphone that connects to the recording device and a Tri-pod shall be used for stabilizing the recording device. Recordings that are shaky, poor audio and/or video quality, incomplete, or other issues will not be accepted and the contractor will be responsible for providing a new recording and training within five (5) business days of notification. Provide a digital copy, in MP4 format, on a USB flash drive to the Owner and AV Consultant. Also locate a USB flash drive with the training videos, programing, etc. in the as-built drawer of the main equipment rack. Digital copies sent as a link are not acceptable. identify within the Operating and Maintenance manuals, in the first section, where the flash drive is stored. Clearly label the flash drive as training videos. The second training shall take place within a month of the first training and all questions shall be answered.

C. Contractor shall be present at the first two performance using the system within rooms listed below. Owner to coordinate with contractor 3 weeks in advance for personnel trained on the system to help with the show and be onsite in case there are any problems. AV Contractor to provide this within his bid.

1. Auditorium

3.8 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.

END OF SECTION 27 4100

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SECTION 27 4101

AUDIOVISUAL SYSTEM INTEGRATOR VERIFICATION CHECKLIST

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 work of this section.

B. Division-27 4100 section apply to work specified in this section.

1.2 ADMINISTRATIVE REQUIREMENTS:

A. This Document is intended to be completed and supplied to the AV Consultant prior to the final punch visit. Refer to specification 27 4100 for system components.

B. Installing contractor shall make copies of this document for large systems. Include all copies in the O & Ms and provide all copies to the AV Consultant.

1.3 DESCRIPTION OF WORK:

A. Refer to “INTEGRATOR VERIFICATION CHECKLIST” at the end of this section, for system verification requirements. Fill out the form and return to the AV Consultant prior to the final punch.

B. Upon completion of installation of each system and after electrical circuitry has been energized, demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units on site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with testing.

C. Before inspection by owner and AV Consultant, and after completion of the installation, conduct system tests and make necessary corrections for proper system operation.

D. Adjust, balance and align equipment for optimum quality and to meet the manufacturer’s published specifications.

E. All limiters and/or compressors shall be set to prevent operators from over-adjusting sound levels and damaging system components, while maintaining the highest amount of gain possible.

F. System shall have no audible hum, noise, RFI, or distortion when operating under normal conditions. System shall reproduce material at the loudspeakers rated output level without audible distortion. All input levels shall be pre-set so system may be operated without causing unstable feedback under normal use.

G. System shall have no image distortion, hum bars, color shift, or any other picture distortion while operating under normal conditions. Provide cable equalizers or an HDBaseT video solution. Cable equalizer shall be located near display and powered, on all cables that are more than 30 feet in length or with more than four (4) connection points. Refer to section 2.3.B in this specification for a list of pre-approved equipment. Adjust gain controls for optimum signal-to-noise with 0 dBu at a line-level input.

H. Perform polarity checks of loudspeaker lines by means of a polarity tester or use DC source at one end of each line and a voltmeter at the other end. Loudspeaker lines shall be identically polarized with respect to color coding.

I. Loose parts and poor workmanship or soldering shall be replaced.

J. Sweep Loudspeaker systems with high-level sine wave or 1/3 octave pink noise source. Correct causes of buzzes or rattles related to Loudspeakers or enclosures. Notify owner of external causes of buzzes or rattles.

K. Equalize the loudspeakers to produce less than 6 dB total variation between 500 Hz and

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8000 Hz (+/- 3 dB).

L. Contractor shall provide system testing as described herein using up-to-date and industry accepted test equipment appropriate to the types of links being tested and in accordance with the latest edition of IEC 61935-1. AV Contractor shall own and have access to a handheld Quantum Data 780C tester to allow for on-site verification testing and troubleshooting of HDMI and digital video networks and analog video displays. All test equipment used shall be factory calibrated within one year of use with references set daily prior to testing.

M. Contractor shall provide HDCP compliant device with digital cables, and digital HDCP content for testing of routing and HDCP compliant distribution and switching. Also provide analog VGA output equipment for testing of video switching, scaling, and distribution if analog is included with this project.

N. Horizontal cabling contractor shall test all twisted pair cabling used within the AV system following the standards in specification 27 1500 under the testing section. Provide documentation of testing to AV Consultant prior to final walk through.

PART 2 – PRODUCTS

2.1 SECTION NOT USED

PART 3 – EXECUTION

3.1 AUDIOVISUAL SYSTEMS INTEGRATOR VERIFICATION CHECKLIST

Project Title		Date	
City, State		Integrator	
Room/Area			

Audio/Video Signal Processors/Switchers					
Location	Rack #	Manufacturer & Model #	Serial #	Total Channels (In, Out)	Unused Channels (In, Out)

Power Amplifiers						
Location	Rack #	Amp #	Manufacturer & Model #	Serial #	Total Channels	Watts/Channel

Loudspeakers Zones							
Location	Rack #	Amp #	Amp Chan	Manufacturer & Model #	Serial #	Calculated Impedance	Measured Impedance

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Wireless Microphone Receivers					
Location	Rack #	Manufacturer & Model #	Serial #	Usable Frequency Range	Chosen Frequency

Portable & Miscellaneous Equipment			
Description	Location	Quantity	Manufacturer & Model #.

Sign below to confirm you have received portable & miscellaneous equipment listed above.

Owner Signature: _____
Date:_____

Title:_____

Personal Delivering Equipment: _____

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General Items

Title	Description	Initial	Notes
Labeling	Verify that all cabling, equipment, and wall plates are labeled per specifications and as noted on drawings		
Cable management	Verify that proper cable management has been provided and that everything looks well-ordered.		
Power	Verify that power supplies are secured and in an accessible area.		
Sequencer	Verify that the sequencer(s) are setup correctly for industry standard power on/off function.		
Cyber Security	Verify that all default passwords have been changed. Provide all login information to the owner representative		
System testing	Verify that all systems have been tested and are in working order.		
System Certification	Verify system has been tested with industry standard testing equipment including the use of Quantum Data 780C		
Cabling	Verify that all cabling on the project meets the document requirements.		
Network	Verify that the owner has all of the needed information for all devices on the network. Provide this information to the owner via a spread sheet.		
Network	Verify that all IP address are within the owner's network scheme.		
Network	Verify that VLANS are setup as indicated in drawings and within owner's network infrastructure		
System One-lines	Verify that each equipment rack contains a set of one-lines diagrams for system installed. Refer to specifications for one-line requirements.		
Thermal Management	Verify active thermal management is setup correctly and working properly.		
Training	Verify training has been scheduled with the owner representative.		

Audio Performance

Title	Description	Initial	Notes
Audio Signal Distribution	Verify that audio signal is being transported and distributed according to project documentation.		
Phantom Power	Verify that the correct phantom power is provided at the correct locations according to project documentation.		

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Gain Before Feedback	Verify that the audio system is capable of reproducing speech above nominal operating levels without audible distortion or feedback.		
Rough Balance (input)	Verify that all inputs have the same nominal level.		
Gain Structure	Verify that proper gain structure has been followed from each input to output		
Rough EQ	In systems with equalization capability, equalize the loudspeakers to produce less than 6 dB total variation between 500 Hz and 8000 Hz (+/- 3 dB).		
DSP Programming	Verify that DSP systems have been programmed to allow signal routing, balance, and EQ. DSP programming should be saved in editable form prior to final commissioning visit.		
Rough Balance (output)	Verify that loudspeaker zones reproduce program content at the same level (+/- 1 dB).		
Emergency Muting	Verify that any required muting or operational changes are in accordance with location regulations in the event of a life safety or similar emergency.		
Assistive Listening	Verify that the assistive listening system functions as a complete personal listening system at specified levels without distortion or excessive background noise.		
Loudspeakers	Verify that there is no hum, noise, RFI, or distortion when operating under normal conditions.		
Loudspeakers	Verify that there are no rattles or buzzes with a high-level sign wave or 1/3 octave pink noise.		
Loudspeaker Zoning	Verify that loudspeaker zones are assigned correctly according to project drawings and specifications.		
Loudspeaker Impedance	Verify that all loudspeaker circuits have correct impedance as defined in the project drawings and specifications. Note measured impedance on previous page.		
Loudspeaker Alignment	Verify that loudspeakers are mounted and aligned as shown in project documentation.		
Loudspeaker Polarity	Verify that all loudspeakers in a given space are wired with the same polarity.		
Loudspeaker Tap Settings	Verify the tap settings on all constant voltage loudspeakers.		

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Loudspeaker Delays	Verify that loudspeakers are set with the proper delay. Refer to drawings and specifications for requirements		

Control System Performance

Title	Description	Initial	Notes
Functionality	Verify that the control system functions according to project documents.		
Automatic controls	Verify that the automatic features work ie: room combining, video detection, etc..		
Lighting controls	Verify that the lighting system presents are correctly recalled by the control system as indicated in project documents.		
Shade controls	Verify that the shade controls are correctly recalled by the control system as indicated in project documents.		
Sequencer	Verify the sequencer is controlled as noted in project documents. If no specific requirements are noted, sequencer will be powered on/of from the front panel.		

Video Performance

Title	Description	Initial	Notes
Video Routing & Switching	Verify that all video signals are properly routed, switched, scaled, and displayed according to project documents.		
Projector Alignment	Verify that projectors and screens provide a projected image that is properly aligned and fills the projection area.		
Projector Alignment	Verify that projector and screen are in the correct locations, correctly aligned and keystone correction is not in use.		
Projector Interactivity	Verify that projector touch sensors are calibrated and working per manufacture instructions. Provide offset hardware as needed.		
Image Scaling	Verify that all displayed images are scaled to the full native resolution of displays and projectors in all cases where scaling hardware is specified.		
Image Quality	Verify that all displayed images are correctly focused and are free from distortion.		
Aspect Ratio	Verify that all displayed images maintain the proper aspect ratio and image geometry. Key-stoning and stretching should not be used. Any exceptions to this should be noted.		

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Display Image setting	Displays are set to dot to dot or full. Images shall fill the screen without cropping.		
Signal Bandwidth	Verify that all equipment from endpoint to endpoint supports the resolution/data rate as indicated in the documents.		
System Certification	Verify system has been tested with industry standard testing equipment including the use of Quantum Data 780C		

3.2 OPERATING AND MAINTENANCE MANUALS: Include a copy of this document within the Operation and Maintenance Manuals.

END OF SECTION 27 4101

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SECTION 27 5123

INTERCOMMUNICATION SYSTEMS

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 work of this section.

B. Division-26, 27 & 28 basic materials and methods sections apply to work specified in this section.

C. Refer to specification 26 0553 conduit and junction box color requirements.

D. Refer to specification 27 1500 for category and/or optical fiber cable and connectivity specifications.

E. All unshielded category 'UTP' and/or optical fiber cable, for AV equipment, used on this projector shall match the horizontal cabling within the building.

1. Category cables used for transporting video, audio and controls simultaneously from transmitters to receivers and/or switchers shall follow the Manufacturer's recommend cabling specifications.

2. Division 27 1500 shall provide installation and execution requirements for all category and/or optical fiber cabling and connectivity required within the audiovisual system

1.2 ADMINISTRATIVE REQUIREMENTS:

A. Bid Submittal:

1. Equipment Costs: Breakout cost of material and labor as different line items.

2. Provide separate line items for each section that you are being bid on.

a. Contractor shall not provide a single number with all of the sections/scopes combined.

B. All bids shall be based on the expansion of the school districts existing Intercommunication and Bell Schedule Server Systems and must be compatible with Audio Enhancements - Epic System - No Exceptions. Equipment as specified herein is part of the Epic System.

C. Coordination:

1. Coordinate final inspection of the systems installed, with Audiovisual (AV) Consultant, three (3) weeks in advance.

2. Obtain GANTT chart for construction time frame from the General Contractor.

3. Coordinate with Electrical contractor to meet at least twice with the ceiling installer. Hold first meeting before submittal of shop drawings to coordinate the mounting condition of all ceiling-mounted AV equipment with ceiling type. During second meeting, coordinate the location of all ceiling-mounted AV equipment in each area.

4. Meet at least once with the mechanical installer prior to fabrication and installation of duct work. Coordinate depth and location of all loudspeaker and duct work in all areas.

5. Meet with Electrical contractor prior to pathway rough-in to coordinate Intercom system requirements in each area.
6. Meet at least once, prior to rough-in, with horizontal cabling installer to verify all required drop points are accounted for. Coordinate cable color according to specification 26 0553 and 27 1500.
7. Coordinate all AV system components within millwork/furniture with millwork shop drawings prior to rough-in.
8. Meet at least twice with owner to coordinate network requirements. Hold the first meeting before submittal of shop drawings to coordinate network protocols, including but not limited to: IP address schedules, MAC address schedules, patchbay schedules, security requirements, and VLANs. Hold the second meeting prior to system deployment.
9. Meet at least twice with owner to coordinate security system integration. Hold the first meeting before submittal of shop drawings to coordinate microphone placement and security tie in requirements. Hold the second meeting prior to system deployment.
10. Coordinate color (including custom color) and finish of all AV system components with Architect prior to ordering. Architect may require custom color of grills, face plates, etc.. Intercom contractor shall paint or have devices painted by others. The cost for custom colors shall be within the Intercom Contractors Bid.
11. Coordinate all system components within millwork/furniture with millwork shop drawings prior to rough-in.

1.3 **DESCRIPTION OF WORK:**

A. The work covered by this section of the specifications shall include all material, labor, hardware, software, firmware and programming to install a completed and operating system as described herein and shown in the drawings. The system shall utilize the schools shared data network, and not require the use of any proprietary switches, routers, or other network components. Beyond the shared data network hardware, the rest of the system shall be complete with all necessary materials, labor, hardware, software, firmware and programming specifically tailored for the installation. It shall be possible to permanently modify the software on site by using a system administrator software network interface.

B. This section includes a fully operational IP platform for school internal communications system incorporating school safety notifications and general communications including but not limited to the following:

1. Classroom systems and common zone network interfaces shall be capable of utilizing standard Category based infrastructure, Category 6 or better, for installation from the intermediate distribution frames only to the classroom and/or zone, allowing for only one type of wiring infrastructure within the school. Distribution of all voice signaling shall utilize a shared or dedicated IP network.
2. The platform shall provide complete internal communications employing SIP (Session Initiation Protocol) including the minimum functions listed.
    a. Integration with any VoIP telephone system using SIP type integration. It shall allow the school(s) to upgrade or replace their telephone system without requiring the owner to replace, or lose any feature of, their internal communications (intercom) system.
    b. Support a SIP trunk from the building's VOIP phone system to provide hands free two-way communication from all administrative telephones to

any location equipped with a talkback speaker or audio system with room microphone

c. Provide its own SIP environment, and in the case of a failure of the schools VoIP telephone system, be capable of operating completely independently for all functions, except access from the handsets connected to the schools VoIP system.

d. Access remote classrooms (trailers, temporary classrooms etc.) via IP interface or room audio system with room microphone. It shall provide intercom, class change tones, emergency tones, and normal / emergency paging via a wired network to these remote locations.

e. Integrate with the classroom sound amplification system (CSAS) and utilize the same loudspeakers as the CSAS.

3. Emergency announcement that will override any pre-programmed zones assuring that all Emergency/Lockdown etc., are heard at each and every loudspeaker location.

4. The system shall be a software-controlled system, whose primary interface is a web-based portal, accessible from any authorized computer.

5. Provide a map-based user interface. All major functions, including intercom, paging, notifications and alerts shall be done using the map as the foundation for those actions.

6. Bell Event announcement

a. Bell Schedules shall be easily assigned to days and changed simply with authenticated access to the system through any browser-based device.

b. Provide a simple calendar-based scheduling system for bells. It shall provide the ability to have an unlimited number of bell schedules.

c. Provide a calendar-based scheduling up to four years in advance. The system shall be capable of displaying a fully year calendar and differentiating which bell program is scheduled to run on each day in an easy-to-read format. The calendar shall be based on a standard school year and provide a selectable start month.

d. Provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone within the facility or outside the facility to any other location within the facility or district.

7. Capability of prerecording normal/emergency announcements that can be activated by a Soft Key or via a dedicated call-switch.

8. The system shall utilize a shared data network (VLAN enabled) or dedicated network as means of distribution for all voice overhead paging, emergency paging, emergency tones, intercom, and class change tones.

9. The system shall provide two I/O Ports on each classroom network interface, and common zone network interface which can be used as programmable inputs or outputs to control contact closures. Contact closures can be activated manually to turn on cameras, unlock doors, emergency lockdown, etc.

10. The system shall provide a flexible and robust event engine, and in addition to pre-programmed events and actions, the event engine shall be capable of accepting Java based programming to accomplish advanced integrations and functions.

11. The system shall automatically broadcast emergency instructions throughout the entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions shall be preprogrammed and require no user intervention. The system shall provide a redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
12. The system shall have the capability of maintaining a record of all alerts that are received and provide appropriate school personnel the capability to enter information about the alert, which shall be maintained in the systems database. That information shall also be made available to appropriate school personnel in the form of a report that shows all alerts that have occurred, their date, time, and the end alert information.

C. Equipment submitted in bid proposal that has not been approved by AV Consultant in writing will not be accepted and shall be replaced by approved equipment at contractor's expense. Equipment not listed within this specification, or contract documents, that are required for a complete and working system, shall be of professional grade and used in the same manner as needed for a complete and working system.

D. Input plates shall match the color and style being used throughout the project.

E. Contractor is responsible for coordinating with all other trades for equipment locations, mounting requirements, supports and plenum space requirements.

F. All cabling shall be installed in a minimum of 1" conduit to accessible ceiling space unless otherwise noted. Provide conduit to accessible ceiling space and then utilize non-continuous open top cable supports every 5'.

G. Intercom contractor shall participate in a mandatory pre-construction meeting no more than sixty (60) days prior to ordering equipment, and before work can begin. Contractor is responsible for coordinating meeting. The meeting will be held at AV Consultant's office. All submittals, shop drawings, and bill of materials shall be completed and submitted to AV Consultant for review eight (8) working days prior to this meeting.

1. Intercom contractor shall attend the electrical pre-construction meeting per specification 26 0500.

1.4 **QUALITY ASSURANCE:**

A. Manufacturers:

1. Firms regularly engaged in manufacture of sound equipment, components and accessories, of types, capacities and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years. Equipment supplier shall be authorized representative of the manufacturer of each major piece of equipment and be currently authorized by the manufacturer to furnish, install and service that particular equipment.
2. System shall be compatible with the districts security system.

B. Installer:

1. Qualified with at least 5 years of successful installation experience with similar systems.
2. Integrating firm shall have worked satisfactorily for a minimum of (5) years of completing systems equal to this scope, quality, type and complexity.

3. Key personnel assigned to the project shall each have minimum of (10) years of experience in completing systems equal to this scope, quality, type and complexity.
4. Contractor shall be a factory authorized distributor of all equipment specified for the geographical area of the project.
5. Contractor shall maintain complete installation and service facilities for the duration of the project contract.
6. Contractor shall have current manufacturer certificates for system and equipment listed within this specification.
7. All contractors biding on this project must have local representation that is within 4 hours of the job site.

C. Contractor must follow the standards described within:

1. BICSI/AVIXA AV Design Reference manual.
2. ANSI/AVIXA 2M-2010 Standard guide for Audiovisual Systems Design and Coordination Processes.
3. ANSI/AVIXA 10:2013 Audiovisual Systems Performance Verification Guide.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

E. Comply with NFPA 70 and with NEMA Standard SB-40 for Emergency Communications in K-12 schools.

F. Comply with UL 60950.

1.5 **SUBMITTALS: Refer to Section 26 0502 for requirements.**

1.6 **WARRANTY:**

A. Systems shall be guaranteed for a period of one (1) year from the date of substantial completion against defective materials, inferior workmanship or improper installation adjustment. Guarantee shall cover all parts and labor.

B. If system failure causes audiovisual system to be inoperative or unusable for its intended purpose, contractor, when notified of the problem, shall repair system so it will be operational and usable within three (3) business days. If defective components cannot be repaired in time, provide temporary equipment as required.

C. Contractor shall supply one (1) year warranty on all system programming from the date of substantial completion. During this time period, upon owner request, the contractor shall provide programming changes up to four (4) sessions free of charge. During this time the programs shall be password protected. At any time during the one (1) year, the owner can terminate the warranty and request the programming of each system. At this time the programs are to be turned over to the owner and all passwords are to be removed. The owner shall own all rights to the programming after this time, to be used in this facility.

D. Contractor shall honor equipment warranties for term established by manufacturer if greater than warranty time frame mentioned above. Equipment for the project shall not be purchased until ready to be installed/programmed. Manufacturer warranties for this project shall extend more than 2/3rd of their term past substantial completion. Example, a three (3) year manufacturer warranty shall have more than two (2) years left once substantial completion has occurred.

E. Prior to the end of the one (1) year warranty. The Intercom Integrator shall preform the

following:

1. Three (3) months prior to end of warranty remind the owner and AV Consultant that the end of the warranty is approaching. At this time coordinate the events below with the owner and notify the AV Consultant of the time of the walk through(s).

2. One (1) month prior to end of warranty, walk through campus and verify all components are working. Supply list of components with location, type equipment and status to the AV Consultant and Owner. Correct any and all malfunctions as necessary.

PART 2 - PRODUCTS

2.1 GENERAL:

A. The platform shall utilize IP network Technology, Call-in Notification, School Paging and Evacuation tones, IP infrastructure, Atomic Time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone, Two-way hands-free Internal Intercommunications and Paging, and Program Distribution. The system shall be easy to learn and operate. All standard programming shall be web based and user friendly to allow the system administrator the ability to easily program system features.

B. Provide complete and satisfactorily operating school communications and school safety as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction, in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.

C. Each Classroom shall be provided with a call-in momentary contact button, microphone, and integration with classroom sound amplification system.

D. All main components and software shall be distributed from (1) manufacturer and be a complete system. This includes; Software and IP Endpoints, excluding the VoIP telephone system.

E. Intercom paging system power and network intercom interface:

1. Shall allow users to install intercom paging systems spanning multiple building or facilities connected through a VLAN. Provide a 100/1000 Ethernet switch port configured on a dedicated VLAN.

2. All Network interfaces used in the classroom and for the common zones shall be powered via PoE from the district provided network switches.

   a. PoE switches and network cabling from MDF (Main Distribution Frame) and IDF (Intermediate Distribution Frame) to devices provided by others.

F. All network switches shall include an uninterruptable power source to provide adequate runtime. In the event the school has a generator the UPS systems shall hold the switches long enough until generator power can be provided. Customer to provide all necessary UPS for network switches.

2.2 SYSTEM FUNCTIONS/SOFTWARE

A. Server and Server software:

1. Software-controlled system, whose primary interface is a web-based portal, accessible from any authorized computer. The system shall support being deployed on physical server hardware.
    a. The system shall utilize a 1U rack server, operating as an appliance, and dedicated to the operation of this system only.
    b. The entire system shall be Linux based.
    c. (4) HDD Bays with (2) 240 GB SSD drives in a RAID 1 configuration
    d. Dual 1 Gbps Ethernet ports, 1 dedicated server on board management NIC/ethernet port.
    e. Intel Xeon Processor 3.5 GHz with 16 GB DDR4 2400 MHz RAM
    f. Redundancy:
        i. RAID1
        ii. Dual power supplies
        iii. Hot swappable hard drives.
2. The system shall be based on standards compliant SIP and RTP communications across the network and shall allow direct Trunk Integration to the VoIP telephone system.
3. The system shall provide a simple calendar-based scheduling system for bells. It shall provide the ability to have an unlimited number of bell schedules.
4. Provide a map-based user interface. All major functions, including intercom, paging, notifications and alerts shall be done using the map as the foundation for those actions. Paging shall clearly show on the map where the page audio will be transmitted to.
5. The system shall support utilizing a shared data network and support (VLAN [Virtual Local Area Network] enabled) or dedicated network as means of distribution for all voice overhead paging, emergency paging, emergency tones, intercom, and class change tones. System shall support routing of traffic across multiple subnets and network segments.
6. Bell Event announcement.
    a. Bell Schedules shall be easily assigned to days and changed simply with authenticated access to the system through any browser-based device.
    b. Provide a simple calendar-based scheduling system for bells. It shall provide the ability to have an unlimited number of bell schedules.
    c. Provide a calendar-based scheduling up to four years in advance. The system shall be capable of displaying a fully year calendar and differentiating which bell program is scheduled to run on each day in an easy-to-read format. The calendar shall be based on a standard school year and provide a selectable start month.
    d. Provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone within the facility or outside the facility to any other location within the facility or district.
7. The system shall automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions shall be preprogrammed and

require no user intervention. The system shall provide redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems

8. User access:

   a. Provide discreet control over roles for the system. Roles shall be definable down to the individual feature level and provide the district with the ability to restrict or grant access to any roll individual features or groups of features.

   b. Web based administration programming tool which allows the administrative personnel to easily manage audio sources, class change schedules, paging groups, time updates, holiday schedules and day/night mode operation from a web browser.

   c. Fully integrated with the school's existing LDAP or active directory system.

   d. Be based on a database structure, utilizing a robust commercially available database such as SQL.

   e. Provide web browser access to the system specifically for a teacher. Teacher access shall be assigned through LDAP or active directory. The teacher screen shall provide information specific to the room that the teacher is assigned to. That information shall consist of, but not limited to, the next scheduled event for the room (Bell, Announcement, etc.), teacher name, room number, an intercom call button, and an emergency call button.

   f. Provide for a complete personal alert function for each teacher. The alert functionality shall be an integrated part of the administrative head end software and shall not require any separate application or hardware to support this functionality.

      i. The teacher personal alert functionality shall be integrated into the classroom microphones and the teacher web screen.

9. Have the ability to synchronize to the same NTP server utilized for the Master Clock system.
10. Ability to monitor operations and functions of the system.
11. Provide web-based off-site programming and diagnostics of the system. It shall also be capable of determining basic circuit faults.
12. Provide the ability for the school to upload their own recorded files for both Bell Tones, and Notifications.
13. The system shall provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone within the facility or outside the facility to any other location within the facility or district.
14. IP-enabled two-way voice communication shall be available from any provided telephone or administrative console through any speaker in the system. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A pre-announce tone shall sound immediately before the intercom path is opened.
15. Display the location of the alert on the map in the case of a wireless microphone being within range of its paired receiver, or from the teacher's web access screen. The system shall also be capable of approximately locating the location of the alert in the case of a wireless microphone that is not in range of its paired receiver.

16. Upon alert, the system shall:
    a. Have the ability to provide notification on the dedicated console at the front office, or on any other computer which is currently logged into the administrative interface and has the appropriate credentials.
    b. Provide both an audible tone, and a change on the screen that clearly indicates that an emergency alert has been received.
    c. Capable of sending e-mail and SMS text messages to designated school personnel. These alerts shall include a web link to the administrative console.
    d. Acknowledge the receipt of the alert by changing the indicators on the classroom microphone receiver in the room where the alert was received from. In the case of an alert received from a microphone not in range of its paired receiver, no acknowledge shall be sent.
    e. If cameras are installed in the classrooms, the system shall be capable of showing a live video from the classroom that received an alert. This shall only be shown in the case of an alert where the microphone is within range of its paired receiver.
17. The system shall contain a rules-based integration engine that allows for input of TCP, HTTP, or Serial Data and allows for the parsing of data for actions or triggering other systems via TCP, HTTP or Serial.
18. The system shall support digital message displays that provide visual feedback in the form of scrolling messages via an LCD or LED display all controlled from the network.
19. The system shall have the ability to carry IP Communications to the edge of the classroom Audio/visual Systems. It shall be able to control connected A/V Devices, provided that those devices are controllable by RS-232.

B. Intercom Paging System Administrative Console:
1. The administrative console shall be customizable, flexible and provide full access to the intercom paging system.
2. Console shall be micro-computer based running a Linux OS and run in a Kiosk mode locking the user into the intercom screen.
3. The supplier is required to provide a dedicated touch screen console as noted within the drawings, with a minimum size of 22” Diagonally. The Console shall not require the district to provide any additional hardware, software or licensing. The Console shall also provide a boom microphone attached via USB to the console for paging/intercom use.
4. Administrative access to the system shall be browser based and shall also be capable of being any administrative computer.
5. Functionality to provide full access to all features such as all call, paging groups, emergency tones, control music, WAV file distribution, test rooms, crisis mode, schedules, etc.

C. IP addressable Module for non-classroom zones (Audio Enhancement – MS-300):
1. Full Duplex, hands-free communications on intercom call
2. Amplifier powered only by the PoE power source for emergency paging applications
3. Mounting bracket as required, refer to drawings for location and mounting requirements identified on plans as follows:
    a. Individual zones “Z-ID”

b. Common zones with “Z-#X#”

4. Connections – The following connections must be available:
   a. Line-level Output
   b. Two (2) External I/O Connections – Terminal Block
   c. RJ45 for PoE Network Connection
   d. Serial interface for connecting to other equipment or SAFE compatible equipment.
5. Speaker Connection that is powered exclusively by the PoE power from the network that can drive up to two (2) loudspeakers.
6. Integrated Network-Based Communications shall support the following protocols:
   a. Directed UDP
   b. Unicast Audio
   c. Multi-Cast Audio
   d. SIP
7. The system must have integrated SIP communications and be able to communication bi-directionally with any VoIP communications system that follows the standard SIP protocols.

D. IP-addressable Module for classrooms:

1. Classroom IP addressable modules will be provided as part of specification 27 4100 and included in 27 4100 Contractors scope of work. Intercom contractor shall provide all programming for device. 27 5123 Contractor to coordinate with 27 4100 Contractor prior to device deployment for programming. Refer to specification 27 4100 for additional information on the CSAS.

E. Volume control/attenuator:

1. Support up to 100 watts in a 70- or 25-volt distribution system.
2. Mount on a brushed stainless-steel single gang wall plate with the plate being embossed with a dial scale of “0 through 10.” Each number shall be a 3dB step
3. Provided with a skirted black knob with white position indicator.

F. Microphone:

1. Decora style mounting wall plate with an Omni-directional electret microphone that has a -44 dB sensitivity

G. Audio Paging/Program Amplifiers: Stewart Audio – CVA25-1 25V/70V, Atlas Sound – CP400 or equal

1. Power amplifier(s) shall be provided to provide a maximum of 2 watts of power to each loudspeaker on the zone, with the exception to exterior zones provide a minimum of 10 watts to each loudspeaker on the zone.

2. The maximum load on the paging/program amplifiers shall be 50% of the rated maximum output of the amplifiers.

3. Provide 25-volt transformer output for all zones that connect more than one (1) loudspeaker together.

H. Normal (1 Button) Call Switch Indicated on plans as ‘CAL’:

1. Call Switches shall provide the following functions and features within a decora style wall plate:
    a. One (1) “Normal” call switch that shall activate a distinctive “NORM” level call from a single button activation. The button shall be clearly marked “NORMAL” or “CALL”.
    b. Button shall route the call-in to any one or more Administrative Telephones or SIP interface for quick and easy response from an Administrative Telephone or off-site telephone.
    c. Integrated Omni-directional microphone
2. Connection to the intercom system shall be over Category based cable from the Call Switch to the SIP device/loudspeaker.

I. Emergency (1 Button) Call Switch Indicated on plans as ‘CAL’:

1. Call Switches shall provide the following functions and features within a decora style wall plate:
    a. One (1) “Emergency” call switch that shall activate a distinctive “EMERGENCY” level call from a single button activation. The button shall be red in color and shall be clearly marked “EMERGENCY”.
    b. Buttons shall route the call-in to any one or more Administrative Telephones or SIP interface for quick and easy response from an Administrative Telephone or off-site telephone.
2. Connection to the intercom system shall be over Category based cable from the Call Switch to the SIP device/loudspeaker.

J. Loudspeakers:

1. AtlasIED and Quam loudspeaker assemblies are the basis of design. Intercom manufacturer equivalent loudspeakers are allowed if they meet the function and form of the loudspeakers listed below.
2. Loudspeaker cabling for common zones shall use a 16 AWG 2-pair stranded conductor cable assembly unless otherwise noted. Refer to Audiovisual Cable and Conduit Schedule on the drawings for approved cabling manufacturer.
3. Type ‘IC1’ - loudspeaker assembly (lay-in tile):
    a. Quam – System 5 or equal
    b. 1’x2’ ceiling tile replacement loudspeaker with 5 oz. magnet and 5 watt 24/70V transformer. 92dB SPL 1W/1M with 99dB max SPL at maximum tap. 65Hz – 17kHz frequency response ±3dB and 100-degree dispersion angle.
4. Type ‘IC1’ - loudspeaker assembly (lay-in tile):
    a. Atlas – SD72W w/ 81-8R mounting ring and CS95-8 enclosure
    b. Quam – C10X/BU/WS w/ SSB-2 mounting ring and ERD-8U enclosure
    c. Gyp loudspeaker with 10 oz. magnet and 5 watt 24/70V transformer. 95dB SPL 1W/1M with 102dB max SPL at maximum tap. 60Hz – 8kHz frequency response ±3dB and 90-degree dispersion angle.
5. Type ‘IC2’ - loudspeaker assembly (hard lid ceiling):

a. Atlas – SD72W w/ 76-8 mounting ring and BMTT95-8 enclosure

b. Quam – C10X/BU/WS w/ SSB-7 mounting ring and ERD-8U enclosure

c. Gyp loudspeaker with 10 oz. magnet and 5 watt 24/70V transformer. 95dB SPL 1W/1M with 102dB max SPL at maximum tap. 60Hz – 8kHz frequency response ±3dB and 90-degree dispersion angle.

6. Type 'IC3' - loudspeaker assembly (structurally mounted):

a. Atlas – SD72W w/ BMTT95-8 enclosure

b. Quam – C10X/BU/WS w/ ERD-8U enclosure

c. Open ceiling direct mount to structure loudspeaker with 10 oz. magnet and 5 watt 24/70V transformer. 95dB SPL 1W/1M with 102dB max SPL at maximum tap. 60Hz – 8kHz frequency response ±3dB and 90-degree dispersion angle.

7. Type 'IC4' - loudspeaker assembly (lay-in tile IP);

a. Intercom Manufacturer specific assembly with an IP Addressable module and loudspeaker.

8. Type 'IW1' - loudspeaker assembly (recessed wall mount interior):

a. Quam – 8C5PAX/TBLU w/ ES-8 enclosure and BS8W grill

b. Indoor recessed wall 8" loudspeaker with 5 oz. magnet and 5 watt 24/70V transformer. 92dB SPL 1W/1M with 99dB max SPL at maximum tap. 65Hz – 17kHz frequency response ±3dB and 100-degree dispersion angle.

9. Type 'IW2' - loudspeaker assembly (recessed wall mount exterior):

a. Atlas – VTF-152UCN or VTF-157UCN w/ AR Adapter Ring

b. Exterior recessed wall 4" loudspeaker with 5 watt 24/70V transformer. 96dB SPL 1W/1M with 107dB max SPL at maximum tap. 600Hz – 5.5kHz frequency response ±5dB and 170-degree dispersion angle.

10. Type 'IW3' loudspeaker assembly (exterior hour):

a. Atlas – AP-15T

b. Exterior Horn with compression driver and 15 watt 24/70/100V transformer. 106dB SPL 1W/1M with 120dB max SPL at maximum tap. 400Hz – 14kHz frequency response ±5dB and 70-degree dispersion angle.

K. UPS – Juice Goose – SCV-20001 or equal

1. Contractor to verify UPS load requirements prior to purchase of UPS. Intercom system shall maintain power for 30 minutes after building loses power.

L. Clocks:

1. Clocks shall be battery powered. The contractor shall provide a fresh battery and install each clock set to the correct local time. Room types will have different size requirements.

2. 12" clock – American Time and signal – E56BAQD304BF

a. Provide 1 clock per the following room types:

i. Learning Studio/Classrooms
ii. Collaboration Area
iii. Offices
iv. Work rooms
v. Conference rooms

3. 15" clock – American Time and signal – E66BAQD304BF (Recreational Space Clock)

a. Provide 1 clock per the following room types:

i. Gymnasiums (provide 1 on each side of the dividing curtain)
ii. Music rooms
iii. Shops
iv. Kitchen
v. Commons/learning stairs
vi. Media center

4. Provide wire guard on all clocks in locations where other devices are protected. Coordinate with fire alarm plans for locations requiring wire guards.

2.3 INTERCOMMUNICATION, PROGRAM DISTRIBUTION, CLOCK/TIME SIGNALING SYSTEM

1. Separately addressable paging zones shall be provided as indicated on the drawings. Zones shall be capable of being grouped for various call scenarios as defined or requested by the owner.

2. Refer to the intercom drawings for identification of zones, zone types, and ceiling construction type.

1. Individual zones are designated with “Z-ID”.
2. Common and exterior distributed zones are identified with a unique zone number “Z-#X#”.
3. Intercom drawings are intended to be printed in color in addition to having the zone information under the room tag.

4. Space requirements:

a. Classrooms/Teaching spaces.

i. The IP module/loudspeakers for each space shall be utilized for the intercommunication system.
ii. One (1) Call switch shall be provided in each room near the CSA antenna location. Refer to drawings for location of devices.
iii. One (1) Clock located above the entrance door.

b. Shared spaces between Classrooms/Teaching spaces.

i. The IP module/loudspeakers for each space shall be utilized for the intercommunication system.
ii. One (1) Call switch shall be provided on the wall adjacent to the main hallway.
iii. One (1) Clock located above the entrance door.
iv. These rooms will be used as shelter in place rooms for adjoining classrooms.

c. Specialty Teaching spaces with high ambient noise floor (Wood/Metal/AG shops).

i. Distributed ceiling recessed loudspeakers (Qty. as required) at 14’ by 14’ minimum spacing, type as required for ceiling construction.

ii. Visual strobe
iii. One (1) Call switch shall be provided at the primary teaching station. Coordinate location of primary teaching location with drawings.
iv. One (1) Clock located above the entrance door

d. Private Offices, Conference rooms, Faculty Lounges & Work Rooms (outside of the main office/administration suite)
i. One (1) ceiling mounted loudspeaker, type as required for ceiling construction.
ii. Connect to adjacent corridor zone you enter the office from
iii. Offices off of a classroom shall be on the same zone as the classroom
iv. Gymnasium

e. Gymnasium
i. Wall mounted loudspeakers, Qty. and type as required for ceiling construction and adequate coverage (< 6dB level variation).
ii. One (1) Call switch shall be provided co-located with any light switches adjacent to each entrance.

f. Cafeteria/Commons/Dining
i. Ceiling mounted loudspeakers, Qty. and type as required for ceiling construction and adequate coverage (< 6dB level variation).

g. Kitchen
i. Ceiling mounted loudspeakers, Qty. and type as required for ceiling construction and adequate coverage (< 6dB level variation).
ii. One (1) Call switch shall be provided co-located with any light switches adjacent to main entrance.
iii. Within the Kitchen office provide a two-way system with call button and loudspeaker.

h. Corridors, Vestibules & Open Collaboration/Circulation areas
i. Distributed ceiling recessed loudspeakers (Qty. as required) at 20’ minimum spacing, type as required for ceiling construction.
ii. Rooms that are wider than 25’ shall require an additional row of loudspeakers and located on a maximum of a 20’ x 20’ spacing centered in the room.
iii. Coordinate with ceiling devices and locate adjacent to smoke detectors when within few feet of one. Loudspeakers shall be in line with any lighting within the space
iv. Provide a minimum of one (1) loudspeaker for each space type

i. Stairwells
i. One (1) ceiling mounted loudspeaker, type as required for ceiling construction.
ii. Connect to the adjacent corridor zone.

j. Restrooms
i. One (1) ceiling mounted loudspeaker, type as required for ceiling construction.
ii. Connect to the adjacent corridor zone
iii. Do not provide loudspeakers in single use restrooms adjacent to

a corridor zone.

k. Administration Suite (Private offices, Conference rooms, Nurse areas, work rooms, reception, etc. within the main administration suite)

i. Distributed ceiling recessed loudspeakers (Qty. as required) at 20’ minimum spacing down corridors and 14’ x 14’ in open areas, type as required for ceiling construction.
ii. Provide a minimum of one (1) loudspeaker for each space type.
iii. Provide a minimum of one (1) loudspeaker on an individual zone in the reception area. General pages from the reception area shall not play over this zone, it shall only be used for prerecorded messages.

l. Building Exterior

i. Distributed recessed loudspeakers (Qty. as required) to cover all sides of the building and all entrances.
ii. Coordinate and co-locate loudspeaker rough-in with exterior fire alarm horn strobe locations.
iii. Provide unique zone for each side of the building (North/South/East/West)
iv. Provide ‘IW3’ type loudspeakers on areas with:
1. Playground equipment
2. Fields
3. Other play surfaces
v. Provide ‘IW2’ type loudspeakers on the front of the building and in locations where the property line is less than 30’ from the building.

m. Rooms smaller than 100 sqft and that are adjacent to a corridor/hallway will not require a loudspeaker when an announcement is audible within the room. Audible within the room shall be defined as 15 dB above the ambient noise within the room.

i. Vestibules are excluded from small rooms and will require a loudspeaker tied to the adjacent corridor zone.

B. All class-change bell signaling shall be sounded over the intercommunication system.

1. Each dialing administrative console in the system shall be programmable for the following options:

a. Allow zone paging.

b. Allow All-Page announcements.

c. Allow Executive Override.

d. Allow Emergency paging.

e. Allow activation of Time Zone tones.

f. Set the priority level and target display of "normal" calls.

g. Set the priority level and target display of "emergency" calls.

h. Assignment of architectural number.

i. Class of Service.

j. Assignment of associated speaker to paging zone.

k. Automatic Call-Back-Busy.

l. Call Forward-No Answer.

m. Call Forward-Busy.

n. Allow activation of security monitoring functions on a per room and per zone basis.

C. All class-change signaling shall be sounded over system loudspeakers as programmed.

PART 2 - EXECUTION

2.1 **GENERAL**

A. Wiring shall be installed in metallic conduit and provided with necessary junction and pull boxes. All wiring shall be color coded and in accordance with the manufacturer's instructions, local and national codes. Care shall be exercised in wiring to avoid damage to the cables. All boxes shall be plumb and square. Cables shall be pulled continuous without splicing, leaving ends in lengths as directed by the manufacturer's representative.

B. After all circuits and cables have been pulled and completed from one extremity to the other, the electrical contractor shall check all circuits free of opens, shorts and grounds. The electrical contractor shall identify and tag all cables at the head end.

C. The manufacturer's representative shall make all final connections to the equipment, shall test and adjust the systems, and shall instruct the proper parties as to care and operation.

D. Any additional equipment required for a fully functional system to meet the intent of the specifications shall be provided whether or not specifically listed herein.

2.2 **INSTALLATION OF SOUND SYSTEMS:**

A. Install sound systems as indicated, in accordance with equipment manufacturer's instructions, and with recognized industry practices, to ensure that system equipment complies with requirements. Comply with requirements of NEC and applicable portions of NECA's "Standard of Installation" practices.

B. Equalize systems using industry recognized practices and equipment.

C. Pathway Requirements:

1. General:

a. All pathways shall be designed, constructed, grounded and installed in accordance with all recommendations delineated within TIA 569-B and Standard TIA 942.

b. Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. Arrangements to remove any major obstructions not identified on plans need to be determined at that time with the Engineer.

2. Conduits:

a. Contractor shall provide a minimum of 1-1" EMT conduit from device to accessible ceiling space unless otherwise noted. Then utilize non-continuous cable support from devices to connecting device. Refer to symbol schedule for specific conduit requirements.

i. Provide non-continuous open top cable supports every 5’ above accessible ceiling.

b. Achieve the best direct route parallel with building lines with no single bend greater than 90 degrees or an aggregate of bends in excess of 180 degrees between pull points or pull boxes.

c. Provide large radius elbows on all bends.

d. Conduit runs shall not have continuous sections longer than 100 feet without a pull box. Refer to rough-in schedule for conduit fill capacity.

e. AV conduits should not be routed over or adjacent to heat sources such as boilers, hot water lines, or steam lines. Neither should they be routed near large motors, generators, photocopy equipment, or electrical power cabling and transformers.

f. After installation, conduits shall be clean, dry, unobstructed, capped for protection, labeled for identification, reamed and fitted with bushings.

g. A 200lb pull cord (nylon, 1/8” minimum) shall be installed in any empty conduit.

3. Open Top Cable Support Requirements:

a. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables

b. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.

4. Pull Box Requirements:

a. NEC sized pull boxes are not acceptable. Follow BICSI and EIA/TIA 569-B guidelines for pull box sizing.

b. Provide pull boxes in sections of conduit that are 100 feet or longer, contain more than two 90 degree bends, or contain a reverse bend.

c. Conduits that enter a pull box from opposite ends should be aligned.

d. Pull boxes shall have a length 12 times the diameter of the largest conduit.

e. All pull boxes must be accessible.

D. Cabling System:

1. Follow T568B scheme for copper category cabling terminations.

2. Provide a minimum 6” service loop in each AV system junction box. Cables shall be coiled in the in-wall boxes if adequate space is present to house the cable coil without exceeding manufacturers bend radius.

3. In a false ceiling environment, a minimum of 3 inches shall be maintained between cable supports and false ceiling. At no point shall cable(s) rest on lay-in ceiling grids or panels.

4. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

5. Cables shall not be attached to ceiling grid seismic support wires or lighting

fixture seismic support wires. Where support for AV cable is required, the contractor shall install appropriate carriers to support the cabling.

6. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.

7. Pulling tension for balanced twisted pair shall not exceed 25lbf and for optical fiber shall not exceed 50lbf.

8. Pair untwist at the termination shall not exceed 0.125”. The cable jacket shall be maintained as close as possible to the termination point.

9. Cable shall not be draped on, tied or otherwise secured to electrical conduit, plumbing, ventilation ductwork or any other equipment. Cable shall be secured to building supports or hangers or to additional blocks or anchors specifically installed for this purpose.

E. Cabling groups and conduit separation:

1. Refer to “CABLING GROUPS AND CONDUIT SEPARATION SCHEDULE”.

F. Firmly secure all equipment in place that is not intended for portability.

G. Mount projectors permanently and provide mechanical index ensuring precise alignment of the projected image.

H. Provide adequate structural support for AV system components. Provide fastenings and supports with a safety load factor of at least five.

2.3 GROUNDING:

A. All grounding and bonding shall be done according to ANSI J-STD-607-A, TIA 942, and NEC.

B. All cabinets/racks shall utilize paint piercing grounding washers, to be used where rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.

C. All racks shall further utilize a full-length rack ground strip attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact. Similar to Panduit RGS.

D. All active equipment shall be bonded to ground. If the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. All active equipment shall be bonded using the appropriate jumper for the equipment being installed using the thread-forming screws. Similar to Panduit RG.

E. Racks shall have individual, appropriately sized conductors bonded to the grounding backbone. Do not bond racks or cabinets serially – daisy-chained rack grounds will not be accepted.

F. Refer to electrical diagrams for additional ground connection requirements.

2.4 LABELING

A. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the contractor.

At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and wall plates. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

B. All labels shall meet UL 969 requirements for legibility, defacement and adhesion requirements. Handwritten, Ink, or Laser Printing labels are not allowed. Labels shall be uniform in physical size and text height with minimal blank space. Provide labels using thermal transfer print. Heat shrinking or wraparound labels are required, flag style labels are not allowed.

C. Provide laminated plans (minimum size 11x17) of all Intercom as-built plans (including riser diagrams) intercom rack. Contractor shall be responsible for providing a 1RU drawer.

D. Label each equipment with the date (month/year) that it was installed along with the IP address, if applicable, and equipment type.

2.5 CYBER SECURITY

A. Contractor shall change all default username and passwords for all network devices provided. A Strong Password should include at a minimum the following:

1. Be at least 12 characters in length

2. Contain both upper and lowercase alphabetic characters (e.g. A-Z, a-z)

3. Have at least one numerical character (e.g. 0-9)

4. Have at least one special character (e.g. ~!@#$%^&*()_-+=)

5. Cannot contain full words

B. No written username or passwords shall be located in any areas of installation.

C. Network devices to be set up on a separate network other than owner’s LAN ensuring no internal or external users can access system without authorization.

D. Follow manufacturers hardening guide and use best industry practices to secure network and devices provided by contractor and associated with system.

2.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Services:

1. Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Inspection:

1. Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap

settings of paging speaker line matching transformers.

2. The installation technician from the installer / manufacturer shall perform all system tests as specified. Perform all tests in the presence of the Owner, Architect / Engineer and any designated personnel as deemed necessary by the Owner or Architect / Engineer. This test shall be performed with the devices at their operational location and under normal operational conditions. Bench or default settings for devices are not acceptable. All test and test report costs shall be included in the contractors bid. A checkout report shall be generated by the installation technician and submitted to the Owner and Architect. The report shall include but not be limited to the following:

    a. A complete list of all equipment installed with corresponding serial numbers.

    b. Indication that all equipment is properly installed, functions and conforms to the specifications.

    c. Serial numbers, locations by device and model number for each installed device.

    d. Technician's name, specified certification credentials and date of system test.

    e. Any additional information as deemed necessary by the Owner and or Architect / Engineer.

C. TESTING:

1. Upon completion of installation of each system and after electrical circuitry has been energized, demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units on site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with testing.
2. Before inspection by owner and AV Consultant, and after completion of the installation, conduct system tests and make necessary corrections for proper system operation.
3. Adjust, balance and align equipment for optimum quality and to meet the manufacturer's published specifications.
4. All limiters and/or compressors shall be set to prevent operators from over-adjusting sound levels and damaging system components.
5. System shall have no audible hum, noise, RFI, or distortion when operating under normal conditions. System shall reproduce material at the loudspeakers rated output level without audible distortion. All input levels shall be pre-set so system may be operated without causing unstable feedback under normal use.
6. System shall have no image distortion, hum bars, color shift, or any other picture distortion while operating under normal conditions. Provide cable equalizers, located near displays, on all cables that are more than 30 feet in length and/or have more than 4 connection points.
7. Adjust gain controls for optimum signal-to-noise with 0 dBu at a line-level input.
8. Perform polarity checks of loudspeaker lines by means of a polarity tester or use

DC source at one end of each line and a voltmeter at the other end. Loudspeaker lines shall be identically polarized with respect to color coding.

9. Loose parts and poor workmanship or soldering shall be replaced.

10. Sweep Loudspeaker systems with high-level sine wave or 1/3 octave pink noise source. Correct causes of buzzes or rattles related to Loudspeakers or enclosures. Notify owner of external causes of buzzes or rattles.

11. Contractor shall provide system testing as described herein using up-to-date and industry accepted test equipment appropriate to the types of links being tested and in accordance with the latest edition of IEC 61935-1.

12. Horizontal cabling contractor shall test all twisted pair cabling used within the system following the standards in specification 27 1500 under the testing section. Provide documentation of testing to Intercom Consultant prior to final walk through.

D. At the time of final commissioning, if the Intercom consultant determines that the systems are not sufficiently complete to do a final punch list, and was not notified at least three (3) days prior to the visit, then a return visit will be required. The Intercom Consultant's return visit will be paid for in advance by the Intercom integrator at a flat rate of $500 per person, at no cost to the owner.

2.7 OCCUPANCY ADJUSTMENTS:

A. When requested by the Architect within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, resetting matching transformer taps, and adjusting controls to suit actual occupied conditions.

2.8 TRAINING

A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.

B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.

C. All staff development training is to be coordinated through the owner's designated representative. As training sessions are completed, the trainer will provide the school's administrative staff and school district's staff a document listing all of the staff and faculty members who attended, received and completed the training program.

D. Provide a minimum of two (2) one (1) hour sessions of in-service training with this system. These sessions shall be broken into segments that will facilitate the training of individuals in the operation of this system. Operators Manuals and Users Guides shall be provided at the time of this training.

E. Schedule training with Owner through the Architect, with at least fourteen (14) days advance notice.

F. Training shall be recorded using a video recording device that support a minimum resolution of 1080P/60 with an integrated microphone connection for an external microphone and a camera tri-pod mount. Presenter shall be wearing a lapel microphone that connects to the recording device and a Tri-pod shall be used for stabilizing the

recording device. Recordings that are shaky, poor audio and/or video quality, incomplete, or other issues will not be accepted and the contractor will be responsible for providing a new recording and training within five (5) business days of notification. Provide a digital copy to the Owner and Intercom Consultant. If Digital copy is sent in a link, verification of end user download shall be provided to the owner and Intercom Consultant showing IP address or user that download and what date. The link cannot have an expiration date and will be the responsibility of the contractor to maintain. Links shall be included in the Operating and Maintenance manuals in the first section. Video files shall also be provided on a flash drive within the intercom equipment rack adjacent to the server location. Flash drive shall be clearly labeled.

2.9 **CLEANING AND PROTECTION**

A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up.

2.10 **OPERATING AND MAINTENANCE MANUALS: Refer to Section 26 0502 for requirements.**

END OF SECTION 27 5123

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SECTION 27 5320

PUBLIC SAFETY DAS/ERRCS

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.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 26, 27, and 28, Specification Sections, apply to this Section.

C. Refer to Appendix A – Altamont ES ERRCS/DAS System Preliminary Design

D. 28 3111 Fire Detection and Alarm System

1.2 ADMINISTRATIVE REQUIREMENTS:

A. BNA Project Contact:

1. Drayton Bailey – Principal
   a. Phone: 801-532-2196
   b. Email: dbailey@resolutgroup.com

B. Bid Submittal:

1. Equipment Costs: Breakout cost of material and labor as different line items. Refer to bid form for breakout cost requirements.

C. Coordination:

1. Coordinate final inspection of the systems installed, with Emergency Responders Radio Communication System (ERRCS) Consultant, three (3) weeks in advance.
2. Obtain GANTT chart for construction time frame from the General Contractor.
3. Coordinate with Electrical contractor to meet at least twice with the ceiling installer. Hold first meeting before submittal of shop drawings to coordinate the mounting condition of all ceiling-mounted ERRCS equipment with ceiling type. During second meeting, coordinate the location of all ceiling-mounted ERRCS equipment in each area.
4. Meet with Electrical contractor prior to pathway rough-in to coordinate ERRCS requirements in each area.
5. Meet at least once, prior to rough-in, with horizontal cabling installer to verify all ERRCS network requirements. Coordinate cable color according to specification 26 0553.
6. Coordinate color and finish of all ERRCS components with Engineer.

D. Contractor is responsible for coordinating with all other trades for equipment locations, mounting requirements, supports and plenum space requirements.

E. ERRCS contractor shall participate in a mandatory pre-construction meeting no more than sixty (60) days prior to ordering equipment, and before work can begin. Contractor is responsible for coordinating the meeting. The meeting will be held at job trailer. All submittals, shop drawings and bills of materials shall be completed and submitted to Consultant for review eight (8) working days prior to this meeting.

F. ERRCS contractor shall attend the electrical pre-construction meeting per specification 26 0500.

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1.3 GENERAL SYSTEM REQUIREMENTS

A. Public Safety DAS/ERRCS

1. SUMMARY: This specification describes technical and performance criteria for deploying an Emergency Responders Radio Communication System (ERRCS) capable of supporting Public Safety Networks (PSN). Contractor shall provide a full turn-key solution and installation of the ERRCS as indicated per specifications.
2. Division 26 and/or DAS Contractor is responsible for including all required contractors bids. Division 26 contractor is responsible for all pathway, power, and grounding requirements necessary for DAS system.
3. 700/800 MHz ERRCS (Emergency Responders Radio Communication System)

B. The DAS components typically specified include:

1. Bi-Directional Amplifiers (BDA)
2. Donor Antennas
3. Coverage Antennas
4. Coaxial Cable and Coax Connectors
5. Splitters, Combiners, and Couplers
6. Battery Backup Unit

C. Planning shall include:

1. Model projected antenna locations based upon floor plan layouts.
2. Survey building conditions for signal coverage as building walls are built to verify antenna locations.
3. Survey building conditions for signal coverage at building commissioning to verify there are no signal conflicts prior to building opening.
4. Survey building conditions for signal coverage six (6) months after building is operational to ensure that there are no signal conflicts as building medical equipment has come online.
5. All surveys are to be completed utilizing PCTel's Touch platform or equivalent.

D. PSN Approval: The Contractor shall only propose and deploy a DAS system capable of receiving approval of the PSN Authority Having Jurisdiction (AHJ).

E. Supervision and Monitoring:

1. Provide the following outputs for monitoring by the Fire Alarm System. Connect these outputs to the fire alarm system for trouble monitoring:
   a. Donor Antenna Malfunction
   b. Signal booster Failure
   c. Signal Booster Trouble.
   d. Loss of AC Power
   e. Failure of Charging Circuit
   f. 70% of Battery Depletion

F. Battery Backup: Provide a UPS capable of backing up the DAS system for a period of 24-hours.

G. Mount antenna in an aesthetically pleasing manner.

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H. Provide plenum rated cabling throughout the entire system.

I. Performance Requirements:

1. The PSN DAS shall comply with local AHJ's code & requirement.
2. The DAS shall deliver coverage of -95 dBm RSSI throughout 95% of all occupied building spaces and 99% in critical areas as defined in NFPA 72/1221 unless specified otherwise by the AHJ.

J. Related Requirements

1. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section
2. Division-7 Firestopping, apply to work of this section
3. Division-26 Basic Materials and Methods sections apply to work specified in this section
4. SECTION 27 1500 COMMUNICATIONS HORIZONTAL CABLING
5. 2018 IFC SECTION 510
6. 2019 NFPA 1221

1.4 DEFINITIONS

A. AHJ: Authority Having Jurisdiction
B. AWS: Advanced Wireless Service
C. BC: Band Carrier
D. BDA: Bi-Directional Amplifier
E. BOM: Bill of Material
F. BTS: Base Transceiver Station
G. CDMA: Code Division Multiple Access
H. CW: Continuous Wave
I. DAS: Distributed Antenna System
J. dB: decibel
K. dBc: decibel relative to Carrier
L. dBm: decibel relative to milliwatts
M. DL: Downlink
N. DTF: Distance-to-fault
O. ERRCS: Emergency Responders Radio Communication System
P. IFC: International Fire Code
Q. LMR: Land Mobile Radio
R. LTE: Long Term Evolution
S. MHz: Megahertz
T. MIMO: Multiple Input, Multiple Output
U. PCS: Personal Communications System
V. PIM: Passive intermodulation

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W. POI: Point of Interface

X. PSN: Public Safety Network

Y. RL: Return Loss

Z. RSRP: Reference Signal Received Power

AA. RSSI: Received Signal Strength Indicator

BB. SINR: Signal-to-Noise Ratio

CC. SISO: Single Input, Single Output

DD. SMF: Single-mode Fiber

EE. TRCES: Two-Way Radio Communications Enhancement System

FF. UL: Downlink

GG. UMTS: Uniform Mobile Telephone Service

HH. VSWR: Voltage Standing Wave Ratio

II. WCS: Wireless Communications Service

JJ. WSP: Wireless service provider

1.5 SUBMITTALS

A. Submittal Requirements

1. Certificates:

a. An FCC-issued general radio operator license (GROL) is required to be held by the contractor.

b. A certificate from the manufacturer of the equipment to be installed stating that the DAS installer is trained or certified on the equipment.

2. Test Equipment:

a. Submit certificates indicating that staff is certified on required test equipment including but not necessarily limited to:

1) Signal Generators if required
2) Spectrum Analyzers
3) PIM Testers if required
4) Scanner

b. Submit current calibration data for test equipment to be used.

3. Bid Assumptions:

a. Contractors shall state the assumed channel count for the PSN Frequency Bands identified above with submittal of bid response. Prior to installation, contractors shall confirm the channel count and frequencies with the AHJ and shall guarantee coverage for these channels per the criteria stated above.

B. Submittal Requirements Prior to Start of Construction:

1. Statement of Work (SOW): The contractor shall submit a SOW that has been accepted by the customer or customer’s designated representative.

2. Acceptance Test Plan (ATP): The contractor shall submit an ATP that has been accepted by the customer or customer’s designated representative.

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3. The contractor shall explain the method used to avoid downlink and uplink interference.
4. Contractor will submit properly scaled floor plans showing the location of system Components:
   a. Coordinate all antenna locations with the architect utilizing the reflected ceiling plan during the submittal process. All locations must be approved and may be changed during the submittal process to eliminate antenna in certain locations.
5. Final RF link budget
6. Detail Drawings for Donor Antenna and grounding.
7. RF propagation modeling (Heat maps)
8. Product Data Sheets for each type of equipment to be installed.
9. Maintenance Service Contract
10. Permit drawings as required by the AHJ.
11. Acquire permission to rebroadcast public safety signal from AHJ and provide documentation as proof.

C. Submittal Requirements at Close Out:

1. Drawings: Submit as-built drawings indicating:
   a. Donor antenna, grounding and lighting protection details
   b. Cable routing, splitters, couplers and coverage antenna locations
   c. Active component locations, layout and configuration
2. Test Reports:
   a. PSN: Submit Accepted ATP reports confirming the requirements have been meet.
3. Cable Test Reports: Submit cable test results for all cable segments. Testing shall include Return Loss (RL) and Distance to Fault (DTF).
4. Field Reports: Submit OTDR test results for all fiber runs.
5. Operation and Maintenance Data: Submit hardware and software manuals for all Active Components.
6. Acceptance Certificate or Document from the AHJ
7. Register the system with the FCC and provide documentation as proof.
8. Warranty Documents:
   a. Submit for all manufactured components specified in this Section.
   b. Submit Contractor's System Warranty.
   c. Submit Manufacturer's Extended Warranty

1.6 GUARANTEE AND CERTIFICATE

A. Any item of material, apparatus, or equipment, furnished and installed, or construction by the Contractor showing defects in design, construction, quality or workmanship within two years from the date of final acceptance by the State shall be replaced by such new materials, apparatus or parts as may be found necessary to make such defective portion of the complete system conform to the true intent and meaning of the Specifications and Drawings. Contractor shall turn over all manufacturer's warranties to include 10, 15, and 25-year warranty programs for example.

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1.7 DESCRIPTION OF WORK

A. The Contractor shall furnish all labor, materials (except as hereinafter noted), tools, equipment and appliances required to provide and install all Distributed Antenna System (DAS) Work, complete, as indicated on the drawings and as specified herein. The drawings note various sizes of equipment as determined for basis of design; the electrical work, however, shall be installed by qualified electrician to comply with the equipment manufacturer's installation requirements that are furnished by the successful supplier.

B. The work shall include but not necessarily be limited to the following:

1. Complete design and build of wireless communications infrastructure systems including: all RF and fiber vertical and horizontal cabling, connectors, splitters, couplers, antennas, fiber patch panels, fiber distribution panels and equipment racks; excluding: junction boxes, cable trays, weather heads, pull boxes and conduits required.

2. Connector testing of terminated fiber and coaxial cabling and all active electronic equipment furnished and installed. Tested per manufacturers specifications for the following: RF multi-band sweep showing VSWR or Return Loss (in dB), DTF (distance to fault) and OTDR of fiber cabling showing total optical loss and reflection at 1310 and 1550nm wavelengths. All high voltage electrical connections, provided by others, will be tested for proper grounding and AC sinusoidal waveform compliance.

1.8 QUALIFICATIONS

A. Contractor shall have a minimum of 5 years documented experience in DAS design and deployment of cellular distributed antenna systems and over the air public safety wireless networks in which the last 3 years' experience to be submitted for review. All installers shall be required to have at least 3 years' experience and have certification by product manufacturer to be installed. Contractor and installer shall be certified by manufacturer and submit certification. Contractor must also have an iBwave 3 certified individual on staff as well as a general radio operators license (GROL).

B. Key personnel assigned to the project shall each have minimum of (10) years of experience in completing systems equal to this scope, quality, type and complexity

C. ERRCS installer shall be qualified to install the system per IFC (2018) Section 510.5.2

D. All work shall be done by expert technicians qualified in the field with knowledge of specified systems. Workmanship shall comply with industry best practices concerning grounding, shielding, cable dressing, cable termination and equipment mounting.

E. Bids submitted by non-approved installers will not be accepted.

F. PRE-APPROVED INSTALLERS:

1. Groove Technology Solutions

1) Jim Henderson

a) Phone: (801) 396-6630

b) Email: JimH@getgrooven.com

G. Bidders not pre-approved shall submit in writing the following for review at least (8) working days prior to bid:

1. List of qualifications including:

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1) Industries certifications including manufacturers.

2) Approved resale manufacturers.

2. Past and current projects within the last 5 years similar in scope and size.

3. (3) Different referrals from the owners of (3) different projects within the last 5 years.

PART 2 - SYSTEM REQUIREMENTS

2.1 FREQUENCY / BAND REQUIREMENTS

A. ERRCS shall support the following bands:

1. 700 MHz Band (Public Safety)
   a. BC14 DL: 758-775 MHz
   b. BC 14 UL: 788-805 MHz
2. 800 MHz
   a. DL: 851-862 MHz
   b. UL: 806-817 MHz
3. 700/800 MHz LMR with AT&T FirstNet

2.2 SYSTEM PERFORMANCE

A. ERRCS

1. Shall comply with IFC 510/NFPA1221.

2. Coverage Requirement

   A. DL DAQ shall be (3.0 DAQ) or greater throughout 95% of all areas.
   B. DL DAQ shall be (3.0 DAQ) or greater throughout 99% of all critical areas, such as egress routes and stairwells

2.3 DAS MANUFACTURERS:

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

1. Approved DAS Active Components

   1) ERRCS

      a. Nextivity (Basis of Design)
      b. Wilson
      c. Westell Technogies

2. Approved DAS Passive Component Manufacturers (Refer to Specification 27 1500)
   a. Single Mode Optical Cable
      i. General Cable
      ii. Panduit
   b. CAT-6A Cable
      i. General Cable
      ii. Panduit
   c. Coaxial Cable
      i. Commscope

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ii. RFS

d. Couplers/Splitters/Diplexers

i. Commscope
ii. Waveform
iii. Wilson

e. Antennas

i. Commscope
ii. Laird
iii. Galtronics
iv. Nextivity

PART 3 - EXECUTION

3.1 FIBER OPTIC CABLING

A. Active distribution network requires single-mode fiber-optic cabling between system head end(s) and secondary distribution points.

B. Contractor to provide armored SMF backbone with twelve (12) strands to each expansion node location, terminated in a wall or rack mount fiber panel with LC angled polish (LC/APC) connector terminations.

C. All strands of each run shall be terminated at each expansion node location. Strands shall be terminated using core alignment fusion splicing of factory-polished APC connectors.

D. Contractor to provide LC/APC to LC/UPC single-mode fiber-optic jumpers from fiber panel to DAS equipment.

E. Contractor to provide innerduct or comparable protection for non-armored fiber-optic jumpers.

F. EMT or GRC conduit will be installed where required in section 27 0528.

3.2 DATA AND COAXIAL CABLING

A. For the ERRCS, the passive distribution network also requires coaxial cable between access points and antenna locations.

B. Distribution network may require and/or CAT-6A between expansion nodes and antenna or wireless access point locations.

C. GRC conduit will be installed where runs could be subject to vehicular impact.

D. All cables shall be supported at a minimum separation interval not to exceed cable manufacturer's specification or Section 27 1500, whichever is more stringent.

E. The use of shared communications/data cable raceways is permitted for DAS cabling.

F. All new concrete cores' locations must be submitted to the Owner's staff for approval prior to drilling.

G. GPR/XRAY must be used to avoid damage where required in section 27 0528.

3.3 SYSTEM COMPONENTS

A. Active and passive components shall be installed in accordance with the system design and with Manufacturer's recommended installation guidelines.

B. All active and passive components shall be labeled with machine generated labels.

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3.4 COMPONENT TESTING

A. Fiber-optic cabling

1. SMF shall be tested in accordance with Section 27 1500 for each strand of SMF.
2. All test results will be submitted for review.

B. CAT-6A cabling (if used)

1. All CAT-6A cabling shall be tested in accordance with Section 27 1500 and ANSI/TIA-568-C.2 standards.
2. All test results will be submitted for review.

C. Coaxial cabling

1. All field terminated coaxial cables shall be Sweep tested.
2. Return Loss (RL) testing, per segment of coax, for both low and high bands.
3. Distance to Fault/Return Loss (DTF) testing, per segment of coax, for both low and high bands.
4. Coax Sweep Testing Minimum requirements
   a. Low Band sweeps will be set at 698-960 MHz
   b. High Band sweeps will be set at 1710-2700 MHz
   c. All tests shall be into a calibrated load terminator.
   d. RL on any segment shall not exceed -18 dB
   e. DTF/RL shall not exceed -24 dB

D. Non-conforming work as covered in the General Conditions applies, but is not

E. limited to the following:

1. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced at no additional cost to the Owner.
2. Any defect in cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced to ensure 100% useable conductors in all cables installed at no additional cost to the Owner.
3. Correct deviation and repeat applicable testing at no additional cost to the Owner.
4. Re-test cable(s) and provide new test data.

F. CONTRACTOR TEST EQUIPMENT

1. The contractor shall ensure all contractor supplied test equipment is properly calibrated, and certified. If requested by the Owner, the contractor shall be able to supply any certificates tied to the quality and calibration of the test equipment.

3.5 Locate equipment, antennas and splitters at locations shown on the contract drawings:

A. Extend cabling from the EOS enclosures to the splitters in a neat and orderly manner per the routing indicated on the contract drawings. Support cabling in compliance with NEC chapter 8 requirements and manufacturers recommendations.

B. Maintain a 6” minimum distance from the DAS cabling and other cabling for parallel runs. Do not install coaxial cabling open in any areas were the cabling will be subject to physical damage.

C. All locations must be approved prior to installation via the submittal process. When providing the layout of the antennae, locate antennae in back of house spaces whenever possible.

3.6 EQUIPMENT MOUNTING:

A. Install wall mounted enclosures in telecommunication rooms in accordance with manufacturers instructions and seismic requirements.

B. Provide and install equipment rack in main telecommunications room. Fasten to the floor per manufacturers instructions and provide seismic bracing.

C. Install donor antennas per details shown on the contract documents.

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3.7 COORDINATION WITH OTHER TRADES:

A. Field coordinate the installation of the ERRCS headend equipment and remotes to ensure that each location is provided with the following:

1. A dedicated 120V, 20A emergency circuit for UPS equipment served from the life safety generator system.
2. (12) strands of single mode fiber from the head end location to each remote location terminated in LC/APC connectors.
3. Grounding per NEC and TIA standards.
4. Coordinate Alarm and Monitoring points with the Fire Alarm contractor.

3.8 EXAMINATION:

A. The contractor must examine areas and conditions under which ERRCS components are to be installed and notify the owner's representative, in writing of those conditions which are, in the Contractor's opinion, potentially detrimental to proper completion of the work. The Contractor shall not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the owner.

B. Examine pathway elements intended for cable, check raceways, cable trays and other elements for compliance with space allocations, installations tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Specific items of examination shall include, but shall not necessarily be limited to, the following:
   a. Locations for all new ERRCS antennas, cable and splitter equipment.
   b. The Contractor shall examine all rooms designated to house ERRCS equipment to ensure adequate space, power, and environment conditions to support installation.

3.9 COMMISSIONING:

A. DAS commissioning will occur when head end DAS components are integrated and configured.

B. Contractor shall submit a system commissioning and testing plan to the Owner prior to commissioning.

C. Contractor shall submit certificate from the manufacturer of the equipment installed stating that the DAS installer is trained / qualified on the equipment.

3.10 WARRANTY:

A. Splitters, Couplers, and Coverage Antennas: 5-year limited warranty from date of completion.

B. Coaxial Cable and Connectors: 10 -year limited warranty from date of completion.

C. Fiber-Optic Cable: 20-year limited warranty from date of system completion.

D. Active Components: The earliest of 1-year limited warranty from date of completion.

END OF SECTION 27 5320

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SECTION 28 0501

COMMON REQUIREMENTS FOR ACCESS CONTROL, IP VIDEO SURVEILLANCE, & INTRUSION DETECTION SYSTEMS

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 work of this section.

B. Architectural, Structural, Mechanical, Electrical and other applicable documents are considered a part of the security documents insofar as they apply as if referred to in full. The contractor must review the entire set of plans and specifications. Reviewing only the security set *is not* acceptable.

C. Division 26, 27 & 28 basic materials and methods sections apply to work specified in this section, including but not limited to requirements for raceways, trays, boxes, and fittings, and supporting devices, and other sections, as applicable.

D. Refer to specification 26 0553 Electrical Identification for conduit, junction box, and cabling color requirements.

E. Refer to specification 27 1500 Telephone Data Systems for the specified category cabling and optical fiber cabling, connectivity specifications, additional pathway requirements, and installation standards.

F. This specification does not address other Division 28 sections, such as the Nurse Call System and/or Fire Alarm and Detection Systems.

1.2 ENGINEERS CONTACT INFORMATION:

A. BNA Security Contacts:

1. Eric Skinkis
   Phone: 801-532-2196
   Email: ESkinkis@bnaconsulting.com

2. Dan Varney
   Phone: 801-532-2196
   Email: DVarney@bnaconsulting.com

1.3 DESCRIPTION OF WORK:

A. Security work is defined as any Division 28 system specified, including but not limited to the access control system, the IP video surveillance system, and the intrusion detection system.

B. The extent of security work is indicated in the plan drawings and specified in Divisions 26, 27 and 28 sections of the specification. Provide all labor, materials, equipment, supervision, and service necessary for complete and working systems.

C. Provide the specified systems in a complete and operating condition with all necessary materials and labor to fulfill the requirements and the intent of the drawings and specifications. Except as otherwise indicated, provide the manufacturers standard system components. Contractors shall provide all cables, materials, and equipment, whether specifically mentioned herein or not, to ensure a complete and functional system.

D. Contractor is responsible for coordinating with all of the other trades for equipment locations, mounting requirements, supports, and plenum space requirements. The contractor shall provide plenum rated cabling if required per the mechanical drawings.

E. Contractor shall provide ¾" EMT conduit from the end devices and/or junction boxes up to the accessible ceiling space. From there, non-continuous cable support devices (e.g., cable hooks, bridle rings, etc.) are to be used to route the cabling back to the designated rooms where the head-end control panels and equipment are located, utilizing the cable tray if available on the project.

F. All installed security systems shall be seamlessly integrated and operate cohesively with one another.

G. All raceways and enclosures shall be securely fastened or mounted in accordance with the most current version of the National Electrical Code "NFPA 70". All work shall be performed in a neat and workmanlike manner.

1.4 BID SUBMITTAL:

A. Provide a detailed scope of work document for all services provided.

B. Provide a complete bill of materials for all components, accessories, and hardware to be provided to assemble complete and fully functional security systems as described within the contract documents.

C. Provide a breakout cost of material and labor as different line items. Bids must include line-item pricing for major parts and components of the system.

D. Submit manufacturer certifications for all systems provided. Certifications must be provided by the local office providing the installation.

E. All permitting costs shall be included in the base bid.

F. All equipment shall be installed as shown in the plan drawings and in strict accordance with the specifications. Any errors, conflicts, or omissions discovered in the specifications, or drawings, shall be submitted in writing to the Security Consultant for clarification in an RFI prior to bid.

1.5 QUALITY ASSURANCE:

A. MANUFACTURERS: Firms regularly engaged in the manufacturing of security system equipment and components of the types described here in and whose products have been in satisfactory use in similar applications for not less than five years.

B. Integrating firm shall have worked satisfactorily for a minimum of five years of completing systems equal to this scope, quality, type, and complexity.

1. Key personnel assigned to the project shall each have a minimum of five years of experience in completing systems equal to this scope, quality, type, and complexity.
2. Contractor shall be a factory authorized installer of all equipment specified for the geographical area of the project.
3. The contractor shall maintain complete installation and service facilities for the duration of the project contract.
4. The installation contractors shall have current manufacturer certifications for all security systems and equipment listed within this specification. Certifications must be provided by the local office providing the installation.

C. All work shall be done by expert technicians qualified in the field with knowledge of specified systems. Workmanship shall comply with industry's best practices concerning grounding, shielding, cable dressing, cable termination and equipment mounting.

D. All technicians are required to have proper state licensing to perform work within this specification.

E. List of qualifications include:

1. Industries certifications including manufacturers.
2. Past and current projects within the last five years are similar in scope and size.
3. Provide three referrals from the owners of three different projects completed within the last five years.

1.6 GENERAL COORDINATION:

A. Meet with Electrical Contractor prior to pathway rough-in to coordinate system requirements in each area and review each security device that requires 120V power.

B. Meet with Owner's IT Department prior to ordering equipment to coordinate IT services to equipment.

C. Meet with Low Voltage Cabling Contractor (Division 27 1500) at least once, prior to rough-in, to verify all category cabling needs to equipment.

D. Regular inspections are required and shall be scheduled by the contractor through the Owner/Architect at least twenty-four hours in advance.

E. Coordinate color and finish of all components with Architect.

F. Notify engineers of any modifications between contract documents and submittals. It is the contractor's responsibility to ensure compliance with the documents.

G. The contractor's project manager will be required to schedule and provide weekly updates via remote meeting and/or email communications on progress of installation and update project schedule if any dates change from original completion.

1.7 SUBMITTALS:

A. Refer to specification 26 0502 "Electrical Submittals and Spare Parts" for submittal requirements.

PART 2 – PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide a complete raceway system for security system including but not limited to, raceway, outlets, cover plates, backboards, cabinets, grounding and miscellaneous items as required.

B. Provide plywood terminal backboards, 4' x 8' x ¾" unless otherwise noted for all security equipment unless otherwise noted to be installed in racks.

PART 3 – EXECUTION:

3.1 GENERAL REQUIREMENTS

A. Provide and install proper finger wire duct with covers within each panel per project requirements. Provide and install Velcro to neatly bundle cables. All cabling shall be installed in a neat and workmanlike manner.

B. Install security systems as indicated, and in accordance with the equipment manufacturers written instructions, and with recognized industry practices, to ensure that system equipment complies with requirements. Comply with NEC requirements and applicable

portions of NECA's "Standards of Installation" practices.

C. Coordinate all equipment locations and mounting details with other trades and suppliers.

D. Provide at least one duplex receptacle on dedicated power circuit next to specified panels.

E. Grounding: All grounding connections must be securely tightened to ensure a permanent and effective ground.

F. Conceal raceways and conduits unless otherwise noted in specifications and drawings. Where exposed raceways are permitted, run parallel/perpendicular to walls.

PART 4 – TESTING:

4.1 GENERAL REQUIREMENTS:

A. Testing: Upon completion of installation of system and after being energized, demonstrate system compliance with intent.

B. Coordinate final inspection of the systems installed, with Security Consultant, three weeks in advance.

PART 5 – LABELING & TRAINING

5.1 GENERAL REQUIREMENTS:

A. The contractor shall develop and submit for approval a labeling system for the device and cable installation. Coordinate with the owner and negotiate an appropriate labeling scheme with the contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels, and wall plates. The labeling system shall designate the cables' origin and destination and a unique identifier for the cable within the system. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

B. All labels shall meet UL 969 requirements for legibility, defacement, and adhesion requirements. Handwritten labels are not allowed. All labels shall maintain consistent typeface, size, and color.

5.2 TRAINING:

A. Provide two sessions that consist of two hours each of training on the operation of the system, at job site, and at no cost to owner. The system shall be complete and have been finalized by the consultant prior to training.

B. The security contractor will terminate, program and test control equipment. As built drawing package (refer to specification 26 0502 "Electrical Submittals and Spare Parts" for as-built drawing package requirements) shall be provided to Owner personnel before commissioning shall begin. System loops will be tested, and any fault conditions found shall be corrected immediately by the contractor.

5.3 CYBERSECURITY

A. The contractor shall change all default username and passwords for all network devices provided. A Strong Password should -

1. Be at least 8 characters in length.
2. Contain both upper and lowercase alphabetic characters (e.g., A-Z, a-z)
3. Have at least one numerical character (e.g., 0-9)
4. Have at least one special character (e.g., ~! @#$%^&*()_-+=)

B. No written username or passwords shall be located in any areas of installation, except in the O&M manual.

C. Network devices to be set up on a separate network other than owner's LAN ensuring no internal or external users can access system without authorization. Follow manufacturers hardening guide and use best industry practices to secure network and devices provided by contractor and associated with system.

5.4 WARRANTY AND SERVICE:

A. The minimum warranty period shall be one year, the warranty period will begin when the system completion documents are submitted to the owners and the system has successfully passed all tests and inspections. Included in the completion documents will be a warranty and service contact form, this form will be filled out by the burglar alarm contractor, all necessary contact information shall be included to guarantee a response to the system site within 24 HOURS OF THE REQUEST FOR SYSTEM SERVICE. Only qualified technicians capable of making needed repairs and/or system programming are accepted to respond to the service.

B. Contractor shall honor equipment warranties for term established by manufacturer if it is greater than warranty time frame mentioned above.

C. During warranty time period:

1. Systems designed for 24/7 operation shall be repaired and/or replaced within 24 hours of time of notification. If defective components cannot be repaired in time, provide temporary equipment as required.

2. During warranty time period, upon owner request, the contractor shall provide programming changes up to four times or four hours free of charge.

END OF SECTION 28 0501

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SECTION 28 1600

INTRUSION DETECTION SYSTEM

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 work of this section.

B. Division-26, 27 & 28 basic materials and methods sections apply to work specified in this section.

C. Division 28 0501 Common Work Results for Electronic Safety & Security, apply to this section.

1.2 DESCRIPTION OF WORK:

A. Provide a complete and a fully functional intrusion detection system, that will communicate to a certified central monitoring / reporting station; with all necessary material and labor to fulfill the requirement and the intent of the drawing and specifications. Any requirements not understood, or proposed deviances from these installation guidelines should be directed to and approved by the owner. Changes, adjustments, or deviations from this standard by the contractor that are not approved in writing by the owner are the sole responsibility of the contractor and may be ordered corrected at any time before or after completion of the job.

B. The intrusion detection system work is indicated by drawings and is hereby defined to include, but not be limited to, head-end control panel and slave panels, power supplies, cabling, keypads, audible sirens, motion detectors, outlets, cover plates, backboards, grounding, and all miscellaneous items required for complete system.

C. Monitoring service is not included in the scope of work.

1.3 QUALITY ASSURANCE (INTRUSION DETECTION SYSTEM SPECIFIC):

A. Pre-Approved Installation Contractor:

1. Peak Alarm

PART 2 – WIRING

2.1 WIRING SPECIFICATIONS:

A. All security cable outer jacketing shall be gray, UL Listed, stranded, CMP rated, and approved by the owner.

B. ALL system wiring (except line voltage and telephone connections) shall be minimum 22AWG, jacketed, stranded, CMP rated, copper cable, unless otherwise noted.

C. Telephone connections shall be minimum CAT6 CMP rated and connect to panel telephone line connection terminals via an RJ31X telephone jack and cord. Direct wiring of telephone lines to panel circuit board is not acceptable.

2.2 WIRING:

A. WIRING: Provide the following wiring for the security system components:

1. Arming / Disarming Keypad: (1) 22AWG 4-Conductor, UL listed, Jacketed (Gray), Stranded, and CMP rated.
2. Motion Detector: (1) 22AWG 4-Conductor, UL listed, Jacketed (Gray), Stranded, and CMP rated.
3. Door Position Contact: (1) 22AWG 2-Conductor, UL listed, Jacketed (Gray), Stranded, and CMP rated.
4. Audible Siren: (1) 22AWG 4-Conductor, UL listed, Jacketed (Gray), Stranded, and CMP rated.

PART 3 – EXECUTION:

3.1 AUTHORIZED INTRUSION DETECTION SYSTEM MANUFACTURE:

A. DMP

3.2 DOOR POSITION CONTACTS:

A. Authorized door position contact wireless transmitter: DMP

B. Each door position contact is to be independently zoned

C. If the door position contact is wired, the wiring shall be home run to the head-end control panel or zone expander, and the loop supervision resistor shall be installed on the door position contact.

3.3 MOTION DETECTORS:

A. Authorized motion detector manufacturer: DMP

B. Each motion detector is to be independently zoned.

C. If the motion detector is wired, the wiring shall be home run to the head-end control panel or zone expander, and loop supervision resistors shall be installed inside the motion detector.

D. Motion detectors are to monitor for device trouble and tampering.

E. Mount security devices a minimum of 3 feet from any heat or air movement sources.

3.4 DURESS / PANIC BUTTONS:

A. Authorized duress / panic button manufacturers: DMP, Honeywell, and Bosch

B. Duress / Panic type signals will neither be audible nor visible but will send a silent signal to the central monitoring station of the emergency.

C. Prior to starting any work coordinate with the owner and the millwork drawings and discuss the button mounting locations.

D. If the duress / panic buttons are wired, the wiring is to be home run to the head-end control panel or zone expander.

3.5 AUDIBLE SIREN:

A. Authorized audible siren manufacturers: DMP, Amseco, Elk, Potter, Honeywell.

3.6 RECHARGEABLE BACK-UP BATTERY:

A. Authorized rechargeable back-up batteries: Yuasa, PowerSonic, or Elk brand.

B. Minimum back-up and standby capacity shall be 24 hours.

3.7 INTRUSION DETECTION HEAD-END CONTROL PANEL PLUG-IN TRANSFORMER:

A. Provide one duplex outlet near the head-end control panel for the plug-in transformer. Transformer shall connect to outlet using the anchoring screw that is provided with the transformer.

PART 4 – INSTALLATION REQUIREMENTS:

4.1 CONTROL AND AUXILIARY EQUIPMENT:

A. Install the intrusion detection security system to the manufacturer's specifications and instructions. Utilize recognized industry practices, to ensure that the system and the equipment comply with the requirements. Comply with the requirements of NEC and applicable portions of NECA's "Standards of Installation" practices.

B. Coordinate all equipment locations and mounting details with other trades and suppliers.

C. System enclosures shall be surface mounted no higher than 72” AFF to the top off enclosure and installed only after all wallboard and painting work is complete. All wiring shall enter system enclosures through minimum 1 ¼” nipple located on the top far right-hand side of the enclosure. Plastic bushings are required on all nipples.

D. Provide at least one duplex receptacle on dedicated emergency powered circuit next to head-end intrusion detection panel.

E. Mounting: Coordinate & verify each device mounting with the owner(s). Mount security devices a minimum of 3 feet from heat or air movement sources.

F. Grounding: Provide grounding connections sufficiently tight to assure permanent and effective ground.

END OF SECTION 28 1600

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SECTION 28 2205

ACCESS CONTROL SYSTEM

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 work of this section.

B. Refer to Division 8 for the door hardware schedule and requirements.

C. Division 26, 27 & 28 basic materials and methods sections apply to work specified in this section.

D. Division 28 0501 Common Work Results for Electronic Safety & Security, apply to this section.

1.2 DESCRIPTION OF WORK:

A. Provide a complete and operating access control system as indicated in the plan drawings, schedules, diagrams, and specifications, and is hereby defined to include, but not be limited to: access control head-end panels, system server, operating software, controller boards, input/output boards, enclosures, power supplies, back-up batteries, credential card readers, raceway, outlets, cover plates, jacks, backboards, cabinets, grounding, IP video surveillance system integration, intrusion detection system integration, protective enclosures, and all required wiring.

B. The contractor shall furnish all cable, equipment, and materials whether specifically mentioned or not, to ensure the systems are complete and fully functional.

C. Contractor to provide all necessary labor, materials, tools, and equipment to meet the requirements and intent of the drawings and specifications. Unless otherwise specified, use standard system components from the manufacturer.

D. Contractor is responsible for coordinating with the Division 8 door hardware contractor to review the door hardware specification and ensure all components requiring a connection are installed.

E. Equipment lists are provided to set equipment expectations and may not be complete. Coordinate with devices shown on drawings for system intent. Provide a complete and functional system as described within the construction documents.

1.3 COORDINATION (ACCESS CONTROL SPECIFIC):

A. Coordinate with the owner, the Division 8 contractor, and Division 26 contractor prior to starting any work or rough-in to coordinate exact location and rough-in of end devices and door functionality. Carefully review Division 8 package (including door hardware schedule and specification) prior to bid and include all components requiring a connection by Division 26 & 28. Meet with Division 8 post-bid and prior to purchase of any equipment. It is not the Security Engineer's responsibility to complete the coordination between Division 8 and Division 26 & 28 for exact locations, connections, and rough-in.

B. All door hardware specified shall be reviewed upon award of the bid and before ordering any equipment.

C. During construction, each location showing equipment shall be walked by the contractor and any discrepancies on door hardware fit, finish, and function shall be brought to the architect and security engineer's attention immediately. It is the contractor's responsibility to provide a complete and a fully functional access control system and door openings.

D. Division 26, 27, and 28 contractors shall verify electrical service provided prior to ordering any electrical equipment serving electronic door hardware equipment and has the final responsibility for properly coordinating the electrical work, including the exact location of the electrical connection(s).

E. The contractor shall obtain and thoroughly review the door hardware submittal and the Division 8 door hardware specification and provide written notice of any discrepancies.

F. The contractor shall include all necessary wiring and programming for the fire alarm panel tie-in and door release and is responsible for scheduling and coordinating with the fire alarm contractor.

G. It is the contractor's responsibility to review the Division 8 door hardware specifications and schedule, to confirm which doors require fire alarm release.

H. Prior to starting any work coordinate with the owner, the Div.8 and Div.26 contractors and discuss how the ADA equipment will need to be programmed to operate with the access control system. The access control contractor shall include the necessary wiring to the ADA operators.

I. Coordinate all interfaces between door hardware and electrical contractor, including any additional panel interface modules and licensing to provide interface between PoE/wireless electronic locks.

J. Provide a dedicated 20-amp circuit for access control panel equipment.

1.4 QUALITY ASSURANCE:

A. Pre-Approved Manufacturer Certified & State Licensed Contractor:

1. Utah Yamas Controls

B. Bidders not pre-approved:

1. See Division 28 0501, Part 1.5.

PART 2 – PRODUCTS

2.1 GENERAL REQUIRMENTS:

A. Provide a complete and operable open platform / mercury-based access control system that meets the owner’s requirements, operates to the manufacturer specifications, and maintains building security.

B. The network appliance shall be able to run on an existing TCP/IP network and accessible, configurable, and manageable from any network-connected PC with a browser and/or client.

2.2 AUTHORIZED EQUIPMENT MANUFACTURE:

A. ICT Protégé GX Integrated Access Control System

2.3 GENERAL EQUIPMENT REQUIREMENTS:

A. Provide the necessary equipment as a baseline to ensure a fully functional access control system is provided:

1. Access Control Head-End Equipment, Control Boards, Power Supplies, Etc.

Description	Manufacturer

Protégé GX Integrated Access Control Server	ICT
Access Control Operation Software	ICT Protege GX Enterprise
Protégé GX Photo ID License	ICT
DIN Rail System Controller	ICT
DIN Rail 4A Intelligent Power Supply	ICT
Protégé Half DIN Rail 2 Reader Expander	ICT
Protégé DIN Rail 8 Input 4 Output Expander	ICT
Protégé GX 50 Door License	ICT
Intelligent System Controller	ICT
Integrated System Controller	ICT
Input / Output Controller Boards	ICT
Interface Module Network Repeater	ICT
Elevator Controller	ICT
Input / Output Expander	ICT
Cellular Modem	ICT
Lockable Enclosures with DIN rails	ICT
Electrified Door Hardware Power Supplies	LifeSafety Power or Altronix
12V 8Ah Rechargeable Back-Up Batteries	Yuasa, UltraTech, Power Sonic, Elk

2. End Devices

Description	Manufacturer
OSDP Wall Credential Card Reader	HID - Signo 40 - #40NKS-00-000000
OSDP Mullion Credential Card Reader	HID - Signo 20 - #20NKS-00-000000
Mifare DESFire Credentials (e.g: Cards, Mobile, Fobs)	ICT
Request to Exit Motion	Bosch - #DS160
Request to Exit Motion Trim Plate	Bosch - #TS160 (if applicable)
Push To Exit Button	Securitron - #EEB (or equivalent)
Momentary Door Release Button	Alarm Controls - #TS-18
Duress / Panic Button	Honeywell - #269R

B. Equipment lists are provided to set equipment expectations and may not be complete. Coordinate with devices shown on drawings, system risers and equipment list for system intent. Provide a complete and functional system as described within the construction documents.

1. The Div.28 access control contractor shall provide and install all integrated credential card reader electrified lockset combinations.
2. The Div.28 access control contractor shall provide all the power supplies for electrified door hardware equipment. Coordinate & verify with Div.8 contractor for the exact power requirements.
3. The Div.28 access control contractor shall coordinate, discuss, and verify with the architect, owner, Div.8 & 26 contractors the door hardware that is going to be provided & installed.
4. The Div. 8 door hardware contractor is responsible for providing and installing all of the door position contacts. And the Div. 28 access control contractor is responsible for providing and installing the wiring/cabling for the door position contacts that homerun back to the access control head-end panel(s).
5. The Div.28 access control contractor shall provide the request-to-exit motions and trim plates, push-to-exit buttons, momentary door release buttons, and duress/panic buttons that tie into and operate with the access control system.
6. Provide 1 year of software updates for access control software.

2.4 POWER SUPPLIES:

A. The DC voltage power supplies shall provide dual output fused ports of either 12 or 24

VDC and receive its power input from 120VAC. Units shall be expandable by adding additional modules for up to three power modules. Power modules shall provide power capabilities from 75 to 250W. The system shall provide configurations for power distribution, control & signaling, fire alarm interface, fail safe/fail secure locking control, and shall be a standard feature of the system.

B. Locate separate power supplies by the access control panels. Provide additional enclosures if needed.

C. Provide all access control panels and electrified door hardware power supplies with 12V sealed lead rechargeable backup batteries that will provide minimum standby power capacity for 24 hours.

D. Provide a category cable as required to each device for remote functionality such as control, status reporting, information logging, remote battery testing, fault reporting / restore, and shall interface with multiple control and monitoring modules to extend the remote functionality to multiple individual outputs for direct control, extended information gathering and reporting.

2.5 CREDENTIAL CARD READERS:

A. Connect contactless smart credential card reader with pigtail cable.

B. Tamper detection on the credential card readers shall be programmed to send a notification through the access control system in the event of damage or tampering.

C. Credential card readers must support mobile phone credentials.

D. All of the credential card readers being installed must be OSDP-compliant.

E. Mount card readers on a 4 square j-box with a single gang mud ring. Do not provide a junction back box for mullion style credential card readers; route wiring though mullion/door frame.

PART 3 – EXECUTION

3.1 INSTALLATION OF THE ACCESS CONTROL SYSTEM:

A. GENERAL: Install the access control system as indicated, in accordance with the equipment manufacturer's specifications, written instructions, and with recognized industry practices, to ensure that system equipment complies with requirements.

B. Comply with the requirements of NEC, and applicable portions of NECA's "Standards of Installation" practices.

C. Prior to starting any work, coordinate and verify the access control layout, wiring, equipment device locations, and mounting details with the owner, architect, and any other trades and suppliers that are applicable, and get written approval.

D. COORDINATION MEETINGS:

1. Meet at least twice with the door hardware systems installer. Hold the first meeting before the submittal of shop drawings to coordinate electronic door hardware components for each door, rough-in requirements, and door schedules. Hold the second meeting before the physical installation of components to verify raceway and cabling, equipment list, any changes have been accounted for, and site conditions for each area.
2. Review and coordinate access control system layout and wiring with owner.

E. NETWORK DEVICES: Provide network cables to all networked access control system

devices and coordinate the terminations.

F. Grounding: All grounding connections must be securely tightened to ensure a permanent and effective ground.

G. Testing: Upon completing the installation and energizing the systems, demonstrate that the systems comply with the intended design and functionality.

H. WIRING & TERMINATIONS: All components of this system will need to be in accordance with the manufacture's specifications & recommendations. All final connections shall be made by a qualified & certified technician familiar with the manufacture's equipment and adhering to the owner's procedures.

I. ON-SITE EQUIPMENT: The contractor shall provide their own installation equipment unless they have written permission from the owner to use any of the owner's equipment (lifts, ladders, tools, etc.) onsite. It is the contractor's responsibility to provide all labor and equipment costs in their proposals.

J. ZONING: Each detector, door position switch, and sensing device shall be considered a location. Multiple doors at a common entry can be considered one location. The system is to be programmed to log and detect individual status of a monitored door based on a schedule. Doors with a door position contact must have the ability to receive alerts for that specific opening if the door is opened during a certain time and/or left open for a specific time (60 seconds).

K. LABELING: The contractor shall develop and submit for approval a labeling system for the cable installation. Coordinate with the owner and negotiate an appropriate labeling scheme with the contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels, and wall plates. The labeling system shall designate the cable's origin and destination and a unique identifier for the cable within the system. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

1. All labels shall meet UL 969 requirements for legibility, defacement, and adhesion requirements. Handwritten labels are not allowed. All labels shall maintain consistent typeface, size, and color.
2. Provide laminated plans (minimum size 11x17) of all Security Systems as-built plans (including riser diagrams) at each telecom room/panel location.

L. Occupancy Adjustments: When required within one year of date of substantial completion, provide on-site assistance in adjusting and reprogramming to suit the actual occupied conditions. Provide 1 visit to the site for this purpose without additional cost.

M. Mounting Height: Credential card readers and intercoms should meet all ADA mounting requirements. Card readers shall be mounted 48" from the floor to the top of the card reader.

N. Request-To-Exit Motions: Prior to installation, coordinate with the owner each location of request to exit motions above each door.

O. Push-To-Exit Buttons: Prior to starting any work coordinate a meeting with the owner to discuss each push to exit button locations, and there mounting heights.

P. Provide all relays required to tie access control system into fire alarm system.

Q. ADA Operation: Prior to starting any work, the installation contractor must coordinate with the owner, as well as the Division 8 and Division 26 contractors, and discuss how the access control equipment will need to integrate with the ADA equipment.

R. ADA Door Operator Requirements: Configure and program the access control and ADA equipment to operate in compliance with International Building Code (IBC) standards. Provide and install all necessary cabling, relays, and other components required to integrate the access control system with the ADA equipment, ensuring a seamless

operation. The system must be programmed to meet the owner's specifications, including disabling the ADA equipment during lockout and closure periods to maintain security.

3.2 WIRING:

A. Pathway Requirements:

1. See specification 28 0501 for requirements.

B. Cabling:

1. See specification 27 1500 for category cable requirements.
2. All of the access control cable outer jacketing shall be Yellow; UL Listed; Stranded, and CMP rated.
3. Access Control OSDP Composite Cable:
   a. Access Control Composite Cable: Windy City Wire #4461030-OSDP.
4. Individual cabling for access control end devices:
   a. OSDP Credential Card Reader: (1) 22/1P OAS Lo-Cap, RS-485, 120 Ohms + 18-02 Twisted Non-Shielded, Jacketed, Stranded, UL listed, & CMP rated.
   b. Request-To-Exit Motion: (1) 22AWG 4/C, Jacketed, Stranded, UL listed, & CMP rated.
   c. Electrified Door Hardware Equipment: (1) 18AWG 4/C, Jacketed, Stranded, UL listed, & CMP rated.
   d. Door Position Contact: (1) 22AWG 4/C, Jacketed, Stranded, UL listed, & CMP rated.
   e. Push-To-Exit Button: (1) 22AWG 4/C, Jacketed, Stranded, UL listed, & CMP rated.
   f. Momentary Door Release Buttons: (1) 22AWG 4/C, Jacketed, Stranded, UL listed, & CMP rated.
   g. Panic / Duress Buttons: (1) 22AWG 4/C, Jacketed, Stranded, UL listed, & CMP rated.
5. The access control contractor shall provide, install, terminate, and test all necessary communication cabling to facilitate seamless communication between the existing access control panel and the new access control panel. Cabling must meet industry standards, be properly labeled, and organized. Post-installation testing is required for performance verification. Compliance with relevant regulations and guidelines is mandatory.
6. Wiring by Divisions 26: The electrical connections/terminations for certain equipment provided under door hardware divisions has not been specifically indicated on the electrical drawings and must be provided by and field coordinated by the door hardware trade requiring such electrical connections. Electrical contractors shall review architectural drawing, and door hardware specifications and coordinate with said contractors to confirm electrical needs.

3.3 SYSTEM CONFIGURATION AND PROGRAMMING:

A. Configure the system so it is fully functional. Include owner in the process as much as feasible to understand their intent of the operation and to ensure full transfer of operations to them.

B. Provide a fully functional and operational system to ensure the entire system is operating as intended and in accordance with the owner's policy.

C. Label all cables on both ends in all boxes, panels, and racks according to owner's standards.

D. The contractor shall include in the base contract all costs required to program lockdown procedures based on the owner's requirements and direction.

E. The contractor shall include necessary programming for fire-alarm panel tie-in and door release based upon the requirements and direction of the owner and/or AHJ.

F. The contractor shall input a database of all required card holders and desired schedules for users and/or groups. It is the contractor’s responsibility to coordinate with the owner on which card holders have access to which openings.

END OF SECTION 28 2205

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SECTION 28 2300

IP VIDEO SURVEILLANCE SYSTEM

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 work of this section.

B. Divisions 26, 27, & 28 Basic Materials and Methods sections apply to work specified in this section.

C. Refer to specification 27 1500 Telephone Data Systems for the specified CAT6 category cable, connectivity specifications, additional pathway requirements, and installation standards.

D. All unshielded twisted pair (UTP) CAT6 category cable for the IP surveillance camera equipment used on this project shall match the horizontal cabling within the building.

1.2 DESCRIPTION OF WORK

A. The extent of the IP video surveillance system work is indicated by the drawings and is hereby defined to include, but not be limited to raceway, outlets, coverplates, backboards, cabinets, grounding, and any other miscellaneous items that are required to provide a complete raceway system.

B. All of the active IP surveillance equipment and programming will be provided by the owner. But all of the IP surveillance equipment will be installed by the Division 28 security contractor.

C. Refer to the other Division 26 and 27 sections for requirements for raceways, trays, boxes and fittings, and supporting devices, category cabling, and other sections, as applicable.

D. The Div.27 contractor is to provide the following cable to IP surveillance cameras:

1. Interior (indoors) IP Surveillance Cameras: To each camera provide one green-jacketed CAT6 UTP, 4-pair, CMP rated category cable.

2. Exterior (outdoors) IP Surveillance Cameras: To each camera provide two green-jacketed CAT6 UTP, 4-pair, CMP rated category cable and coil the cables inside the building.

3. Provide industry-standard service loops at both ends of the CAT6 cables.

4. Home run each CAT6 category cable from the IP surveillance camera back to the designated telecommunications equipment rack, terminated into the assigned patch panel, and tested.

5. Provide the following equipment:

   a. Terminate one CAT6 jack/module to the CAT6 category cable and install it into a surface mount box inside the cameras junction backbox.

   b. Provide one green CAT6 patch cable that goes from the jack/module to the IP surveillance camera.

E. The specified CAT6 cabling for the IP video surveillance cameras and recording system will be provided by the Division 27 low voltage cabling contractor, ensuring a single installer and unified cable warranty.

F. All of the IP surveillance camera symbols that are indicated on the system plan pages are for rough-in reference.

G. It is the Division 26 electrical contractor's responsibility to coordinate with the owner and the Division 28 security contractor prior to starting any work to review each of the IP video surveillance equipment and their rough-in requirements (e.g.: junction box sizes, camera locations, heights, orientation, head-end NVR location).

H. Contractors shall provide all labor, materials, tools, and equipment required for the complete installation of work.

1.3 QUALITY ASSURANCE:

A. Comply with applicable portions of NEC, NECA, ANSI/TIA and ANSI/BICSI:

1. NEC as to type products used and installation of components.
2. NECA's "Standards of Installation" practices.
3. ANSI/TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
4. ANSI/BICSI 005 - Electronic Safety and Security (ESS) System Design and Implementation Best Practices.

B. Provide products and materials that have been UL-Listed and labeled.

1.4 COORDINATION:

A. Prior to starting any work coordinate a meeting with the owner and discuss each of the device's location, their heights, orientation, and pathway requirements in each area.

B. Notify the engineer of any modifications between contract documents and submittals. It is the contractor's responsibility to ensure compliance with the documents.

PART 2 – PRODUCTS

A. GENERAL: Provide a complete raceway system for the IP video surveillance systems including but not limited to, raceway, outlets, coverplates, backboards, cabinets, grounding, cabling, connectors, and miscellaneous items as required.

PART 3 - EXECUTION

3.1 INSTALLATION OF THE SECURITY RACEWAY SYSTEM:

A. GENERAL: Install raceway system as indicated to comply with NEC and recognized industry practices.

B. Electrical contractor shall provide ¾" EMT conduit from each IP surveillance camera junction box up to the accessible ceiling space, then utilize non-continuous cable support devices (e.g.: j-hooks) to the designated equipment room and over to the designated telecommunications equipment rack; and utilizing cable tray if on project.

C. Provide pulling twine in all installed raceway and conduits.

D. Provide all stubbed-out conduit ends with plastic or nylon bushing.

E. No splicing is allowed on any of the cabling, and the specified CAT6 category cabling.

F. GROUNDING: Provide a #6 bare copper ground cable from each security system control panel to the service entrance ground. Enclose the grounding cable in an appropriate raceway for its entire length, coiling six feet of conductor at each terminal board. Make the final connection at the service entrance ground.

END OF SECTION 28 1601

SECTION 28 3111

FIRE ALARM AND DETECTION SYSTEM

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 work of this section.

B. Division-26 Basic Materials and Methods sections apply to work specified in this section.

1.2 DESCRIPTION OF WORK:

A. Provide a new addressable fire alarm and detection system.

1. Locate FACP Panel within the MDF/Equipment Room.
2. Provide and install NAC/booster panels as needed throughout the project.

B. Provide new duct smoke detectors and fan relays at all fan units 2000 CFM and over. Shut down all supply and return fans upon a general alarm signal.

C. Provide CO detectors, Monitor Module and fan relays at all gas fired fan units. Shut down all supply and return fans upon a general alarm signal.

D. Install all wiring in steel conduit (3/4" minimum). All conduit runs shall form a complete loop from the fire alarm control panel.

E. Provide vandal resistant cages to protect horn/strobes, smoke and heat detectors as indicated on drawings and, in gyms whether shown or not. Securely fasten security cages as required. Provide backing and bracing as required to ensure that attachment extends beyond the ceiling materials. Cages shall have two pieces, one backplate and one cover to attach to backplate. Provide cages/guards on horn/strobes that are clear and do not limit their effect on the field performance with the listing requirements.

F. Comply with NEC as applicable to construction and installation of fire alarm and detection system components and accessories. Provide components and systems, which are UL-listed and labeled for fire alarm. Provide fire alarm and detection systems and accessories, which are FM approved. Comply with State and local requirements as applicable.

G. The fire alarm system supplier shall be UL, UUJS Listed as a Local, Auxiliary, Remote Station, and Proprietary Signaling Services company. The UL Certification number shall be submitted with the bid documentation.

H. The project shall be UL Certificated. Upon completion of the project, provide to the owner, a certificate from the UL Listed supplier with the project specific certificate. Certificate and number shall be documented and included as part of the closeout documentation.

I. Ensure that the fire alarm supplier has a minimum of (1) NICET Level IV, and (3) NICET Level III technicians on staff.

J. Comply with applicable provisions of current NFPA Standard 72 National Fire Alarm and Signaling Code (as applicable), local building codes, the most current adopted revision

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of the International Building Code (IBC), the International Fire Code (IFC), the International Mechanical Code (IMC), and meet requirements of local authorities having jurisdiction.

K. **Carefully review all Division 23 drawings for all fire/smoke and smoke dampers. Fire/smoke and smoke dampers are NOT shown on electrical plans. Electrical contractor is responsible for coordinating 120V power to all dampers and providing fire alarm connections to each one. See mechanical drawings for all locations.**

L. Coordinate exact quantity and locations of all fire sprinkler system tamper and flow switches with fire sprinkler drawings. Provide and connect all tamper and flow switches to fire alarm system.

M. Provide a fire alarm duct detector within 5-feet of any fire/smoke damper as required to comply with IMC 607.5.4.1. The duct detector shall be listed for the air velocity, temperature and humidity at the point where it is to be installed. A duct detector will not be required at a fire/smoke damper located on a corridor wall where the corridor has smoke detection devices installed. For dampers installed within an un-ducted opening in a wall, a spot-type detector listed for releasing service shall be installed within 5-feet horizontally of the damper. Provide a fire alarm relay at each fire/smoke damper. Provide a test switch at each location where the damper is located above an inaccessible ceiling or is located more than 10 feet above the finished floor. Coordinate the location of test switches with owner/architect.

1.3 QUALITY ASSURANCE:

A. Installer:

1. Fire alarm equipment supplier shall be a Gamewell-FCI Platinum Level Distributor and UL Listed Installer.
2. Integrating firm shall have worked satisfactorily for a minimum of (5) years of completing systems equal to this scope, quality, type and complexity.
3. Key personnel assigned to the project shall each have minimum of (10) years of experience in completing systems equal to this scope, quality, type and complexity.
4. Contractor shall be a factory authorized distributor of all equipment specified for the geographical area of the project.
5. Contractor shall maintain complete installation and service facilities for the duration of the project contract.
6. Contractor shall have current manufacturer certificates for all fire alarms systems and equipment listed within this specification.
7. Contractor shall be in good standing with owner based on previous projects.
8. Contractors that do not meet the above requirements cannot bid on this project.

B. All work shall be done by expert technicians qualified in the field with knowledge of specified systems. Workmanship shall comply with industry best practices concerning grounding, shielding, cable dressing, cable termination and equipment mounting.

C. PRE-APPROVED INSTALLERS:

1. Nelson Fire Systems
   a. Ben Nelson, (801) 468-8300, 1481 S. Major St, Salt Lake City, UT 84115
2. Bids submitted by non-approved installers will not be accepted.
3. Bidders not pre-approved shall submit in writing the following for review at least (8) working days prior to bid:

a. List of qualifications including:
   i. Industries certifications including manufacturers.
   ii. Approved resale manufacturers.
b. Past and current projects within the last 5 years similar in scope and size.
c. (3) Different referrals from the owners of (3) different projects within the last 5 years.

1.4 SUBMITTALS:

A. Refer to Section 260502 for electrical submittal requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. MANUFACTURER: Provide fire alarm and detection system of Gamewell-FCI; By Nelson Fire Systems. Fire alarm supplier shall be Gamewell-FCI Platinum Level Distributor.

2.2 FIRE ALARM AND DETECTION SYSTEMS:

A. GENERAL: Provide an electrically operated, electrically supervised fire alarm system as described herein. Include control units, power supplies, alarm initiating and indicating devices, conduit, wire, fittings and accessories required to provide a complete operating system. Enclose entire system in raceway. Provide basic wiring materials which comply with Division 26, Basic Materials and Methods Sections for raceways, conductors, boxes, fittings, supports, etc. Minimum wire size to be #14 AWG copper.

B. SYSTEM TYPE: Analog addressable, non-coded. Either manual activation of a fire alarm station or activation of an automatic initiating device energizes all fire alarm signaling devices, sounding a non-coded alarm and providing device identification on an annunciator panel.

C. SYSTEM OPERATION: Provide system such that any manual station or automatic initiating device annunciates all alarm indicating units (bells, horns, buzzers, chimes, visual alarm lamps, etc.) continuously until the manual station or initiating device is restored to normal and the fire alarm control unit reset. Annunciate alarm signals by device at the control panel and all remote annunciators. Provide all conductors, raceway, equipment and labor to accomplish the following:

D. Deactivate air supply and return fan units simultaneously by means of a supervised master fan shutdown relay with slave relays as required. Restart air units automatically after panel has been reset. Provide a bypass switch for master fan shut down relay for drill purposes, and indicate by a locked-in lamp that the circuit has been bypassed.

E. Selectively activate and/or deactivate fan units as required.

F. Release all magnetic door holders upon activation of an alarm from any device by use of a master relay in the control panel.

G. Provide supervised circuits for the following:

1. Close dampers upon activation of an alarm from any device through the HVAC interface relays at the Fire Command Center.

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2. Recall elevators, upon activation of an alarm, to the floor of building egress unless the alarm is on the egress floor, in which case recall elevator to the level designated by the Fire Marshall. Cooperate with the elevator supplier to ensure complete operable system. Provide shunt trip breaker(s) as required.

H. Central Station Monitoring. Provide an interface to the building security panel for fire alarm signal transmission to the district central station. Provide dry contacts at the main fire alarm control unit for 'Alarm', 'Supervisory', and 'Trouble'. Connections shall be supervised by the security alarm panel.

I. Provide fire alarm control panel with capability of shutting down individual initiating devices for maintenance purposes without affecting the continued operation of other initiating devices.

J. Provide manual fire alarm stations in boiler rooms, kitchen and main administrative office.

K. Provide external alarm horns sufficient to be heard in all outdoor within the vicinity of the building.

L. Sprinkler Supervision. Provide a signal initiating and supervisory circuit to each PIV (post indicator) valve, and to each sprinkler riser and subdivision. Provide continuous alarm signal upon actuation of any water flow signal initiating device. Sound alarm until the condition has been corrected and the panel manually reset as required by UL864. Provide separate alarm zones for: (1) alarm zones from "waterflow alarms", (2) alarm zones from "supervisory alarm" indicating sprinkler system trouble. Provide 120 VAC power to all alarm bells furnished under Division 23. Review final fire sprinkler drawings and coordinate for panel, flow and tamper switch locations.

M. Provide relays, monitor modules and connections as required at control panel of kitchen hood suppression system for initiation of alarm signal to fire alarm control panel. Connect hood suppression control panel to shunt trip breakers as required.

N. Provide all required wiring from gas shut off valve to the hood suppression control panel. Make all connections to insure a properly operating system. Verify with Mechanical Contractor.

2.3 FIRE ALARM CONTROL PANEL:

A. The fire alarm control panel shall be microprocessor-based. Each loop shall be capable of 159 analog addresses and 159 monitor and/or control addresses.

B. The fire alarm control panel shall contain a 80 digit alphanumeric display and permit the user to perform all necessary functions including but not limited to the following:

1. Alarm/Trouble Acknowledge.
2. Alarm Silence
3. Reset
4. Lamp Test
5. Control of Initiating Devices (on/off)
6. Control of output modules (on/off)
7. Change sensitivity of devices
8. Change time
9. Walk test
10. View 4000 event history log.

C. The fire alarm control panel shall be capable of alarm verification. The control panel shall indicate which smoke detector is in alarm during the pre-alarm window.

D. All alarm signals shall be locked in at the panel until the operated device is returned to it's normal condition and the control panel is manually reset.

E. Alarm or trouble activation of initiating points shall be represented in English on the alphanumeric display on both the remote operating panel and the fire alarm control panel indicating the address of the specific device, i.e. Device L4S76, Smoke Detector, 1st floor Rm. 17.

F. Each initiating and signal circuit shall be electrically supervised for opens, shorts, and ground faults in the wiring.

G. The occurrence of any fault shall activate the system trouble circuitry but shall not interfere with the proper operation of any circuit that does not have a fault condition.

H. The system communication loops shall be capable of being wired using Class "A" (Style 6) supervised circuits (a ground fault on either conductor or a break shall not prevent a device from operating on either side of the break)

I. The fire alarm control panel shall contain circuitry permitting the transmission of trouble and alarm signals over leased phone lines by the means of reverse polarity. There shall be a supervised disconnect switch to allow testing of the fire alarm control panel without transmitting an alarm to the central station.

J. The fire alarm control panel shall include the following features.

1. Auxiliary SPDT fire alarm actuated contacts.

2. Auxiliary SPDT supervisory alarm actuated contacts.

3. Auxiliary SPDT trouble actuated contacts.

4. A solid-state power transfer circuit that shall switch to standby power automatically and instantaneously if normal power fails or falls below 15% of normal ("brown out" conditions). This electronic circuit shall allow the batteries to be effectively "floated" on the operating system to avoid upsetting the normal microprocessor scan and minimize resultant nuisance troubles and/or alarms.

5. A ground fault detector to detect positive or negative grounds on the initiating circuits, signal circuits, power circuits, and telephone line circuit. A ground fault code on the alphanumeric display shall provide indication of either a positive or negative ground fault and shall operate a general trouble but shall not cause an alarm to be sounded.

6. A short circuit error message shall be a standard feature of the fire alarm control panel. Each communication loop shall be monitored and shall have a distinctive error message.

7. Lightning protection shall be a standard feature of the fire alarm control panel and shall be incorporated in the power supply circuit, common control circuits, signal circuits, and telephone line circuit.

8. Individual PTC overcurrent protection shall be provided for the following: smoke detector power, main power supply, signal circuit #1, signal circuit #2, battery standby power, and auxiliary output.

9. The fire alarm control panel shall be of dead-front construction. One key shall allow access to all operator functions.

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10. Opening the main door shall expose all components for inspection or adjustment without further dismantling of the cabinet, control unit, or wiring.

11. It shall be possible to check and adjust the sensitivity of all analog devices from the main fire alarm panel.

K. The fire alarm control panel shall have batteries capable of powering the system for (24) hours in standby condition and (5) minutes in alarm.

L. There shall be no special tools required for the programming of devices. A standard slot head screwdriver only.

M. Provide (16) separate bypass switches for the functions listed below with separate red, green, and yellow LED's per switch:

Strobe/Horn bypass
Fan/Damper shutdown bypass
Door holder bypass
Separate switch for each addressable loop bypass

Owner shall designate purpose for any unused switches.

N. Provide one (1) Gamewell-FCI ANX-SR and one (1) Gamewell-FCI FP-GATE-3 for interface to existing district Gamewell-FCI FocalPoint system. Provide new graphics and populate all new fire alarm system point information. Test communication signals from building to FocalPoint system. Two (2) network IP addresses at the new fire alarm control unit will be required for connection to the FocalPoint system. Coordinate with the district IT department for network connections.

O. In the event of a power outage, the control panel shall be capable of storing and printing the last 4000 events, including during the power outage.

2.4 REMOTE OPERATING PANEL: Gamewell-FCI Model: LCD-E3

A. Remote Operating Panel (Provide color as selected by Architect)

B. The Remote Operating Panel shall contain 80 digit alphanumeric display providing status of all devices including the fire alarm control panel.

C. The Remote Operating Panel shall permit the user to perform all necessary functions including but not limited to the following:

1. Alarm/Trouble Acknowledge
2. Alarm Silence
3. Reset
4. Lamp Test
5. Control of Initiating Devices (on/off)
6. Control of Output Modules (on/off)
7. View Event Log
8. Change time
9. Walk test

2.5 MONITOR MODULE: Gamewell-FCI Model: AMM-2F/AMM-4F

A. Remote identification module devices shall be attached to any single normally open initiating device (heat detector, waterflow switch, duct detectors, sprinkler, tamper switches, kitchen hood, pull station, etc.). The modules shall supply addressing and status information to the Fire Alarm Control Panel through the signaling line circuit.

2.6 CONTROL POINT MODULE: Gamewell-FCI Model: AOM-2RF

A. The control point module shall be connected to the same loop as the initiating devices, and shall provide two relay outputs (Form "C" 2 Amp @ 30 VDC, resistive only).

B. This relay output shall be used to perform auxiliary functions.

C. When the AOM is activated, the red "ACTIVE" LED shall be on solid. Under normal conditions, the green "ON LINE" LED shall flash.

2.7 DOOR HOLDER:

A. Supplied by door hardware installer and installed by division 26. Provide DC power supply as required.

2.8 MANUAL FIRE ALARM STATION: Gamewell-FCI Model: MS-7AF

A. Provide red enclosure, manual fire alarm stations with the following features:

1. suitable for semi-flush mounting.

2. Addressable alarm type electrically compatible with system requirements.

3. Double Action

2.9 PHOTOELECTRIC DETECTORS: Gamewell-FCI: ASD-PL3/B300-6 BASE

A. All photoelectric detectors shall be capable of being replaced without disconnecting any wires or wire connectors from the base of the detector. Each detector shall be installed on a separate base. The detector base shall be capable of receiving a photoelectric, ionization, or electronic thermal detector. All photoelectric detectors shall be UL 268 listed. All detectors shall have two viewable LEDs to indicate the status of the device.

2.10 DUCT FIRE DETECTORS: Gamewell-FCI Model: DNR

A. Provide photoelectric type with UL 268A listings. If duct smoke detector is not readily accessible, provide with a remote indicating light and remote test station.

2.11 THERMAL DETECTORS: Gamewell-FCI Model: ATD-L3R/B300-6 BASE

A. Thermal detectors shall operate on the Rate-of-Rise principal. The detectors shall have a fixed temperature rating of 135 degrees Fahrenheit. Exception: in Boiler rooms, provide temperature rating of 200 degrees Fahrenheit.

1. The heat detector shall consist of a base and a head.

2. The base shall be capable of accepting either a smoke detector or a 135 (or 200) degree heat detector.
3. The head shall automatically restore to its normal standby condition when the temperature returns to its normal range.

2.12 AUDIOVISUAL ALARM HORNS: Gamewell-FCI Model: P2W/P2RK

A. Provide audio-visual alarm horns with selectable multi-candela strobes (15/30/75/110 cd) and selectable horn (90 or 95 dba). Provide outdoor devices listed for exterior use. Provide white devices inside and red devices outside. Synchronize all strobes.

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2.13 VISUAL ALARM STROBES: Gamewell-FCI Model: SW

A. Provide visual alarm strobes with selectable multi-candela strobes (15/30/75/110 cd). Provide white devices. Synchronize all strobes.

2.14 CARBON MONOXIDE (CO):

A. Provide a System Sensor CO1224R carbon monoxide detector with Realtest Technology. Provide detectors with the following features:

1. Compliance with UL2075.
2. Trouble relay.
3. Wiring supervision with SEMS Terminals.
4. A six year end-of-life timer.
5. Sounder base for sound audible alarm.

2.15 VISUAL ALARM STROBE (CO detection) (Gamewell-FCI Model SCW-P)

A. Provide a white ceiling mounted visual alarm strobe with a CO label and a blue lens #LENS-BC.

2.16 AUXILIARY RELAY: Gamewell-FCI Model: PR-1

A. Remote auxiliary relay boards shall be rated at 10 AMPS @ 120 VAC. A red LED shall light to indicate relay activation. All relays shall transfer on general alarm and latch on until reset. All relays shall be supervised. The control output provided can be used in conjunction with fire alarm applications (i.e. fan controls, dampers, doors, and any other general alarm control).

2.17 INITIATING MODULES: Gamewell-FCI Model: AMM-4F

A. Provide style "6" initiating modules capable of receiving and annunciating an alarm from any detector, even with a single fault condition on any initiating circuit.

B. Power all smoke detectors from the "Style 6" initiating loop wiring. For systems which power smoke detectors separately from the "Style 6" loop, provide monitoring for both the power source and the independent initiating wiring, so that complete trouble and alarm indication is achieved by loop. Provide capability to operate all smoke detectors, even with a single fault condition on the smoke detector power wiring.

2.18 SIGNALING MODULES: Gamewell-FCI Model: AOM-2SF

A. Provide signaling as required. Provide power adequate to sound all signaling devices concurrently. Provide supervised indicating circuits for polarized 24V D.C. alarm signaling devices.

2.19 SUPPLEMENTAL NOTIFICATION CIRCUITS: Gamewell-FCI Model: HPFF8

A. Provide supplementary notification appliance circuit panel(s) as required. The ‘SNAC’ shall be capable of supplying up to four Class A, Style Z notification appliance circuits. The panel shall contain its own battery charger, regulated power supply, and shall be supervised for ground fault, overcurrent, open circuits and low battery conditions. Ground fault, battery and circuit trouble conditions shall transmit a trouble signal to the main fire alarm control panel.
Locate all Supplementary Notification Appliance Circuit power supplies as indicated on drawings.

2.20 SYSTEM CONFIGURATION PROGRAMMING:

A. To help the owner in programming, system changes, and servicing, the fire alarm system shall have the following functions:

1. The FACP shall be capable of an auto-configuration, which, via a password, all analog devices and panel modules are automatically programmed into the system. At this point the system will operate as a general alarm system without any other programming.

2. If any two devices are addressed the same, the LED's on both devices will light steady and the panel will read "extra address with the address number".

3. If any device is installed and not programmed into the system, the LED will light steady and the panel will read the same as above.

2.21 BATTERIES/POWER SUPPLIES:

A. Provide standby batteries capable of operating fire alarm system for minimum of 24 hours, then operating all indicating units for at least five minutes. Locate batteries in fire alarm control unit, or in similar type enclosure located as directed. Provide all interconnecting wiring. Place batteries which vent hydrogen gas in separate enclosure. Provide 30 percent spare capacity.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS:

A. Install fire alarm and detection systems as indicated, in accordance with equipment manufacturer’s written instructions and complying with applicable portions of NEC and NECA’s “standard of installation”.

B. Install wiring, raceways, and electrical boxes and fittings in accordance with Division 16 Basic Materials and Methods section, “Raceways”, “Wires and Cables”, and “Electrical Boxes and Fittings”, and in accordance with other sections, as applicable. Label all junction boxes “F.A.” and paint box and cover red, per Section 16135.

C. All wire used on the fire alarm system shall be U.L. Listed as fire alarm protective signaling circuit cable per NEC, Article 760.

D. If twisted or shielded wire is required or recommended by the manufacturer it must be used.

E. Review proper installation procedure for each type of device with equipment supplier before installation.

F. Provide Two (2) network IP addresses at the new fire alarm control unit for connection to the FocalPoint system. Coordinate with the district IT department for network connections.

G. Coordinate the mechanical units that are protected by Carbon Monoxide Detectors and shut down the unit upon detection of CO. Verify exact requirements with the Fire Marshal.

H. Label the end of wires in all boxes including panel, power supplies, pull boxes, etc.V

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I. Label circuit breaker feeding fire alarm panel: “Fire alarm circuit”. Use plastic laminate label, white letters on red background.

J. Where smoke or heat detectors are specified, install device a minimum of three feet from adjacent air supply diffusers to ensure proper operation of device.

K. Refer to NFPA for spacing and exact placement of fire alarm devices.

L. Provide one set of approved, stamped, fire alarm system drawings on site throughout construction, and make available for Fire Marshal reference.

M. Upon completion of the Fire Alarm System Installation, a test of the entire fire alarm and CO monitoring system is required prior to a scheduled inspection in the presence of a representative from the Utah State Fire Marshal’s Office. Include a 24-hour secondary power test.

N. Provide one set of instructions on operation of the Fire Alarm System and one set of the As-Built Drawings in a cabinet, located at or near the Fire Alarm Control Unit (FACU), or Fire Alarm Control Panel (FACP) as approved by the Architect and Fire Marshal. Label the cabinet “SYSTEM RECORD DOCUMENTS”.

3.2 GUARANTEE:

A. Furnish a three-year guarantee for all equipment, materials and installation, including all labor, transportation, and equipment.

B. Emergency Response. The fire alarm equipment supplier shall provide an emergency response within four hours of any reported system failure to resolve the problem on a continuous basis.

3.3 PRE-TEST:

A. The contractor shall with a representative of the manufacturer conduct a test 3 days before the final test to verify operation of all devices. Any problems must be corrected before the final test.

3.4 FINAL TEST:

A. Before the installation shall be considered completed and acceptable, a test on the system shall be performed as follows:

1. The contractor's job foreman, a representative of the manufacturer, a representative of the owner, shall operate every building fire alarm device to ensure proper operation and correct annunciation at the control panel. Fan shutdown and door holder circuits shall operate.

2. Conduct a full 24 hour test of battery operation. System shall be put on the batteries for a full 24 hours and all notification appliances shall be operational for a period of 5 minutes.

3. The supervisory circuitry of the initiating and indicating circuits shall also be verified.

4. Provide printout demonstrating successful performance of all devices.

3.5 LABELING:

A. All devices shall be labeled with their appropriate address. The labels shall be 18 point pressure sensitive labels.

B. All initiating devices shall be programmed to include the device address and a complete user text English location description, i.e. Device L4S76, Smoke Detector, 1st floor Rm.17.

C. Label the end of all wires in all boxes including panels, power supplies, pull boxes, etc.

3.6 RECORD DRAWINGS: Refer to Section 26 0502 for requirements.

3.7 TRAINING:

A. Provide four (4) hours training on the operation and installation of fire alarm system, at job site, at no cost to owner.

END OF SECTION 28 3111

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RIVERVIEW JR. HIGH SCHOOL REBUILD

ERCES 700MHz ASSESSMENT

Prepared By:

GROOVE TECHNOLOGY SOLUTIONS

6849 S 700 W, Midvale, UT 84047

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1.0 SCOPE OF WORK

Provide a turn-key 700MHz Class A public safety DAS solution for the Riverview Jr. High School rebuild. Integrator(s) must conduct their own due diligence in accordance with local building and fire codes as set forth by the local AHJ and FCC license holder(s).

1.1. APPROVED EQUIPMENT

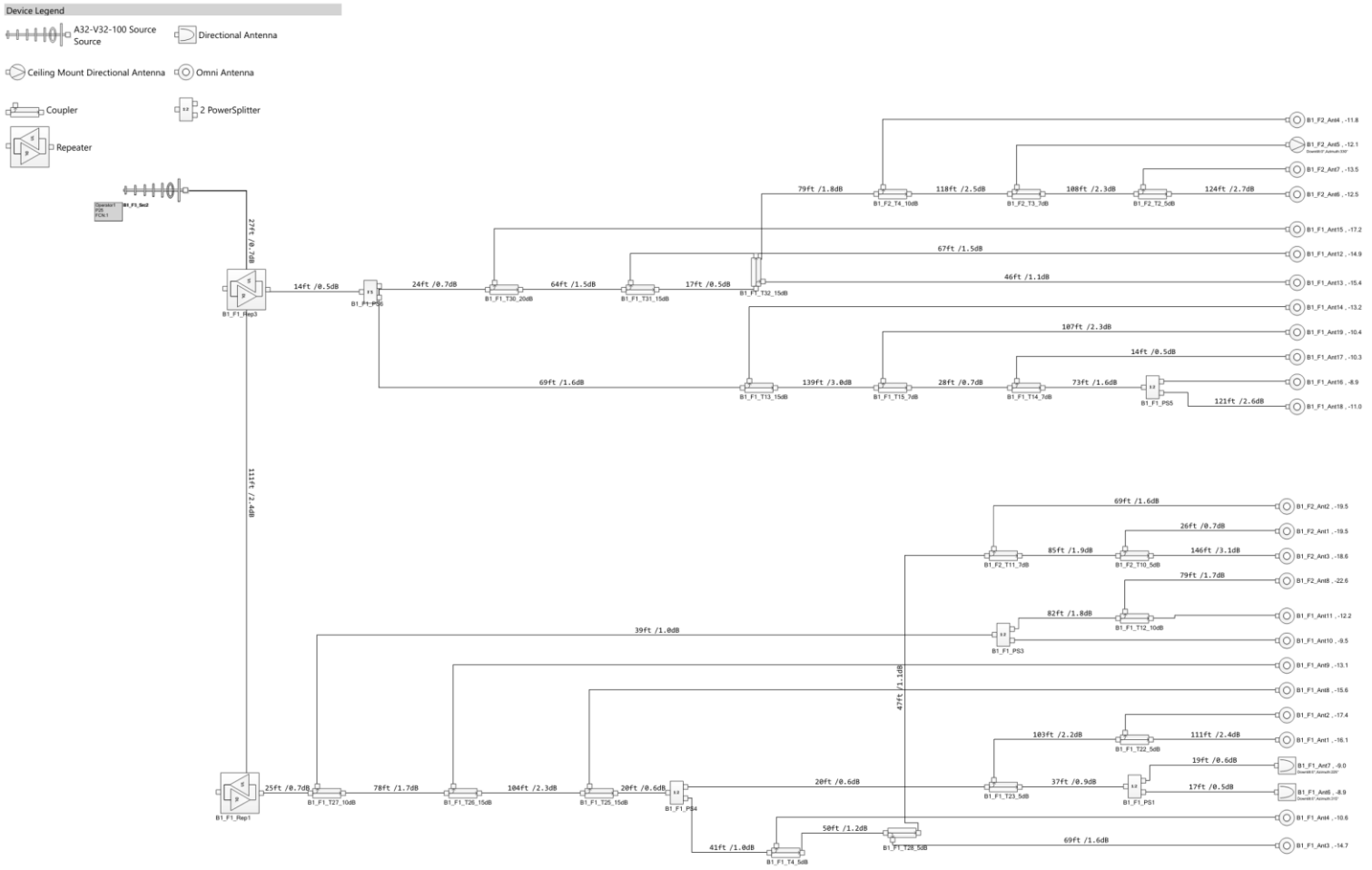
DAS HEADEND- Nextivity SHEILD EXTEND 1W-6W Fiber DAS
COAXIAL CABLE- RFS PLENUM ICA12-50JPLLR
ANTENNAS- Nextivity Low Profile SISO
CONNECTORS- L4TNM-PSA/COMMSCOPE

1.3 SITE ANALYSIS

Riverview Jr. High School 751 Tripp Ln. Murray, Utah 84123	
Recommended Donor Site(s)*	
SLCO Jail- Primary	
40.69721980447574, -111.91461318791812	
Frequency List	
769.15625c 769.21875 769.41875 769.54375 771.06875 771.10625 771.15625 771.41875 771.51875 772.03125 772.13125 772.26875 772.35625 772.61875 773.43125 773.68125 773.71875 773.95625 774.15625 774.19375 774.33125 774.40625 774.55625 774.68125c	
High Site to Project Site Estimated Distance	
3.59mi LOS	
Estimated Free Air Path Loss	
164.6	
* Provided by Utah Communications Authority. Although the SLCO Jail was the recommended site, other suitable sites and/or frequencies may exist.	

SLCO Jail to Riverview Jr. High- Elevation Profile

1.4 NETWORK SYSTEM DIAGRAM



Plan Name	NETWORK SYSTEM DIAGRAM	Date	02/01/2025		GROOVE TECHNOLOGY SOLUTIONS
Project Name	RIVERVIEW JR HIGH ERCES				
Designer Name	SH			Company Name	GROOVE TECHNOLOGY SOLUTIONS

1.5 ANTENNA LINK BUDGET REPORT

Antenna Link Budget Report

Project Name:	Riverview Jr High-BNA	**Design Company:**	Groove Technology Solutions
Project Creation Date:	1/17/2025	**Designer:**	SH

Antenna ID	System ID	Antenna Gain (dBi)	System Pilot (dBm)	System Total (dBm)	Antenna Pilot (dBm)	Antenna Power Per Channel (dBm)	Coupler				
							Tap Loss				
							Generic				
							T-05-NF		T-07-NF		T-10-NF
							5(dB)		7(dB)		10(dB)
							Quantity	Subtotal(dB)	Quantity	Subtotal(dB)	Quantity
B1_F1_Ant12	B1_F1_Src2_WFEEHWKJ	3		-80		-14.9					
B1_F1_Ant13	B1_F1_Src2_WFEEHWKJ	3		-80		-15.4					
B1_F1_Ant14	B1_F1_Src2_WFEEHWKJ	3		-80		-13.2					
B1_F1_Ant15	B1_F1_Src2_WFEEHWKJ	3		-80		-17.2					
B1_F1_Ant16	B1_F1_Src2_WFEEHWKJ	3		-80		-8.9					
B1_F1_Ant17	B1_F1_Src2_WFEEHWKJ	3		-80		-10.3			1	7	
B1_F1_Ant18	B1_F1_Src2_WFEEHWKJ	3		-80		-11					
B1_F1_Ant19	B1_F1_Src2_WFEEHWKJ	3		-80		-10.4			1	7	
B1_F2_Ant4	B1_F1_Src2_WFEEHWKJ	3		-80		-11.8					1
B1_F2_Ant5	B1_F1_Src2_WFEEHWKJ	3		-80		-12.1			1	7	
B1_F2_Ant6	B1_F1_Src2_WFEEHWKJ	3		-80		-12.5					
B1_F2_Ant7	B1_F1_Src2_WFEEHWKJ	3		-80		-13.5	1	5			

Coupler													
Tap Loss					Thru Loss								
Generic					Generic								
T-10-NF	T-15-NF		T-20-NF		T-05-NF		T-07-NF				T-10-NF		T-15-NF
10(dB)	15(dB)		20(dB)		1.7(dB)		0.9999995(dB)		1(dB)		0.9000001(dB)		3199999(d
Subtotal(dB)	Quantity	Subtotal(dB)	Quantity	Subtotal(dB)	Quantity	Subtotal(dB)	Quantity	Subtotal(dB)	Quantity	Subtotal(dB)	Quantity	Subtotal(dB)	Quantity
	1	15											
	1	15											1
	1	15											
			1	20									
									2	2			
									1	1			
									2	2			
10													2
											1	0.9	2
					1	1.7	1	1			1	0.9	2
							1	1			1	0.9	2

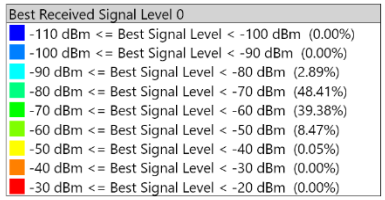
Coupler					PowerSplitter		Cable		Repeater		Connector	
Thru Loss					Loss				Loss		Loss	
Generic					Generic		Generic		Generic		Generic	
T-15-NF			T-20-NF		PS-02-NF		CAB-12F		RP-1W-NF		N-J1/2	
0.3199999(dB)	0.3200001(dB)		0.1(dB)		3.01(dB)				-85(dB)			
Subtotal(dB)	Quantity	Subtotal(dB)	Quantity	Subtotal(dB)	Quantity	Subtotal(dB)	Length(Feet)	Subtotal(dB)	Quantity	Subtotal(dB)	Quantity	Subtotal(dB)
			1	0.1	1	3	196	3.8	1	-85	10	1
0.3			1	0.1	1	3	192	3.8	1	-85	12	1.2
					1	3	121	2.4	1	-85	8	0.8
					1	3	70	1.4	1	-85	8	0.8
	1	0.3			2	6	363	7.1	1	-85	14	1.4
	1	0.3			1	3	291	5.7	1	-85	12	1.2
	1	0.3			2	6	471	9.3	1	-85	14	1.4
	1	0.3			1	3	356	7	1	-85	10	1
0.6			1	0.1	1	3	238	4.7	1	-85	14	1.4
0.6			1	0.1	1	3	352	6.9	1	-85	16	1.6
0.6			1	0.1	1	3	575	11.3	1	-85	18	1.8
0.6			1	0.1	1	3	461	9.1	1	-85	18	1.8

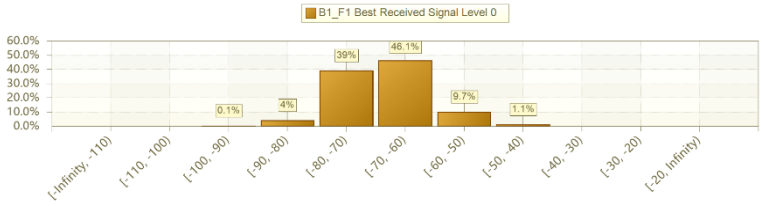
1.6 KEY EQUIPMENT LIST REPORT- ESTIMATED*

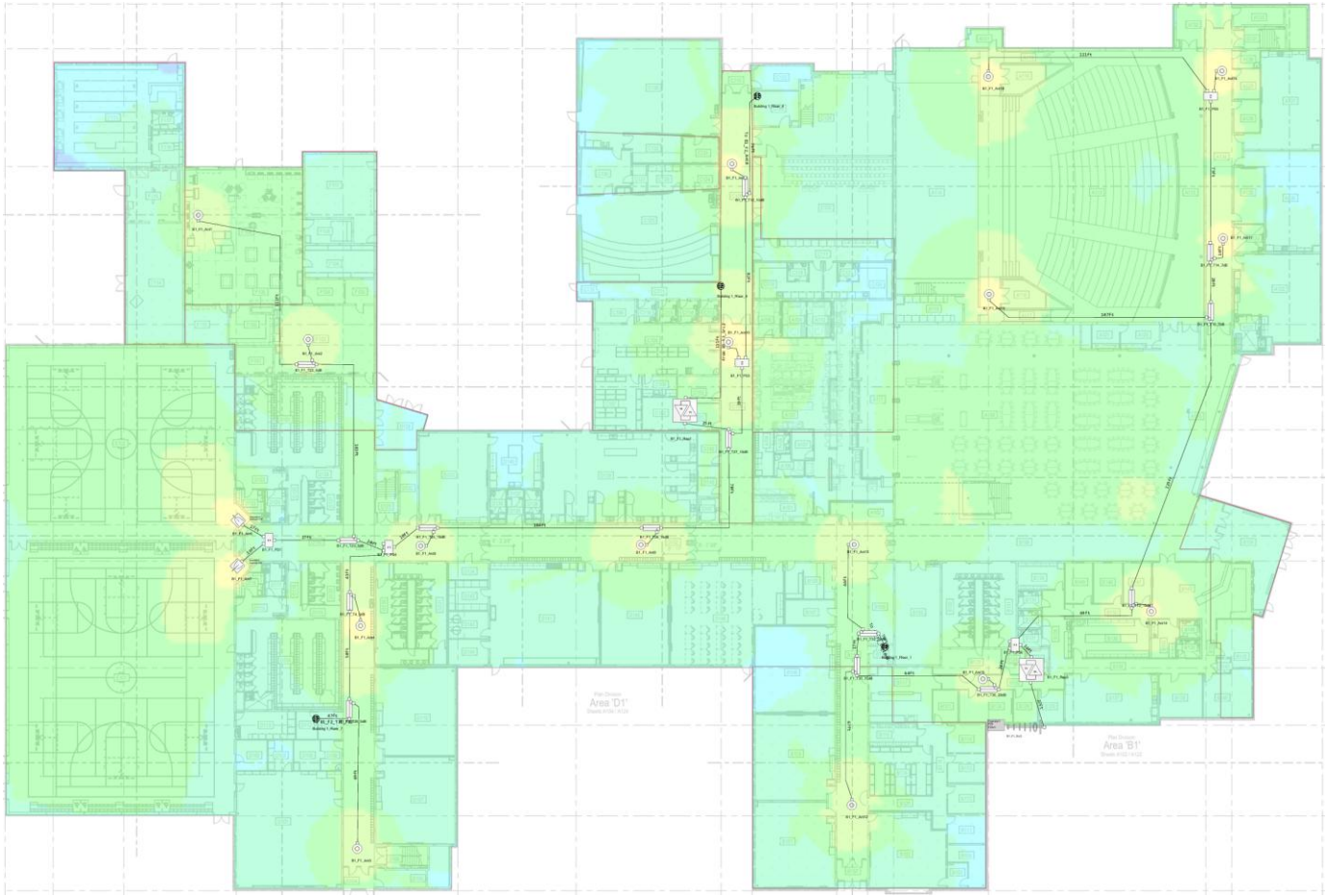
Equipment listed “Generic” for illustrative purposes only. Equipment must be approved as outlined in section 1.1.

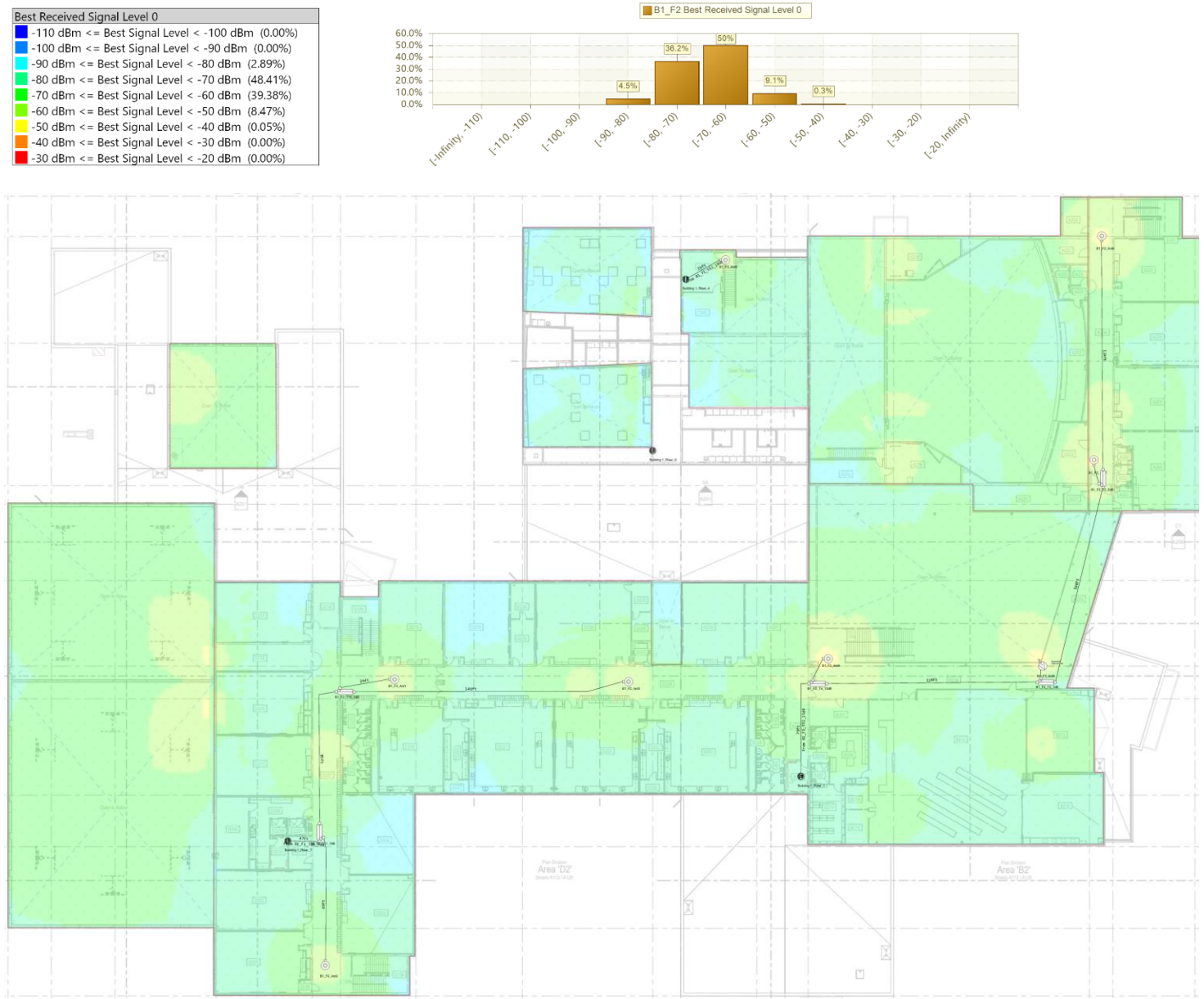
Manufacturer	Name	Type	Comments	Quantity	Unit
Generic	CAB-12F	Cable	1/2" Flexible Foam Dielectric Coaxial Cable	3160	Feet
Generic	N-J1/2	Connector	1/2'' Cable N-Type Male connector	102	-
Generic	T-10-NF	Coupler	10 dB Coupler - 800-6000 MHz - N-Female	3	-
Generic	T-15-NF	Coupler	15 dB Coupler - 800-6000 MHz - N-Female	5	-
Generic	PS-02-NF	PowerSplitter	2-Way Splitter - 100-6000MHz - N Female.	5	-
Generic	T-20-NF	Coupler	20 dB Coupler - 800-6000 MHz - N-Female	1	-
Generic	T-05-NF	Coupler	5 dB Coupler - 800-6000 MHz - N-Female	6	-
Generic	T-07-NF	Coupler	7 dB Coupler - 800-6000 MHz - N-Female	4	-
Generic	ANTCD-1003_17005	Directional Antenna	Ceiling Mount Directional Indoor Antenna, 100+ MHz 3 dBi Gain, 1700+ MHz 5 dBi Gain.	1	-
Generic	ANTD-1005_17007	Directional Antenna	Directional Indoor Antenna, 100+ MHz 5 dBi Gain, 1700+ MHz 7 dBi Gain.	2	-
Generic	Donor Site_3GPP	Source	Donor site for repeater solution - 3GPP. Max Output power 23 dBm.	1	-
Generic	ANTO_1003	Omni-directional Antenna	Omnidirectional Indoor Antenna, 100-6000 MHz 3 dBi Gain.	23	-
Generic	RP-1W-NF	Repeater	Wireless Band Repeater 1 Watt (30dBm) - N-Female.	2	-

1.7 PROPAGATION MODELING ESTIMATES

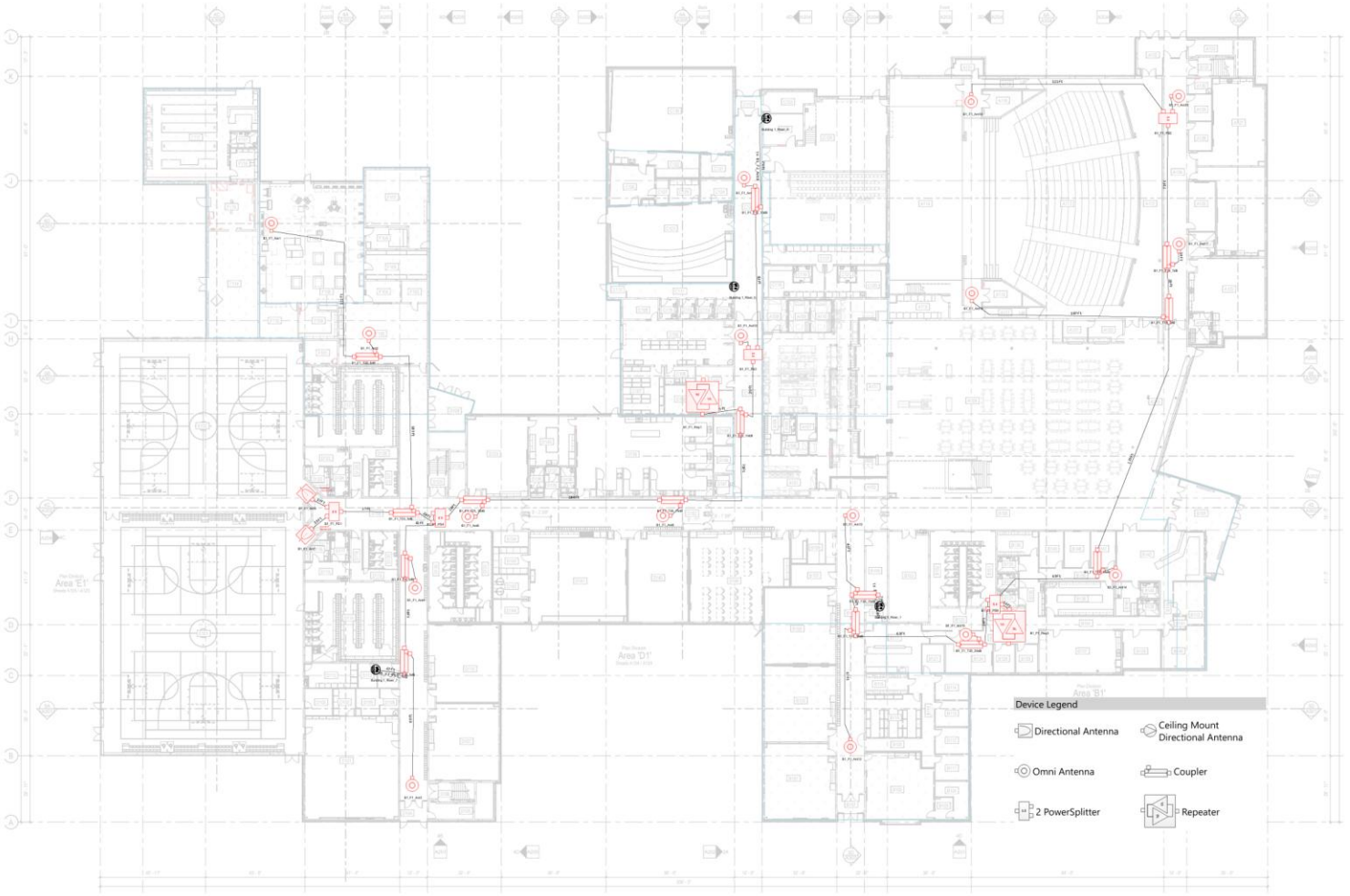




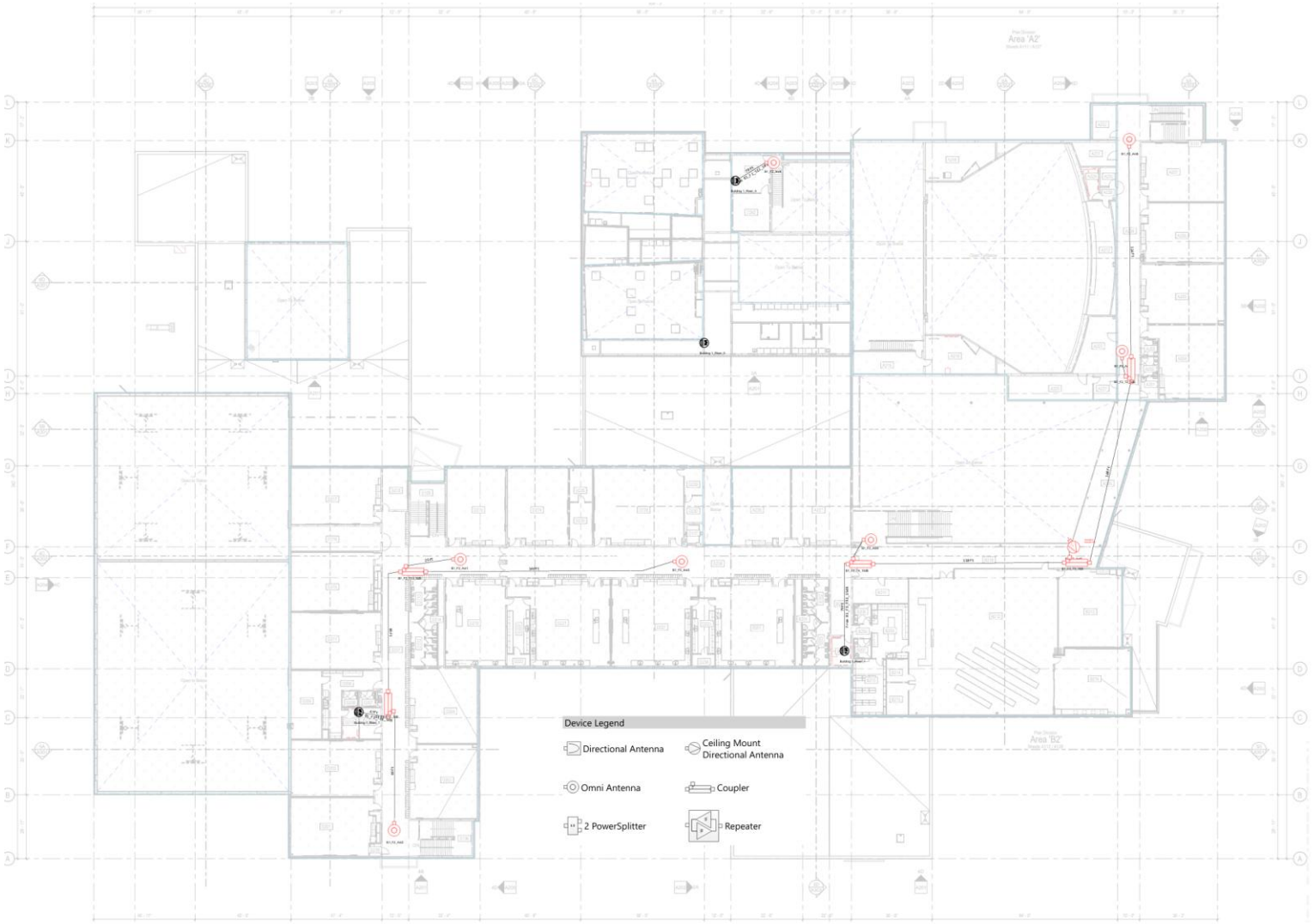



Best Received Signal Level 0
-110 dBm <= Best Signal Level < -100 dBm (0.00%)
-100 dBm <= Best Signal Level < -90 dBm (0.00%)
-90 dBm <= Best Signal Level < -80 dBm (2.89%)
-80 dBm <= Best Signal Level < -70 dBm (48.41%)
-70 dBm <= Best Signal Level < -60 dBm (39.38%)
-60 dBm <= Best Signal Level < -50 dBm (8.47%)
-50 dBm <= Best Signal Level < -40 dBm (0.05%)
-40 dBm <= Best Signal Level < -30 dBm (0.00%)
-30 dBm <= Best Signal Level < -20 dBm (0.00%)
B1_F2 Best Received Signal Level 0
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
4.5%
36.2%
50%
9.1%
0.3%
[-Infinity, -110)
[-110, -100)
[-100, -90)
[-90, -80)
[-80, -70)
[-70, -60)
[-60, -50)
[-50, -40)
[-40, -30)
[-30, -20)
[-20, Infinity)

1.8 DEVICE LOCATION LAYOUT



Plan Name	RIVERVIEW JH L1	Date	02/01/2025		GROOVE TECHNOLOGY SOLUTIONS
Project Name	RIVERVIEW JH ERCES 700MHz				
Designer Name	SH			Company Name	



Plan Name	RIVERVIEW JH L2	Date	02/01/2025		GROOVE TECHNOLOGY SOLUTIONS
Project Name	RIVERVIEW JH ERCES 700MHz				
Designer Name	SH			Company Name	GROOVE TECHNOLOGY SOLUTIONS

1.3 EQUIPMENT DATA SHEETS

NEXTIVITY
Smarter by Design

Data Sheet

SHIELD EXTEND

Scalable Public Safety ERCES

MODEL NUMBERS:
MU: F40-0E; (Class A) NU: F42-67ENU, CU: F41-8XCU; (Class B) NU: F42-67ENUB, CU: F41-8XCUB

SHIELD EXTEND is a public safety ERCES that solves for the toughest emergency communication challenges and delivers consistent coverage in any building. Available in Class A or Class B variations, EXTEND is built upon Power-over-Ethernet (PoE) architecture and includes a Network Unit (NU), Coverage Unit (CU), and Management Unit (MU). The system is scalable to fit buildings of all sizes and compatible with additional equipment such as the SHIELD EXTEND Battery Backup Unit and Fiber Range Extenders, the SHIELD Remote Annunciator, Emergency Power-Off Switch, and Active Server Antennas, as well as third-party public safety options.

SHIELD EXTEND is the only ERCES to concurrently provide 700/800 MHz Land Mobile Radio (LMR) coverage and true carrier-grade support for all FirstNet bands. In addition to delivering industry-leading talk-in and talk-out performance with a no noise guarantee, EXTEND is listed to UL 2524 and complies with IFC 510 and NFPA 1221. The system also works alongside the Nextivity WAVE PRO App and WAVE Portal for seamless installation and robust remote monitoring and management capabilities.

FIRSTNET. Built with AT&T

SAFER BUILDINGS COALITION Member

Features and benefits include:

- ERCES Public Safety Solution: 700/800 MHz LMR and FirstNet
- Class A Device: 56 Channels at 12.5 kHz Bandwidth
- Class B Device: 28 Channels at 100 kHz or 150 kHz Bandwidth
- No Noise Guarantee: Automatic Calculation and Setting of Isolation as well as Uplink and Downlink Gain
- Talk-Out and Grid Testing: Industry-First Uplink and Downlink Tests via Nextivity WAVE PRO App and COMPASS XR
- Nextivity Proprietary IntelliBoost Chip: Delivers Unparalleled Real-Time Talk-In and Talk-Out Performance
- End-to-End System Monitoring: Built-in Remote Monitoring and Management via Nextivity WAVE Portal
- Management Unit: Controls and Monitors all System Components, including NU and CU as well as SHIELD Remote Annunciator Panel (RA), Emergency Power-off Switch (EPO), and Active Server Antennas
- Network Unit: Head-End of the System; Suports up to 6 CUs via PoE
- Coverage Unit: Remote Unit of the System that Rebroadcasts LMR and FirstNet Donor Signals

System Features

Real-time automatic gain control (AGC) per time-slot
PoE architecture allows 325 ft distance range between the NU and the CUs
Up to six (6) CUs can be attached to a single NU
Remote monitoring through Nextivity WAVE PRO app and WAVE Portal

Public Safety Network and Network Protection Features

Support for all FirstNet LTE bands (2, 4, 12, 14)
Support for 700 MHz and 800 MHz (P25, Analog)
NFPA 1221, IFC 210, NEMA 4 certified, listed to UL 2524
Automatic UL and DL gain setting for Public Safety Channels
Uplink Muting Mode (Squelch) automatically shuts down uplink transmissions when no active user equipment is detected
Independent donor antenna ports for FirstNet and LMR

Benefits

One solution provides a complete code-compliant ERCES system
Centralized Power-over-Ethernet (PoE) architecture reduces equipment costs
Modular architecture allows scaling the system from 1W to 6W
Certifications reduce time-to-market and downstream costs
Remote monitoring assures that the system is performing per design
Minimal noise in network through optimal gain and power settings ensure best overall radio performance
Assured best audio quality

Power

Band Configuration	Consumption (Watts) @ 48 VDC					
FirstNet + 700/800 MHz LMR	1X CU	2X CU	3X CU	4X CU	5X CU	6X CU
	102	161	220	279	338	397
Input voltage	110 VAC					
Output voltage	54 VDC					

Environmental

54 VDC
Product Ingress Protection (IP) Rating
Relative Humidity
Maximum Surface Temperature (any point)
-4 to 122°F (NU-CU) / 32-122°F (MU)
NEMA 4
0% to 95%, noncondensing
44°C @ 30°C ambient / 111°F @ 86°F

Installation

Mounting hardware included
NU and CU can be wall mounted
1 NU supports 1 to 6 CUs
iBwave VEX files available

Radio Performance

Band	2(LTE)	4 (LTE)	12 (LTE)	14(LTE)	700 (LMR	800 (LMR)
Frequency Range, Downlink (MHz)	1930–1990	2110–2155	728–746	758–768	768–775	851–861
Frequency Range, Uplink (MHz)	1850–1910	1710–1755	699–716	788–798	798–805	806–816
Technology	LTE–20 MHz	LTE–20 MHz	LTE–10 MHz	LTE–10 MHz	P25/Analog	P25/Analog
DL (Downlink) Output Power (dBm)	24				30	
UL (Uplink) Output Power (dBm)	23		21	23	26	
Minimum Input level (DL/UL) dBm	-100 / -90					
Maximum Input level (DL/UL) dBm	-20 / 0			-20 / -35	-20 / -27	
System maximum gain (dB)	100					
Noise Figure at max gain (dB)	5					
Return loss (dB)	-8					
System Group Delay @ 12.5 kHz (usec) (Class A)	28					
System Group Delay @ 100 kHz / 150 kHz (usec) (Class B)	15 / 13.6					

Physical Specifications

	Width	Height	Depth	Weight
NU	12.36 in	14.61 in	4.29 in	15.43 lb
CU	11.18 in	13.50 in	3.50 in	12.13 lb
MU	10.63 in	12.20 in	4.80 in	8.82 lb

Connections *(NU)*

2x Donor antenna ports – Type-N female connectors
2x Donor antenna ports – Type-N female connectors
1x RJ45 LAN management output port (10/100 Fast Ethernet)
1x SFP+ Optical port, 5 Gbps, up to 6500 ft range from NU1 to NU2

Connections *(CU)*

1x Server antenna port – Type-N female connectors
2x RJ45 Proprietary Gigabit link, 300 ft range from NU to CU

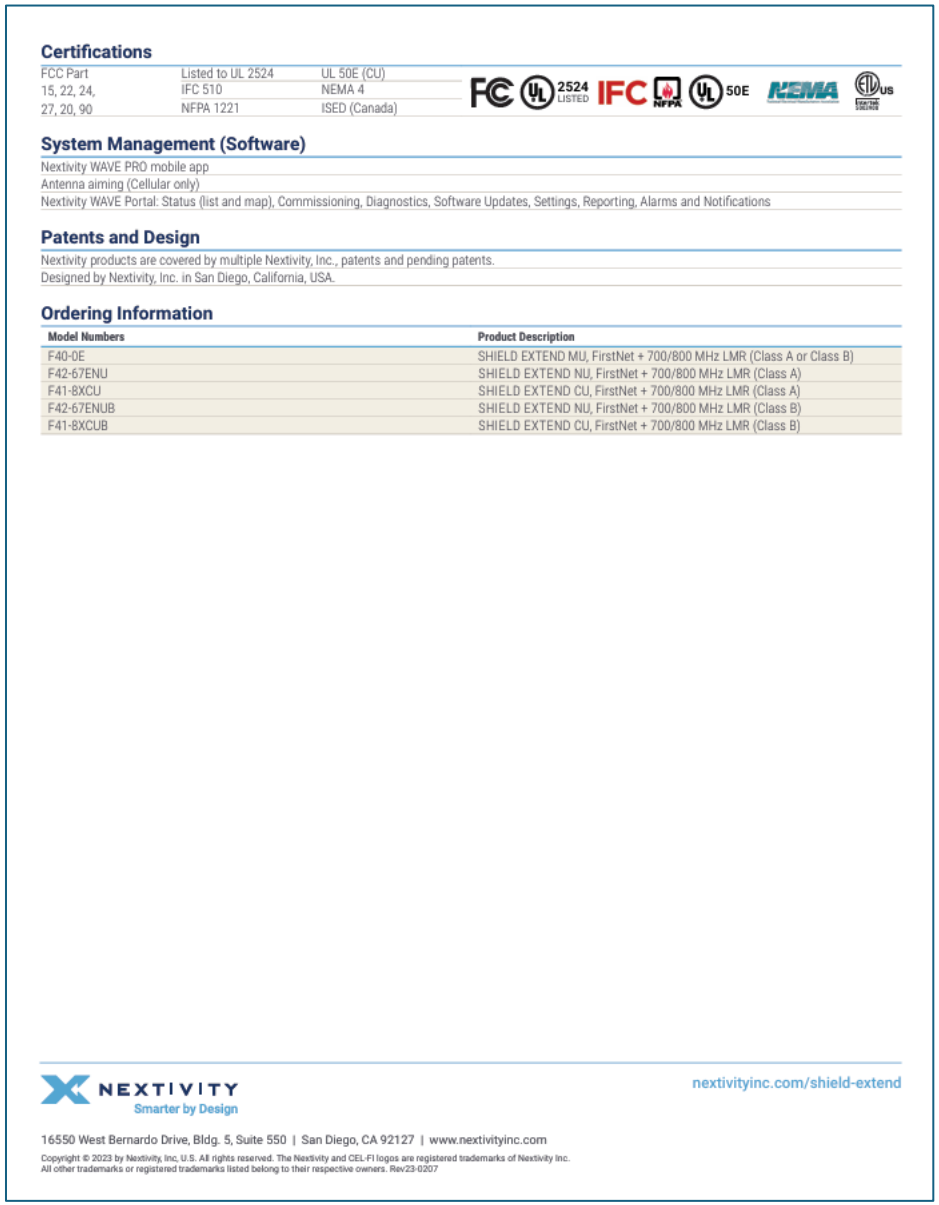
Connections *(MU)*

LAN Port:	RJ45	PoE Port Power:	10W
Port Capability:	10 Mbps	Antenna Port:	SMA

Supported Alarms

• Normal AC power	• Battery Charger Fail
• Donor Antenna Disconnection	• System Component Malfunction
• Loss of Normal AC power	• Low Battery Capacity @ 30% of Capacity
• Active RF Emitting Device Malfunction	• Donor Antenna Malfunction

1.3 EQUIPMENT DATA SHEETS



Certifications

FCC Part 15, 22, 24, 27, 20, 90	Listed to UL 2524	UL 50E (CU)
	IFC 510	NEMA 4
	NFPA 1221	ISED (Canada)

System Management (Software)

Nextivity WAVE PRO mobile app
Antenna aiming (Cellular only)
Nextivity WAVE Portal: Status (list and map), Commissioning, Diagnostics, Software Updates, Settings, Reporting, Alarms and Notifications

Patents and Design

Nextivity products are covered by multiple Nextivity, Inc., patents and pending patents.
Designed by Nextivity, Inc. in San Diego, California, USA.

Ordering Information

Model Numbers	Product Description
F40-0E	SHIELD EXTEND MU, FirstNet + 700/800 MHz LMR (Class A or Class B)
F42-67ENU	SHIELD EXTEND NU, FirstNet + 700/800 MHz LMR (Class A)
F41-8XCU	SHIELD EXTEND CU, FirstNet + 700/800 MHz LMR (Class A)
F42-67ENUB	SHIELD EXTEND NU, FirstNet + 700/800 MHz LMR (Class B)
F41-8XCUB	SHIELD EXTEND CU, FirstNet + 700/800 MHz LMR (Class B)

NEXTIVITY
Smarter by Design

nextivityinc.com/shield-extend

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