Perkins&Will

PROJECT MANUAL

SPECIFICATIONS AND CONDITIONS OF THE CONTRACT

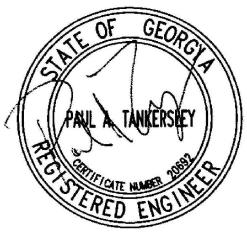
Volume 2 of 2
Divisions 21 - 33

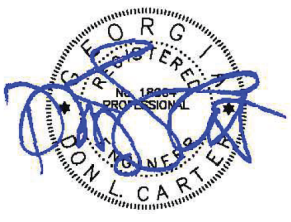
Creekland Middle School Classroom Addition

Cherokee County School District

Perkins&Will Project Number: 801873.000

Construction Documents: June 22, 2023





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SECTION 210500

COMMON WORK RESULTS FOR FIRE PROTECTION

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. Sleeves.
3. Escutcheons.
4. Supports and anchorages.

1.3 DEFINITIONS

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

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

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include roof overhang and loading dock canopy areas.

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.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Valves.
2. Pipe and Pipe Fittings.
3. Sprinkler Heads.
4. Piping layout drawings.
5. Hangers.
6. Piping Identification.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

A. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

B. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

C. Refer to Architectural reflective ceiling plans for additional notes for the installation and locations of sprinkler heads in ceilings.

D. Coordinate routing of new sprinkler piping into new Cafeteria and Media Center additions to be concealed where possible. Exposed piping shall be primed and painted to match adjacent surfaces. Routing of exposed piping shall be coordinated with Architect prior to installation.

1.7 RECORD DRAWINGS

A. As the work progresses, the Contractor shall maintain records and record all changes made daily on a set of record sprinkler installation shop drawings during the progress of the work. The in-progress set of marked-up drawings, clearly showing the nature and extent of all changes, shall be maintained in the construction office at the site and clearly marked “Record Drawings”. The “Record Drawings” shall be up to date and available for use at time of any job site visit by the Engineer or Architect. The completed “Record Drawings” shall be turned over to the Architect upon completion and acceptance of the work. A copy of these record drawings along with a copy of the Fire Marshall approved plans shall be attached to the sprinkler riser. Final payment and “close-out” of the project shall be dependent upon receipt and acknowledgment of the completed “Record Drawings”.

B. The Engineer shall furnish to the Contractor electronic files in AutoCAD format of the Contract Drawings for the Contractors’ use in preparing a final electronic copy of the record drawings of all changes made during the construction of the work.

1. Refer to Division 01 Specification Section “Project record Documents” for additional requirements for Record Drawings.

2. Submittal for electronic Record Drawings shall be made on compact disk in AutoCAD format and accompany one (1) full size set of bond plots on white background. Plots shall be generated from the CD of electronic files. Electronic file names and plot sheet numbering system shall match Contract Document format.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

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

2.2 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch 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. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 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.

1. Finish: Polished chrome plated.

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

2.4 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, non-staining, 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 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

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

J. Install escutcheons for penetrations of walls, ceilings, and floors in finished areas exposed to view.

K. Install sleeves for pipes passing through concrete and masonry walls.

L. 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 Fire Stopping" for materials.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.

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

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

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

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

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metals" for structural steel.

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

END OF SECTION 210500

SECTION 211313

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.

1.3 DEFINITIONS

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

1.4 EXISTING SYSTEM DESCRIPTION

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

1.5 PERFORMANCE REQUIREMENTS

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

B. Delegated Design: Design sprinkler system modifications by a qualified professional Fire Protection Engineer, using performance requirements and design criteria indicated for bidding purposes only. IT IS THE CONTRACTOR'S RESPONSIBILITY TO VISIT THE SITE AND PERFORM A CERTIFIED FLOW TEST. CONSULT WITH THE LOCAL AUTHORITY HAVING JUSISDICTION, OR OTHERWISE OBTAIN POSITIVE CONFIRMATION OF THE AVAILABLE WATER SUPPLY PRIOR TO THE COMMENCEMENT OF HYDRAULIC CALCULATIONS AND DESIGN. CONTRACTOR SHALL SUBMIT WRITTEN DOCUMENTATION OF ANY FLOW TEST DATA OBTAINED THROUGH THIS PROCEDURE. FIRE FLOW TESTS PERFORMED AT THE SITE SHALL BE WITNESSED BY AN INDEPENDENT THIRD PARTY KNOWLEDGEABLE OF THESE MATTERS AND ATTESTING THERETO IN WRITING.

1. Available fire-hydrant flow test records indicate the following conditions to be used for scope of work bidding only:
   a. Date of Test:

b. Performed by:
c. Location of Fire Hydrant:
d. Size of Main:
e. Static Pressure:
f. Measured Flow at Flow Fire Hydrant:
g. Residual Pressure:
h. Flow at residual pressure of 20 psi:

2. A decreased Hydraulic Grade Line (HGL) of 5 psi is used to simulate periods of high sustained demand for flows at 20 psi.

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

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:
   a. See Appendix A in NFPA 13 for recommended hazard classifications.
   b. Building Service Areas: Ordinary Hazard, Group 1**.**
   c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
   d. General Storage Areas: Ordinary Hazard, Group 1.
   e. Mechanical Equipment Rooms: Ordinary Hazard, Group 1**.**
   f. Office and Public Areas: Light Hazard
   g. Classrooms: Light Hazard
3. 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.
4. Maximum Protection Area per Sprinkler: Per UL listing.
5. Maximum Protection Area per Sprinkler:
   a. Office Spaces: 225 sq. ft**.**
   b. Mechanical Platform and Equipment Rooms: 130 sq. ft.
   c. Electrical Equipment Rooms: 130 sq. ft**.**
   d. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
6. 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.

1.6 SUBMITTALS

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

B. Shop Drawings: For existing wet-pipe sprinkler system modifications. Include plans, sections, details, and attachments to other work.

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

D. Coordination Drawings: Sprinkler system modifications, drawn to scale, on which the following items new and/or existing are shown and/or coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. Items penetrating finished ceiling include the following:
    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Ductwork
    d. Exit Lights
    e. Audio system ceiling mounted speakers.

E. Qualification Data: The system modifications shall be installed by an experienced firm duly licensed by the State of Georgia Fire Marshall's Office for the installation of fire sprinkler systems and which shall, upon request, submit the names of 3 installations of similar size.

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

G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13.

H. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Installer's responsibilities include designing, fabricating, and installing a finished sprinkler system and providing professional engineering services needed to assume engineering responsibility.

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

1. NFPA 13, "Installation of Sprinkler Systems."

1.8 COORDINATION

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

B. No fire sprinkler piping shall be routed within a 42" envelope of any electrical panel or switchboard, contiguous to the structure above.

C. Locations of any new test and drain piping shall be shown on the sprinkler shop drawings and closely coordinated with the Architect. Wherever possible, and subject to the local Authority Having Jurisdiction, route inspectors' test and drain connections, and auxiliary drain systems concealed above ceilings, with proper identification signage for test and drain valves, above ceilings, with discharge piping (normally dry) concealed in exterior wall to terminate outside, above grade, with the required orifice simulating flow from a single sprinkler head.

1.9 EXTRA MATERIALS

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

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project. Locate at sprinkler riser service entrance.

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. All products and components installed in the system shall be listed by Underwriters Laboratories (U.L.) and approved by Factory Mutual Engineering (FM).

2.2 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, ductile- or gray-iron standard pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.
    a. Manufacturers:
        1) U.S. Pipe
        2) Griffin Pipe
        3) McWayne

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.
2. Gaskets: AWWA C111, rubber.
    a. Manufacturers:
        1) U.S. Pipe
        2) Griffin Pipe
        3) McWayne

2.3 STEEL PIPE AND FITTINGS

A. Domestic Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, 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 A 733, made of ASTM A 53/A 53M 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.
6. Manufacturers:
    a. Smith-Cooper
    b. Ward
    c. Grinnell/Anvil International

B. Grooved End - Steel Pipe: ASTM A 135 or ASTM A 795, with wall thickness less than Schedule 40 and greater than Schedule 10, and with factory- or field-formed grooved ends.

1. Approved Manufacturers:
    a. Bullmoose Tube Company
    b. Wheatland Tube Company
    c. Allied Pipe
    d. Northwest Pipe
    e. Weld-Tube
    f. Youngstown Tube Company

C. Grooved End - Couplings:

1. Approved Manufacturers:
    a. Victaulic
    b. Gruv-Lock
    c. VGS

2.4 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating. Valves shall have 250-psig minimum 300-psig pressure rating if valves are components of high-pressure piping system.

B. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

1. Manufacturers:
    a. Tyco
    b. Central Sprinkler Corp.
    c. Anvil International.
    d. Viking
    e. Kennedy.
    f. NIBCO.
    g. Reliable Automatic Sprinkler Co., Inc.
    h. Star Sprinkler Inc.
    i. Stockham.
    j. Victaulic Co. of America.

C. Gate Valves: UL 262, OS&Y type.

1. NPS 2 and Smaller: Bronze body with threaded ends.
    a. Manufacturers:
        1) Tyco
        2) NIBCO.

3) United Brass Works, Inc.
4) Reliable Automatic Sprinkler Co., Inc.
5) Stockham.
6) Viking

2.5 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure. All sprinkler heads shall be the products of one manufacturer.

B. Manufacturers:

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

C. Automatic Sprinklers: With heat-responsive element 155°-165°F range, complying with the following:

1. UL 199, for nonresidential applications.

D. Sprinkler Types

1. Sprinkler heads for installation in areas with acoustical lay-in tile ceilings shall be standard 1/2" orifice, fully concealed type with flat closure plate to fit flush with ceiling surface. Sprinklers shall be quick response type for all light hazard occupancies.
2. Sprinkler heads for installation in gyp board ceilings shall be fully concealed type with flat closure plate to fit flush with ceiling surface.
3. Exposed sprinkler heads on exposed piping shall be standard 1/2" orifice, brass upright, with bronze finish.
4. Sidewall sprinkler heads, where required, shall be horizontal sidewall heads, 1/2" orifice, with chrome plated finish.
5. Sprinkler heads installed in Gymnasium and in areas subject to physical damage shall have listed sprinkler head guards installed to protect sprinkler heads.
6. Dry pipe sprinkler heads shall be installed off of the wet pipe sprinkler system to provide coverage for combustible overhead canopy areas at loading docks where required by Code and/or AHJ. No wet pipe sprinkler piping shall be routed thru or installed above non heated spaces above ceilings or soffits.

E. Sprinkler Head Specialties and Options:

1. Install sprinkler guards on all sprinklers located lower than 7'-0" above the floor.
2. Fire sprinklers installed in locations subject to direct sunlight or elevated temperatures shall have minimum 200-212 degree Fahrenheit temperature rating.

2.6 ALARM DEVICES

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

B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 6 inch

diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 inlet and NPS 1 drain connections.

1. Manufacturers:
   a. Tyco
   b. Victaulic Co. of America
   c. Reliable Automatic Sprinkler Co., Inc.
   d. Star Sprinkler Inc.
   e. Viking Corp.

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. Potter Electric Signal Company.
   b. System Sensor.
   c. TYCO Fire Protection Products

D. 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. Potter Electric Signal Company.
   b. System Sensor.
   c. Kennedy Valve; division of McWane Industries.

2.7 PRESSURE GAGES

A. Manufacturers:

1. AGF Manufacturing Co.
2. AMETEK, Inc.; U.S. Gauge.
3. Brecco Corporation.
4. Dresser Equipment Group; Instrument Div.

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.

C. Air System Piping: Include caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

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

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

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

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

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

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

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

G. Fill sprinkler system piping with water.

3.2 JOINT CONSTRUCTION

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

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

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

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

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

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

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

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

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

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

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

3.3 SPRINKLER INSTALLATION

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

3.4 ESCUTCHEON INSTALLATION

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

B. Escutcheons for New and existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece or split casting, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One-piece, stamped steel with set screw or spring clips.

3.5 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in partitions and walls.

B. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

C. Install sleeves in new partitions, slabs, and walls as they are built.

D. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."

E. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

F. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Interior Concrete Walls:
   a. Galvanized-steel-pipe sleeves for pipes smaller than NPS 6.

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 for firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.6 IDENTIFICATION

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

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

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

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

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

D. Prepare test and inspection reports.

3.8 CLEANING

A. Clean dirt and debris from sprinklers.

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

C. Clean all rust from piping and pipe fittings. Rusty fittings will not be allowed on project.

3.9 PIPING SCHEDULE

A. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

3.10 SPRINKLERS

A. All new sprinkler heads shall match existing heads in the same room where possible.

END OF SECTION 21131

SECTION 220500

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

1.3 DEFINITIONS

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

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. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

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

1.4 QUALITY ASSURANCE

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

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

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

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

1.6 COORDINATION

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

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

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

D. Coordinate locations of floor drains and floor cleanouts with HVAC equipment pads and units in all mechanical equipment rooms. Coordination layout drawings shall be prepared and coordinated by all trades. The plumbing subcontractor shall obtain from the HVAC Contractor a copy of his 1/4" scale equipment/pad layout plan(s) for his use in roughing in of floor drains and cleanouts in the main mechanical room

E. No plumbing equipment or piping shall be located within 42" of electrical switchboards or panelboards.

F. No water piping (domestic, storm or sanitary) shall be located above electrical switchboards or panelboards.

1.7 CODES AND REGULATIONS

A. All materials and workmanship shall comply with the latest editions of the following codes and standards, as applicable:

Manufacturer's Standardization Society (MSS) Standard Practice (SP) 58: Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69: Pipe Hangers and Supports - Selection and Application

MSS SP-69: Pipe Hangers and Supports - Fabrication and Installation Practices

NFPA 101: Safety to Life from Fire in Buildings and Structures

National Electrical Code, 2014 Edition, with no Georgia Amendments

International Mechanical Code, 2018 Edition, with Georgia Amendments
International Building Code, 2018 Edition, with Georgia Amendments

International Plumbing Code, 2018 Edition, with Georgia Amendments

International Fuel Gas Code, 2018 Edition, with Georgia Amendments

International Energy Conservation Code, 2015 Edition, with Georgia Amendments

All local prevailing City and County codes

B. All workmanship and materials shall comply with all ordinances and regulations of all local authorities having jurisdiction.

C. Contractor shall obtain all permits and licenses, and pay all fees, as required for execution of the contract. Arrange for necessary inspections required by City, County, State and other authorities having jurisdiction, and deliver certificates of approval to the Owner. In compliance with the Georgia State Boiler Code, it is the responsibility of the Contractor (at his expense) to have each boiler and/or applicable pressure vessel inspected by a State of Georgia certified inspector upon installation of this equipment.

D. This inspection report shall be submitted to the Georgia Department of labor, Safety Engineering Section, 501 Pullman Street, Room 210, Atlanta, Georgia 30312, Attention Chief Safety Engineer.

E. Upon the Georgia Department of Labor review of the inspection report and their inspection, they will place a tag indicating the State Serial Number on the inspected piece of equipment and issue a certificate of boiler or pressure vessel inspection. The original certificate issued is to be posted in the boiler room where the equipment is installed, with a copy sent to Cherokee County Public Schools and one copy is to be included in the closeout documents.

1.8 RECORD DRAWINGS

A. As the work progresses, the Contractor shall maintain records and record all changes made daily on a set of contract mechanical drawings (HVAC and Plumbing) during the progress of the work. The in-progress set of marked-up drawings, clearly showing the nature and extent of all changes, shall be maintained in the construction office at the site and clearly marked "Record Drawings". The "Record Drawings" shall be up to date and available for use at time of any job site visit by the Engineer or Architect. The completed "Record Drawings" shall be turned over to the Architect upon completion and acceptance of the work. Final payment and "close-out" of the project

shall be dependent upon receipt and acknowledgment of the completed "Record Drawings".

B. The Contractor shall prepare electronic files in AutoCAD format of the Contract Drawings as As-Built record drawings of all changes made during the course of construction including all project addenda. Drawing changes shall be identified as follows:

1. The affected change shall be identified in an enclosed clouded area of a consistent color not used to indicate the noted change.
2. Each cloud shall have an identifier adjacent to the cloud identifying the date and origin of the change. (i.e., 1-12-06, Construction Directive, 1-12-06, Change Proposal, 1-12-06, Field Coordination, etc.).

C. Submittal for electronic Record Drawings shall be made on compact disk in AutoCAD format and accompany one (1) full size set of bond plots on white background. Plots shall be generated from the CD of electronic files. Electronic file names and plot sheet numbering shall match Contract Document format.

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-soluble flux according to ASTM B 813.

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

G. 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 for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.
5.

2.4 TRANSITION FITTINGS

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

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

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

1. Available Manufacturers:
   a. Eslon Thermoplastics.
   b. Spears Mfg. Co.
   c. Georg Fischer Piping Systems - Doublesafe

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Available Manufacturers:
   a. Thompson Plastics, Inc.
   b. Spears Mfg. Co.
   c. Georg Fischer Piping Systems - Doublesafe

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

1. Available Manufacturers:
   a. NIBCO INC.
   b. NIBCO, Inc.; Chemtrol Div.
   c. Spears Mfg. Co.
   d. Georg Fischer Piping Systems - Doublesafe

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

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

1. Acceptable manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corp.
   c. Watts Industries.

2.6 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.

2.7 ESCUTCHEONS

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

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

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome plated.

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

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

2.8 GROUT

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

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

2.9 BOLTED CONNECTIONS

A. Accurately punch, drill or ream bolt holes and remove burrs. Use washers, lock washers, and self-locking nuts as specified on Drawings, and as otherwise required. Tighten all bolts and nuts. Use screw threads conforming to National or Unified forms in accordance with Bureau of Standards Handbook H28. Do not use sheet metal screws. Use machine bolts where access or nuts would not be possible, and where unbolting may be required, in which case utilize sufficient thickness of metal to assure that 2 complete bolt threads are engaged. Secure machine bolts in place by proper lock washers.

2.10 MATERIALS FOR TESTING

A. All detergents, solvents and other cleaning shall be compatible with the materials of fabrication of the systems, in which they are used. They shall not adversely affect the materials or mechanisms in the system and they shall be acceptable to equipment manufacturers. All detergents, solvents and other cleaning agents shall also be compatible with the process streams to be handled by the system in which they are used.

B. Blinds, gaskets, bolts, etc., used in isolating segments of systems shall conform to the specification for adjacent materials.

C. Contractor shall furnish all labor, tools and equipment required for pressure testing piping systems.

2.11 ACCESS DOORS & PANELS

A. Provide access doors/panels in all non-removable ceilings and in partitions and walls where necessary to maintain access to cleanouts, valves, shock arrestors, trap primer valves and other mechanical devices requiring access. Comply with requirements for Access Doors and Panels in Division 08, Section "Access Doors and Frames".

B. Any access door installed in fire rated surface or assembly shall carry a U.L. Listing and an approved fire rating for that construction type.

C. Provide all access doors to the General Contractor for the timely inclusion in the building construction.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

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

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. 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 Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

M. Sleeves are required for core-drilled holes.

N. Install sleeves for pipes passing through concrete and masonry walls to extend 1” beyond wall on both sides and concrete floor and roof slabs as described below.

O. Install sleeves for pipes passing through gypsum-board partitions.

1. Cut sleeves to length for mounting in walls to extend a minimum of 1” beyond wall on 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.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Fire Stopping” and "Fire Resistive Joints” for materials and installation.

P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using steel pipe sleeves. Select sleeve size to allow for 1/4" annular clear space between pipe and sleeve.

1. Install steel pipe for sleeves smaller than 10 inches in diameter.

Q. 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 Sections "Penetration Firestopping" and "Fire-Resistive Joint Systems".

R. Verify final equipment locations for roughing-in.

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

3.2 PIPING JOINT CONSTRUCTION

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

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

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

D. Soldered Joints: Apply ASTM B 813, water-soluble 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. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Non-pressure Piping: Join according to ASTM D 2855.
5. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.

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

K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 PIPING CONNECTIONS

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

1. Install unions, in piping NPS 2 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.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

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

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

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

E. All equipment shall be installed in strict conformance with manufacturer's recommendations, as specified herein and as shown.

F. All work provided under this Division shall be installed under the direct supervision of contractors licensed by the State of Georgia.

G. Plumbing work shall be under the direct supervision of a licensed Master Plumber, Class II.

H. The supervising license holders shall be identified, and a copy of their current valid license shall be provided as part of the initial submittal package.

I. Where piping or equipment is exposed to view, special attention shall be given to pipe routing and installation, and the finished installation shall be neat and workmanlike, straight and parallel or perpendicular to the building construction. Piping exposed to view shall be primed and painted as directed by the Architect.

J. All welders shall be qualified by an independent testing agency and certified in accordance with the requirements of ASME Section IX of the Boiler and Pressure Vessel Code. Contractor shall furnish certification of welder’s qualifications with shop drawings.

3.5 ELECTRICAL WORK

A. All electrical equipment provided under this Division shall comply with the electrical system characteristics present on the site and specified in Division 26.

B. Motor controls, system controls, starters, pilot lights, push buttons, etc., shall be furnished complete as part of a motor apparatus which it operates, except starters located in the motor control center. All components shall be in conformance with the requirements of the National Electrical Code (2014 Edition) and Division 26.

C. All power wiring and final connections to the system shall be provided under Division 26.

3.6 PRODUCT HANDLING, DELIVERY AND STORAGE

A. Receive and handle all materials with care so as not to cause damage. Use padded or strap slings, etc., as appropriate for materials being handled. Lift equipment by lift points provided or recommended by manufacturer.

B. Use proper tools, equipment and procedures to handle and lay pipe. Do not damage pipe coating, wrapping or linings. Repair or replace damaged pipe coatings, wrappings, or linings in accordance with manufacturer's instructions or as required to restore original protection.

C. Inspect all materials, upon receipt, for defects and for compliance with Specifications.

D. Properly store all equipment, pipe, piping materials, etc., so as to prevent deterioration while in storage. Store all materials off ground or off floor. Store inside or cover all materials subject to deterioration from weather.

E. Store loose materials such as fittings, gaskets, bolts, nuts, small valves, traps, and specialties in adequate number of bins to properly separate. Protect ends of large fittings, valves and pipe from weather and abuse. Properly grease all machined surfaces.

3.7 PAINTING

A. Factory painted equipment that has been scratched or marred shall be repainted to match original factory color.

B. Field painting of all uninsulated black ferrous metal items exposed to sight such as equipment hangers, piping, frames and supports not provided with factory prime coat, shall be cleaned and painted with one coat of rust inhibiting primer. In addition, such items in finished spaces shall also be painted with two coats of finish paint in a color to match adjacent surfaces or as otherwise selected by the Architect. Comply with requirements for painting in Division 09, Sections "Interior Painting", and "Exterior Painting".

C. All exterior gas piping at meters, emergency generators and on the roof shall be primed at the time of installation with two coats of rust prohibitive primer. Final painting shall be done after testing is completed and prior to system being placed in service. See Division 09, Section "Exterior Painting" for requirements.

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

3.8 CLEANING AND ADJUSTING

A. The exterior surfaces of all plumbing equipment, fixtures, fittings, piping, etc., shall be cleaned of all grease, oil, paint and other construction debris.

B. Start-up and adjustment of all water heaters shall be performed by certified factory representatives of the respective equipment manufacturer.

C. Equipment controls and other accessories shall be adjusted to provide optimal and efficient operation.

3.9 TESTING

A. Concealed or insulated piping shall be tested in place before concealing, insulating or covering.

B. Equipment, materials and instruments required for tests shall be furnished without incurring additions to the Contract.

C. Refer to the individual specification sections for specific testing requirements regarding that item.

D. Furnish certification that the lead content in the domestic water system does not exceed 20 ppb, or a lesser quantity, depending upon the current E.P.A. regulations. A test shall be made at each fixture where potable water can be obtained for drinking, cooking, bathing, washing or any other purpose. This certificate shall accompany the closing papers of the project.

E. Testing of the domestic water mains shall be performed upon the completion of the initial installation and a certification shall be issued to the Owner with a copy included in the close out documents.

F. ELECTRONIC FILES FOR COORDINATION AND SHOP DRAWING DEVELOPMENT

1. Contractor shall obtain from the Architect a copy of the project architectural/structural/HVAC CAD files for coordination and preparation of the Plumbing piping systems installation shop drawings. Contractor shall also obtain a set of the HVAC ductwork shop drawings and shall coordinate all divisions of work into the submittal for review.
2. Should the Contractor be unable to resolve any conflicts regarding location and routing of the plumbing system components, the Contractor shall notify the Architect immediately upon discovery. Contractor shall not proceed with installation, fabrication, or purchase of the associated plumbing components until the conflicts are resolved.

G. SHOP DRAWINGS

1. Submit a minimum of three hard copy sets of shop drawings along with an electronic formatted submittal for approval prior to commencing work. Hard copy shop drawings shall be bound in a three-ring binder and shall include an index page with each item listed and referenced to sections with tabs. Tabs shall be cross referenced to index page. All shop drawings shall be prepared and submitted as a single package. NO SHOP DRAWINGS WILL BE CHECKED UNTIL ALL HAVE BEEN SUBMITTED. (HVAC controls submittals and any items with exceptionally long lead times that may affect the project completion date, as determined by the Engineer may be submitted separately). Electronic shop drawings shall be a single PDF file and formatted as required for hard copy submittals. Each section shall be a bookmarked (tabbed) link named to describe the section and cross referenced to index. (ELECTRONIC SHOP DRAWINGS NOT PROPERLY FORMATTED WILL BE RETURNED UNCHECKED.)
2. The following format shall be followed:
   a. The submittal cover sheet shall include-
      1) Project Name
      2) Type of Shop Drawing including trade (HVAC, Plumbing)
      3) Mechanical Contractor's Company Name
      4) Date of Submittal
   b. The first sheet inside the submittal shall include all items on the cover sheet plus the following-
      1) Owner
      2) Architect
      3) Engineer
      4) Mechanical Contractor's Project Manager's Name
   c. The supervising license holder(s) shall be identified, and a copy of their current valid license shall be included.
   d. The second sheet shall include the following typed statement, signed and dated by the mechanical contractor's project manager-

"The enclosed submittal (shop drawings) has been reviewed for accuracy of equipment and system quality and component quantities. The available voltages have been coordinated with the electrical contractor. All coordination items with other trades have

been completed including structural, electrical, and other mechanical division disciplines prior to ordering any equipment."

3. The Contractor shall review the information prepared by his suppliers and note any changes required prior to submitting the information to the Engineer and shall include the form (found at the end of this section), Exhibit 1, entitled "Certification of Compliance - Shop Drawings" with each submittal prior to the index page and submittal data sheets. Failure to complete and execute this form will result in rejection of the submittal without review.
4. Each individual submittal item shall be marked to show Specifications Section and Paragraph number which pertains to the item. Shop Drawings shall clearly indicate location, fixture no. or equipment designation, etc. with all options and/or accessories clearly marked, so that the intended use of the equipment can be readily identified. Failure to mark the submittals accordingly shall be considered cause for rejection of shop drawings.
5. Submittals shall be supported by descriptive material, such as catalog cuts, diagrams, certified performance curves and charts published by the manufacturer to show conformance to specification and drawing requirements, model numbers alone will not be acceptable. All literature shall clearly indicate the specified model number, options to be included, dimensions, arrangement, rating and characteristics of the proposed equipment. Capacities and ratings shall be based on conditions indicated or specified herein. Any deviations from specified equipment shall be clearly noted in red.
6. The Engineer will review the shop drawings for errors in the Contractor's interpretation of the design intent only. Corrections or comments made on shop drawings during review shall not relieve the Contractor from compliance with requirements of the Contract Documents, plans and specifications. Review of shop drawings shall not relieve the Contractor from the responsibility for conforming and correlating all quantities and dimensions, coordinating his work with that of other trades, and performing his work in a safe and satisfactory manner.
7. Review of shop drawings shall not permit any deviations from the plans and specifications nor shall it permit changes to the plans and specifications by the Engineer. Changes to or deviations from the Contract Documents are subject to the provisions of the General Conditions of the contract. Any required changes will then be issued by the Architect and executed by both the Owner and Contractor.
8. Each individual submittal item shall be marked to show Specifications Section and paragraph number which pertains to the item. Shop Drawings shall clearly indicate location, fixture no. or equipment designation, etc., so that the intended use of the equipment can be readily identified. Shop drawings shall be submitted for each of the following items:
    a. Circulating Pumps
    b. Thermometers
    c. Pressure Gauges
    d. Pipe Insulation & Accessories
    e. Pipe and Pipe Fittings
    f. Pipe Identification Systems
    g. Pressure Reducing Valves
    h. Relief Valves
    i. Pipe Accessories

j. Pipe Hangers, Supports & Accessories
k. Backflow Preventers
l. Plumbing Fixtures & Fittings
m. Water Heaters & Accessories
n. Valves & Unions
o. Cleanouts & Accessories
p. Shock Arrestors
q. Access Covers & Panels
r. Valve Schedules and Diagrams
s. Wall Hydrants & NFWH's
t. Floor Drains
u. Gauges
v. Sheet Lead Flashing

9. For miscellaneous items not listed here, Contractor shall submit shop drawings for approval, unless the item is to be provided and installed exactly as specified, without variance.

H. Submit evidence of welders' qualifications prior to performing any welds.

3.10 CONCRETE BASES

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

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete".

3.11 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 mechanical materials and equipment.

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

3.12 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.

3.13 CONSTRUCTION OBSERVATION

A. Give Architect 2 days notice of all tests and observations.

B. Conduct all tests to satisfaction of Architect or his authorized representative.

C. Make site available at all times for observation by Architect. Contractor shall uncover all concealed areas during construction observation.

D. In addition, the following formal observations by Architect or his authorized representative shall be conducted for each building or part of building and site.

1. Above floor work before being concealed or covered.
2. Final observation after completion of work.

3.14 FLASHING

A. All pipe passing through a roof shall be flashed in an approved manner. Flashing shall be perfectly watertight. Flashing shall be provided under this sub-contract, for installation under the roofing division. Sheet lead flashing shall be minimum 4.0 lb. per square foot, with adjustable flashing boot, with minimum 12" square. Size and gauge shall be coordinated with the architectural plans. Lead sanitary vent flashings shall be smoothly shaped and formed into the pipe penetrations to the full available maximum inside diameter of the pipe. The roof penetration/flashing system shall be coordinated and compatible with roofing manufacturers' system. Comply with requirements of Division 07, Section "Thermal and Moisture Protection" for penetration of roofing systems.

3.15 FREEZE PROTECTION

A. Do not run piping in outside walls, ventilated attic or ceiling spaces, or in other locations subject to freezing conditions. Piping adjacent to exterior walls shall be in furred spaces or cavities, on the warm side of the building insulation barrier, with building insulation between the piping and the exterior wall. In attic or ceiling spaces, piping shall be on the warm side of insulation batts. Insulation of piping in and of itself shall not be considered adequate freeze protection. Domestic water piping or non-potable water piping exposed to freezing conditions shall be insulated as specified, with aluminum weather jacket and electric heating cable, thermostatically controlled.

3.16 CLOSEOUT DOCUMENTATION

A. Close out completion shall be dependent upon satisfactory submittal of the following documents related to this contract:

1. Statement certifying that no systems, components or materials employed on the project contain asbestos in any form.
2. Statement certifying that no flux, solder or fittings employed on the project contain lead.
3. Certification of Owners personnel instruction.
4. Certificate of Insulation Compliance.
5. Final Video testing report shall be submitted prior to Substantial Completion.

B. Reference Division I - Section "Project Closeout" for general requirements.

3.17 PROJECT RECORD DOCUMENTS

A. Record drawings shall be submitted that incorporate all changes to the contract, pre-bid and post-bid. Reference each specification section for the required manuals.

B. Video inspection report for all under ground piping systems shall be submitted for review within 60 days after the last floor slab on grade is poured. Refer to "227000 – Plumbing Systems Testing" for requirements.

C. Reference Division 01 - Section "Project Record Documents" for general requirements.

3.18 OPERATION AND MAINTENANCE DATA

A. Operation and maintenance manuals shall be submitted for all major plumbing equipment. Reference each specification section for the required manuals.

B. Reference Division 01 - Section "Operation and Maintenance Data" for general requirements.

END OF SECTION 220500

SECTION 220500 – Exhibit No. 1

CERTIFICATION OF COMPLIANCE - PRIOR APPROVAL REQUEST

To: _____

Project: _____

I have reviewed the contract documents, including but not limited to specifications, drawings, and addenda. To the best of my knowledge the enclosed submittals (circle the appropriate statement); 1) are consistent with and meet the requirements of the aforementioned documents, or 2) are consistent with and meet the requirements of the aforementioned documents with the following exceptions (attach additional pages if necessary):

_____

_____

_____

I further recognize that; 1) the Engineers review is for general conformance with the design concept and with the information given in the contract documents, 2) approval of the submittals, by the engineer, unless specifically noted is for "manufacturer only" and specific requirements shall be as specified, including standard specifications as listed in the manufacturer's data for the actual product specified, 3) approval of the submittals shall in no way be construed to permit any deviations from plans and specifications.

To the best of my knowledge, substitution of the enclosed items will (circle the appropriate statement) 1) not require any modifications to any other element of the project, or 2) require the following modifications (attach additional pages if necessary):

_____
_____
_____
_____-
_____
____

I understand that I will be required to remove and replace at no additional cost to the Owner any item found to be inconsistent with or not meet the requirements of the aforementioned documents.

The undersigned states that the above is true to the best of his knowledge and that his has the authority to legally bind his firm to the above terms. Failure to provide a legally binding signature shall void the prior approval request.

By:_____ Date:_____

Title:_____

Company:_____

SECTION 220500 - Exhibit No. 2

CERTIFICATION OF COMPLIANCE - SHOP DRAWINGS

To_____

Project: _____

I have reviewed the contract documents, including but not limited to specifications, drawings, addenda, and change orders. To the best of my knowledge the materials described by the enclosed shop drawings are consistent with and meet the requirements of the aforementioned documents. I further recognize that; 1) the Engineers review is to assist me in complying with the documents by checking for errors in my interpretation of the requirements set forth in the contract documents, 2) review of shop drawings, by the Engineer, shall not relieve me of my responsibility for confirming and correlating all quantities, dimensions and work with that of other trades, and for performing the work in a safe and satisfactory manner, and 3) review of shop drawings, by the Engineer, shall not permit any deviations from plans and specifications.

I understand that I will be required to remove and replace at no additional cost to the Owner any item found to be inconsistent with or not meet the requirements of the contract documents.

The undersigned states that the above is true to the best of his knowledge and that he has the authority to legally bind his firm to the above terms. Failure to provide a legally binding signature shall void submittal.

Sub Contractor:

By:_____ Date:_____

Ga. State License No (Required). _____

Title: _____

Company: _____

General Contractor:

By:_____ Date: _____

Title: _____

Company: _____

SECTION 220519

METERS AND GAGES 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. Bimetallic-actuated thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.

B. Related Sections:

1. Section 221119 "Domestic Water Piping Specialties" for domestic water gages at water service entrance piping inside the building
2. Section 223300 "Electric Domestic Water Heaters" for thermometers at electric domestic water heaters inside the building.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Retain first paragraph below for product certificates from manufacturers.

B. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two paragraphs and list of manufacturers below. See Section 016000 "Product Requirements."

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

1. Ashcroft Inc.
2. Marsh Bellofram.
3. Trerice, H. O. Co.
4. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
5. Weiss Instruments, Inc.

C. Standard: ASME B40.200.

D. Case in first paragraph below will typically be the sealed (dry) type. Hermetically sealed cases are available.

E. Case: Liquid-filled and sealed type(s); stainless steel or cast aluminum with 9-inch nominal length.

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

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

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

I. Window: plastic.

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

2.2 THERMOWELLS

A. ASME B40.200 uses the following symbols for thermowell materials: "CNR" for copper nickel (90-10), "CUNI" for copper nickel (70-30), "CRES" for corrosion-resistant steel, "NICU" for nickel copper, "ALBR" for aluminum bronze, and "CSA" for steel. Other materials are allowed.

B. Thermowells:

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

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

2.3 PRESSURE GAGES

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

B. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two subparagraphs and list of manufacturers below. See Section 016000 "Product Requirements."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Trerice, H. O. Co.
   d. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   e. Weiss Instruments, Inc.
2. Standard: ASME B40.100.
3. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

C. Match pressure connection size in first subparagraph below with gage attachment size.

1. 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.
2. Movement: Mechanical, with link to pressure element and connection to pointer.
3. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
4. Pointer: Dark-colored metal.
5. Window: Glass.
6. Ring: Metal.
7. Accuracy: +/- 0.5%.

2.4 GAGE ATTACHMENTS

A. Match attachment size in two paragraphs below with pressure-gage-connection size.

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

C. Valves: Brass ball, 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 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 pressure gages in piping tees with pressure gage located on pipe at the most readable position.

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

G. Install test plugs in piping tees where called for on plans.

H. Install thermometers in the following locations:

1. Domestic Water heater supply.
2. Domestic hot water circulating return lines.

I. Install pressure gages in the following locations:

1. Pressure Reducing Valve Stations

3.2 CONNECTIONS

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

3.3 ADJUSTING

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

END OF SECTION 220519

SECTION 220523

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. This Section includes the following general-duty valves:

1. Bronze angle valves.
2. Copper-alloy ball valves.
3. Ferrous-alloy ball valves.
4. Bronze check valves.
5. Cast-iron plug valves.
6. Resilient-seated, cast-iron, eccentric plug valves.

B. Related Sections include the following:

1. Division 22 Section "Mechanical Identification" for valve tags and charts.
2. Division 22 piping Sections for specialty valves applicable to those Sections only.

1.3 DEFINITIONS

A. The following are standard abbreviations for valves:

1. CWP: Cold working pressure.
2. EPDM: Ethylene-propylene-diene terpolymer rubber.
3. NBR: Acrylonitrile-butadiene rubber.
4. PTFE: Polytetrafluoroethylene plastic.
5. SWP: Steam working pressure.
6. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

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, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. 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 hand wheels or stems as lifting or rigging points.

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 VALVES, GENERAL

A. Refer to Part 3 "Valve Applications" Article for applications of valves.

B. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.

C. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.

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

E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

F. Valve Actuators:

1. Hand wheel: For valves other than quarter-turn types.
2. Lever Handle: 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 10 plug valves, for each size square plug head.

G. Extended Valve Stems: On insulated valves.

H. Valve Flanges: ASME B16.1 for cast-iron valves, ASME B16.5 for steel valves and ASME B16.24 for bronze valves.

1. Valve Grooved Ends: AWWA C606.
2. Solder Joint: With sockets according to ASME B16.18.
   a. Caution: Use solder with melting point below 840 deg F for angle, check, gate, and globe valves; below 421 deg F for ball valves.
3. Threaded: With threads according to ASME B1.20.1.

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

2.3 BRONZE ANGLE VALVES

A. Acceptable Manufacturers:

1. Type 1, Bronze Angle Valves with Metal Disc:
   a. Crane Co.; Crane Valve Group; Stockham Div.
   b. Hammond Valve.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
2. Type 2, Bronze Angle Valves with Nonmetallic Disc:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Div.
   d. Anvil International.
   e. Hammond Valve.
   f. NIBCO INC.
3. Type 3, Bronze Angle Valves with Metal Disc and Renewable Seat:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Div.
   d. Anvil International.
   e. Milwaukee Valve Company.

B. Bronze Angle Valves, General: MSS SP-80, with ferrous-alloy hand wheel.

C. Type 1, Class 150, Bronze Angle Valves: Bronze body with bronze disc and union-ring bonnet.

D. Type 2, Class 150, Bronze Angle Valves: Bronze body with nonmetallic PTFE or TFE disc and union-ring bonnet.

E. Type 3, Class 150, Bronze Angle Valves: Bronze body with bronze disc and renewable seat. Include union-ring bonnet.

2.4 COPPER-ALLOY BALL VALVES

A. Acceptable Manufacturers:

1. Two-Piece, Copper-Alloy Ball Valves:
   a. Apollo Valves; Aalberts IPS
   b. Crane Co.; Crane Valve Group; Crane Valves.

c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. Anvil International.
f. Hammond Valve.
g. Milwaukee Valve Company.
h. Watts Industries, Inc.; Water Products Div.
i. Kitz Valve Company

B. Copper-Alloy Ball Valves, General: MSS SP-110.

C. Two-Piece, Copper-Alloy Ball Valves: Brass or bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.

D. Valves installed in the gas piping system shall be AGA rated and labeled.

2.5 FERROUS-ALLOY BALL VALVES

A. Acceptable Manufacturers:

1. Apollo Valves; Aalberts IPS
2. Cooper Cameron Corp.; Cooper Cameron Valves Div.
3. Crane Co.; Crane Valve Group; Stockham Div.
4. Hammond Valve.
5. Milwaukee Valve Company.

B. Ferrous-Alloy Ball Valves, General: MSS SP-72, with flanged ends.

C. Ferrous-Alloy Ball Valves: Class 300, full port.

2.6 BRONZE CHECK VALVES

A. Manufacturers:

1. Type 1, Bronze, Horizontal Lift Check Valves with Metal Disc:
   a. Cincinnati Valve Co.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Stockham Div.
2. Type 1, Bronze, Vertical Lift Check Valves with Metal Disc:
   a. Cincinnati Valve Co.
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Crane Co.; Crane Valve Group; Jenkins Valves.
3. Type 3, Bronze, Swing Check Valves with Metal Disc:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Anvil International.
   d. Hammond Valve.
   e. Milwaukee Valve Company.
   f. Powell, Wm. Co.
   g. Watts Industries, Inc.; Water Products Div.

B. Bronze Check Valves, General: MSS SP-80.

C. Type 1, Class 150, Bronze, Horizontal Lift Check Valves: Bronze body with bronze disc and seat.

D. Type 1, Class 150, Bronze, Vertical Lift Check Valves: Bronze body with bronze disc and seat.

E. Type 2, Class 150, Bronze, Horizontal Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

F. Type 2, Class 150, Bronze, Vertical Lift Check Valves: Bronze body with nonmetallic disc and bronze seat.

G. Type 3, Class 150, Bronze, Swing Check Valves: Bronze body with bronze disc and seat.

H. Type 4, Class 150, Bronze, Swing Check Valves: Bronze body with nonmetallic disc and bronze seat.

2.7 2.07 CAST-IRON PLUG VALVES

A. Manufacturers:

1. Lubricated-Type, Cast-Iron Plug Valves:
   a. Milliken Valve Co., Inc.
   b. Nordstrom Valves, Inc.
   c. Olson Technologies; Homestead Div.
   d. Walworth Co.
2. Nonlubricated-Type, Cast-Iron Plug Valves:
   a. General Signal; DeZurik Unit.
   b. Anvil International.
   c. Mueller Flow Technologies.
   d. Tyco International, Ltd.; Tyco Valves & Controls.

B. Cast-Iron Plug Valves, General: MSS SP-78.

C. Class 125 or 150, lubricated-type, cast-iron plug valves.

D. Class 125 or 150, nonlubricated-type, cast-iron plug valves.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

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

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

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

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

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

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

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly, or plug valves.
2. Throttling Service: Angle, ball, butterfly, or globe valves.
3. Pump Discharge: Spring-loaded, lift-disc check valves.

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

C. Domestic Water Piping: Use the following types of valves:

1. Angle Valves, NPS 2 and Smaller: Type 2, Class 150, bronze.
2. Angle Valves, NPS 2-1/2 and Larger: Type II, Class 250, cast iron.
3. Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
4. Ball Valves, NPS 2-1/2 and Larger: Class 150, ferrous alloy.
5. Swing Check Valves, NPS 2 and Smaller: Type 4, Class 150, bronze.
6. Swing Check Valves, NPS 2-1/2 and Larger: Type II, Class 250, gray iron.
7. Plug Valves, NPS 2 and Larger: Class 125 or 150, lubricated-type with FDA-approved-material sealant, cast iron.

3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

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

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

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

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

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.

G. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

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

B. Soldered Joints: Use ASTM B 813, water-soluble, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

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

END OF SECTION 220523

SECTION 220529

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 mechanical system piping and equipment:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Fastener systems.
5. Equipment supports.

B. Related Sections include the following:

1. Division 5 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

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 SUBMITTALS

A. Product Data: For the following:
1. Steel pipe hangers and supports

B. Shop Drawings: 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. Equipment supports.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." AWS D1.3, "Structural Welding Code--Sheet Steel." 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

2.1 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. B-Line Systems, Inc.; a division of Cooper Industries.
   2. ERICO/Michigan Hanger Co.
   3. Grinnell Corp.
   4. PHD Manufacturing, Inc.

C. Galvanized, Metallic Coatings: Pre-galvanized 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. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. 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 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: 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.

1. Manufacturers:
   a. B-Line Systems, Inc.; a division of Cooper Industries.
   b. Hilti, Inc.
   c. Powers Fasteners.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes. All supplementary supporting steel for work under this Division shall be provided under this Division of the specifications in accordance with the plans and accepted practices.

2.7 MISCELLANEOUS MATERIALS

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

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

1. Properties: Non-staining, 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 non-insulated or insulated stationary pipes, NPS 1/2 to NPS 8.

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 10.

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

1. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

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. C-Clamps (MSS Type 23): For structural shapes.
6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
7. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
8. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

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.

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.

N. Install a minimum 18”x18” section of room membrane under each intermediate pipe support on roof.

3.2 HANGER AND SUPPORT INSTALLATION

A. SUSPENDED HORIZONTAL PIPING

1. Support Spacing:

NOMINAL PIPE SIZE	MATERIAL	MAXIMUM SPACING OF SUPPORTS /FT.
Up through 1-1/2"	Steel & Copper	6'-0"
2" through 8"	Steel & Copper	8'-0"
3" through 5"	Cast Iron	5'-0"
6" and above	Cast Iron	5'-0"
All sizes	Plastic	4'-0"

2. In addition to the above maximum spacing requirements, hangers and supports shall be installed within 18" of each change in direction, regardless of pipe size or material.
3. Provide all hangers and rods, turnbuckles, angles, channels and other structural supports to support the piping systems. Rods for pipe hangers shall be as follows:

HANGER ROD DIAMETER	PIPE SIZE
3/8"	2" and smaller
1/2"	2-1/2" and 3"
5/8"	4" and 5"
3/4"	6"

4. Intermediate pipe supports provided between building structural members so as not to exceed maximum support spacing specified from top chord of framing joist shall be structural steel angles (minimum 2-1/2" X 2-1/2" X 1/4").
5. All ferrous metal pipe hangers and supplemental steel shall be provided with factory applied coat of rust inhibitive paint, plating or galvanizing.
6. Pipe hangers for suspending the following horizontal insulated piping shall be sized to fit around the pipe, pipe insulation and pipe insulation protective shields.
   a. Cold water piping
   b. Domestic hot water supply and recirculating piping
7. All supporting equipment shall be designed with a minimum factor of safety of five based on the ultimate tensile strength of the materials employed.

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. Fastener System Installation:

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

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

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

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

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

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

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

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

M. 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.
4. Shield Dimensions for Pipe:
   a. Provide galvanized sheet metal pipe insulation protection shields at each pipe hanger for all horizontal insulated water pipes and condensate drain pipes. Shield sizes shall be:
      1) Pipes 2" and smaller: 18-gauge X 12" long
      2) Pipes 2-1/2" and larger: 16-gauge X 18" long

b. Shields shall be 180-degree type at all pipe hangers, except that on trapeze hangers, pipe rack and on floor supported horizontal pipe shields shall be 360 degree type. For pipe sizes 2-1/2" and larger, use Foamglass inserts at all shields, hangers, sleeves, etc.
   1) Pipes NPS 2-1/2" and Larger: Include wood or foamglass inserts.
   2) Insert Material: Length at least as long as protective shield.

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

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 procedure 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.

C. Roof pipe supports adjustments: Adjust gas pipe supports to distribute loads equally and adjust elevation to achieve a level of pipe installation between permanent/seismic pipe anchors.

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 9 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 220529

SECTION 220553

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. This Section includes the following mechanical identification materials and their installation:

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

1.3 SUBMITTALS

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

B. Valve numbering scheme.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

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

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

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

1.6 EQUIPMENT TO BE IDENTIFIED

A. Provide equipment identification for the following:

1. Domestic electric water heaters. (DWH-…)
2. Domestic hot water circulating pumps. (CP-…)
3. Domestic water system tempering valves. (TV-…)
4. Trap primer units located above ceilings.TP-…)

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Labels: 2" high black film adhesive backed letters.

1. Data:
   a. Name and plan number.
2. Location: Accessible and visible.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers not acceptable.

C. Plastic Tape not acceptable.

D. Acceptable Manufacturers:

1. T&B/ Westline
2. Seton
3. MSI (Marking Services, Inc.)
4. Brimar Identification & Safety Products
5. Brady

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme. Provide 5/32-inch hole for fastener.

1. Material: 19-gauge minimum brass, 1-1/2" minimum size.
2. Valve-Tag Fasteners: Self locking cable ties.

B. Acceptable Manufacturers:

1. T&B/ Westline
2. Seton
3. MSI (Marking Services, Inc.)
4. Brimar Identification & Safety Products
5. Brady

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 4 Inches: Snap-on/self-coiling pipe markers. Use color-coded markers lapped at least 1-1/2 inches at both ends of pipe marker and covering full circumference of pipe.
2. Pipes with OD, Including Insulation, 4 Inches and Larger: Snap-on/self coiling pipe markers. Use color-coded markers with permanent nylon fastener straps, one on each end.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 20 feet along each run or otherwise at each wall.
7. Pipe markings on piping more than 7'-0" above floor shall be rotated to allow full observation from floor.

C. Band and letter sizes shall conform to the following table:

O.D. of Piping of Covering:	Width of Color Band	Size of Letter/Numbers
1" and smaller	6"	1/2"
1-1/4" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" and larger	18"	2"

D. Band legend and color and letter color shall conform to the following table:

Piping	Band Legend	Letters	Band Color
Domestic Cold-Water	CW	Black	Green
Domestic Hot Water	HW	Black	Yellow
Domestic Circulating HW	HWC	Black	Yellow
Natural Gas	G	Black	Yellow
Compressed Air	CA	Black	Yellow

3.3 VALVE-TAG INSTALLATION

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

3.4 IDENTIFICATION

1. SYSTEM SHAPE NUMBERS
   Cold Water (Domestic) Round CW-1,2,3.....
   Hot Water (Domestic) Round HW-1,2,3.....
2. Each valve tag shall be attached to the hand wheel or lever handle with jack chain or "S" hooks.
3. A valve chart, framed under glass and wall mounted, shall be located in the main mechanical room and shall list each valve by identification number, its location in the piping system - (i.e., hot water, fire main, water heater, etc.) and its function -(i.e., shut-off, balancing, drain, etc.).
4. Gas valves at the meter, the emergency gas generator, and on the roof shall not have valve tags.
5. All ceiling tiles which provide access to valves shall have a color-coded valve identification number affixed to the permanent ceiling grid immediately below the valve or a 1/2" high black stencil on clear background from a label maker manufactured for that purpose.

3.5 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.6 CLEANING

A. Clean faces of mechanical identification devices.

3.7 UNDERGROUND PIPING IDENTIFICATION

A. All underground PVC piping installed outside the building pad shall have continuous warning identification tape installed 12" above the top of the pipe and a minimum of 6" below finished grade.

B. All underground PVC piping installed outside the building shall have a continuous # 10 copper tracer wire installed on the top of the pipe and attached with cable ties on 6' centers maximum spacing and within 12" from tees, branch connections and manufactured elbows.

END OF SECTION 220553

SECTION 220700

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. This Section includes plumbing insulation for equipment and pipe, including the following:

1. Insulation Materials:
   a. Cellular glass.
   b. Flexible elastomeric.
   c. Mineral fiber.
   d. Polyolefin.
2. Adhesives.
3. Mastics.
4. Sealants.
5. Factory-applied jackets.
6. Field-applied fabric-reinforcing mesh.
7. Field-applied jackets.
8. Tapes.

1.3 DEFINITIONS

A. ASJ: All-service jacket.

B. FSK: Foil, scrim, kraft paper.

C. FSP: Foil, scrim, polyethylene.

D. SSL: Self-sealing lap.

1.4 SUBMITTALS

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

B. Shop Drawings: Show details for the following:

1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Insulation application at pipe expansion joints for each type of insulation.
3. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Removable insulation at piping specialties, equipment connections, and access panels.
5. Application of field-applied jackets.
6. Application at linkages of control devices.
7. Field application for each equipment type.

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 and test methods employed.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

A. Coordinate 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.

1.8 SCHEDULING

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

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 INSULATION MATERIALS

A. Refer to Part 3 schedule articles for requirements about 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. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

G. Products:
   a. Cell-U-Foam Corporation; Ultra-CUF.
   b. Pittsburgh Corning Corporation; Foamglas Super K.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

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

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products:
   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 a factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

J. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Products:
a. Armacell LLC; Tubolit.
b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
c. RBX Corporation; Therma-cell.

K. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

L. Products: Subject to compliance with requirements:

M. CertainTeed Corp.; Duct Wrap.

N. Johns Manville; Microlite.

O. Knauf Insulation; Duct Wrap.

P. Manson Insulation Inc.; Alley Wrap.

Q. Owens Corning; All-Service Duct Wrap.

2.3 ADHESIVES

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

B. Cellular-Glass, Phenolic-Foam, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products:
a. Childers Products, Division of ITW; CP-96.
b. Foster Products Corporation, H. B. Fuller Company; 81-33.
c. Pittsburgh-Corning

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

1. Products:
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.

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

1. Products:
   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:
   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.

2.4 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:
   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.

2.5 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products:
   a. Childers Products, Division of ITW; CP-76.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45.

c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.
f. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

2.8 FIELD-APPLIED JACKETS AND FITTING COVERS

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

B. PVC Jacket/fitting cover: 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:
   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. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.9 TAPES

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

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

1. Products: Subject to compliance with requirements:
   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.
   a. Tensile Strength: 34 lbf/inch in width.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Verify that systems and equipment to be insulated have been tested and are free of defects.

1. Verify that surfaces to be insulated are clean and dry.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. 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.

3.3 COMMON INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

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

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

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

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

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

J. 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
4. Insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
5. 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.

6. 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. 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 duct and pipe 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.

O. All domestic water piping in walls and chases shall be insulated unless otherwise noted on plans.

P. All horizontal rainwater/downspout and overflow roof drain piping installed overhead in spaces exposed to view shall be insulated as specified for domestic water piping. Pipe shall be entirely wrapped with glass fiber mesh wrap and coated with two coats of waterproof mastic and made ready for final painting.

3.4 PENETRATIONS

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

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

1. Firestopping and fire-resistive joint sealers are specified in Division 07 Sections "Penetration Firestopping" and "Fire-Resistive Joint Systems".

C. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies according to Division 07 Section "Penetration Firestopping".

3.5 GENERAL PIPE INSULATION INSTALLATION

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

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, 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 covers with insulation material and density equal to adjacent straight piping sectional 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 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.

3.6 CELLULAR-GLASS INSULATION INSTALLATION

1. Insulation Installation on Straight Pipes and Tubes:
2. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
3. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
4. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.

5. For insulation with factory-applied jackets on below ambient services, 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 cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
5. Insulation Installation on Pipe Fittings and Elbows:
6. Install preformed sections of same material and density as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
7. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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.

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 manufacturers' 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 under fitting covers.
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
3. insulation to valve body.
4. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

5. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on rainwater, downspout and overflow drain piping and sumps (where piping is not exposed to view):

1. Secure with FSK tape and wire at 36" intervals along entire horizontal run of insulation.
2. Secure roof drain sump insulation with FSK tape. All metal surfaces of roof drain body, inclusive of under deck clamps shall be insulated.
3. Tape applied to longitudinal seams shall be continuous.
4. Horizontal downspout and overflow drain piping shall be insulated from underside of roof deck to 12" beyond elbow turned down in wall or chase.

F. Insulation Installation on rainwater, downspout and overflow drain piping and sumps (where piping is exposed to view):

1. Insulate and finish piping the same as for domestic water piping system with the following additions:
   a. Glass fiber mesh tape shall be wrapped continuous around the insulation cover throughout the entire pipe length.
   b. Insulation surface shall have two coats of waterproof mastic applied.

3.9 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturers' 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 polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers' 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 polyolefin 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 cut sections of polyolefin pipe and sheet insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
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.

3.10 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.
   a. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
4. 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 manufacturers' 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.

E. 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 pre-sized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install pre-sized jacket with an approximate overlap at butt joint of 2 inches over the previous section.
3. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
4. 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.

5. 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.
6. 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.

3.11 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 9 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.

3.12 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. Below-grade piping. (Except copper piping shall have protective sleeve or coating).
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
3. Pipe risers to water hammer arrestors/shock absorbers above ceiling.
4. Trap Primer piping from distribution unit to drains on traps.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. 4" and Smaller: Insulation shall be the following:
   a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. 2" and Smaller: Insulation shall be the following:
   a. Mineral-Fiber Pipe Insulation, Type I: 1 inch thick.

C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be the following:
   a. Flexible Elastomeric: 1/2 inch thick.
   b. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.
   c. Polyolefin: 1/2 inch thick.

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

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.

E. Overhead Floor Drains, Traps, and Sanitary Drain Piping within 5 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:
   a. Flexible Elastomeric: 1/2 inch thick.
   b. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.

F. Rainwater/Downspout and Overflow drain piping above ceilings inclusive of roof and overflow drain sumps.

G. All pipe sizes: Insulation shall be the following:

H. Blanket fiberglass insulation 1-1/2" thick.

I. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick. (where exposed to view)

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Piping, Exposed:

1. PVC: 20 mils thick.

2. Aluminum, Smooth or Corrugated: 0.020 inch thick.

END OF SECTION 220700

SECTION 221116

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. This Section includes domestic water piping inside the building.

B. Related Sections include the following:

1. Division 02 Section "Water Distribution" for water-service piping outside the building from source to the point where water-service piping enters the building.
2. Division 22 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
3. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

A. Water Samples: Specified in Part 3 "Cleaning" Article.

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

C. "PEX" type piping shall not be used.

2.2 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
4. Manufacturers:
   a. Cambridge Lee
   b. Howell Metal
   c. Cerro Flow Products

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

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought- copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
4. Manufacturers:
   a. Cambridge Lee
   b. Howell Metal
   c. Cerro Flow Products

C. Wrought Copper and Copper Alloy Solder Joint Pressure Fittings:

1. Copper Pressure Fittings: ASME/ANSI standard B16.18 cast copper-alloy or ASME B16.22, wrought-copper solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Wrought-copper fittings must be NSF/ANSI 61 registered.
   a. Cello Products
   b. Elkhardt Products
   c. Mueller Industries
   d.

2.3 VALVES

A. Bronze and cast-iron, general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Balancing and drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILL

A. Perform all excavation and backfilling for work included in Division 22 of the specifications.

3.2 EXCAVATION

A. Excavations shall be performed in strict accordance with latest OSHA regulations. Sheeting, bracing, barricades and fencing shall be installed wherever necessary to avoid undue hazards to workmen or passersby.

B. During excavation, material shall be piled at a distance from the banks of the excavation that will avoid overloading and will prevent slides and/or cave-ins. Water accumulating in excavations shall be removed by pumping. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled under sidewalks and curbs where pipe can be installed as specified and back-fill can be tamped. All trenches and pit excavations shall be shored and/or braced as required to prevent slides and/or cave-ins.

C. The bottom of the trenches shall be graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length, except for the portions of the pipe sections where it is necessary to excavate for bell holes and the making of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded. Over-depths shall be backfilled as specified and with materials for backfilling as specified.

3.3 BACKFILLING

A. The trenches shall not be backfilled until all required pressure and/or leak tests on piping are performed and until the mechanical systems as installed conform to requirements specified in the several sections covering the installation of the various systems. Trenches shall be backfilled to the ground surface with clean, selected excavated material or other material that meets compaction requirements and as hereinafter specified. Pavement and base course disturbed by trenching operation shall be restored to its original condition.

B. Backfill material shall be deposited in 6-inch thick layers and compacted with mechanical tamps to the density of the adjacent soil or grade until there is a cover of not less than 2 feet over pipes. The backfill material in this portion of the trench shall consist of earth, sandy clay, soft shale, or other materials free from objects larger than 1 inch in any direction.

C. The remainder of the trench shall be backfilled with clean, select material that is free of stones larger than 3 inches in any direction. Backfill material shall be deposited in layers not exceeding 6 inches thick, and each layer shall be compacted mechanically. Settling of granular, non-cohesive material with water

will be permitted. The surface shall be mounded over for settling and left in a uniform condition.

3.4 COMPACTION AND TESTING

A. Areas under building locations, paving, walks or other structures which may be placed on site at a future date shall be compacted to 95% minimum dry proctor.

3.5 PIPE AND FITTING APPLICATIONS

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

B. Flanges may be used on aboveground piping, unless otherwise indicated.

C. Under-Building-Slab, Water-Service Piping on Service Side of Water Meter: Refer to Division 2 Section "Water Distribution."

D. Under-Building-Slab, Domestic Water Piping on House Side of Water Meter, NPS 3/4" and Smaller: Soft copper tube, Type K; copper pressure fittings; no joints below slab.

E. Aboveground Domestic Water Piping: Use the following piping materials:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.

F. Non-Potable-Water Piping: Use the following piping materials for each size range:

1. 1-1/2 and Smaller: Soft copper tube, Type K; copper pressure fittings; and soldered joints. No joints below slab.

3.6 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use bronze ball valves for piping 3" and smaller.
2. Throttling Duty: Use full port bronze ball valves for piping 2" and smaller.
3. Hot-Water-Piping, Balancing Duty: Memory-stop balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use full port ball valves for piping 3" and smaller.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

1. Install hose-end drain valves at low points in water mains, risers, and branches.
2. Install stop-and-waste drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping 2" and smaller. Balancing valves are specified in Division 22 Section "Domestic Water Piping Specialties."

3.7 PIPING INSTALLATION

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

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

C. Install steel pipe 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 Plumbing."

D. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Wall penetration systems are specified in Division 22 Section "Common Work Results for Plumbing."

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Pressure gages are specified in Division 23 Section "Meters and Gages for Plumbing Piping," and drain valves and strainers are specified in Division 22 Section "Domestic Water Piping Specialties."

F. Install water-pressure regulators downstream from shutoff valves. Water-pressure regulators are specified in Division 22 Section "Domestic Water Piping Specialties."

G. Install domestic water piping level and plumb.

3.8 JOINT CONSTRUCTION

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

B. Soldered Joints: Use ASTM B 813, water-soluble, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

C. Press Fit Joints: Copper press fit fittings shall conform to the material requirements of ASME B16.18 or ASME B16.22. Sealing elements for press fittings shall be EPDM and factory installed. Press ends shall feature a design that indicates press stop to ensure sealing element has full penetration prior to compression operation.

3.9 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support devices 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. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

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

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

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

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1-1/2: 72 inches with 3/8-inch rod.
3. NPS 2 thru NPS 3: 96 inches with 1/2-inch rod.
4. NPS 4 thru NPS 6: 96 inches with 5/8-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

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

3.10 CONNECTIONS

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

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

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

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

1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.11 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

1. Do not enclose, cover, or put piping into operation until it has been inspected, tested and approved by authorities having jurisdiction (AHJ), the Owner, and the Building inspections department.
2. Notification of Inspections shall include the Architect, Engineer, Building Inspections Department (AHJ) and the Owner. A notification of at least 48 hours shall be given before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction. All reports shall be submitted to the Architect with any required corrective action listed once test is completed.

B. Test domestic water piping as follows:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four (4) hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.12 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
   b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.13 CLEANING

A. Contractor shall provide signage at all potable water outlets where systems or portions of systems are being tested with date and duration of test(s) prior to commencement of disinfection procedure. Notification of system cleaning shall be sent to the Architect’s office 24 hours prior to actual performance of work. A copy of the biological examination of the test results shall be sent to the Architect’s office for review and approval.

B. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:
        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours. Open and close all valves in system several times during the retention period.
    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time. Open and close all valves in the system several times during the flushing period.
    d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

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

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

END OF SECTION 221116

SECTION 221119

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. Hose bibbs.
8. Wall hydrants.
9. Drain valves.
10. Water hammer arresters.
11. Trap-seal primer valves.
12. Individual fixture water tempering valves.
13. Trap Primer Distribution System
14. Roof Hydrants
15. Sanitary Roof Hydrants

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers and pressure gages in domestic water piping systems.

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

1.5 QUALITY ASSURANCE

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

B. NSF Compliance:

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

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Size: As required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded or sweat.
6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Woodford Manufacturing Company.
2. Vacuum breakers shall be provided on all outlets threaded for hose ends. Vacuum breakers shall be the screw on vandal proof type with hose outlet threads.

2.2 BACKFLOW PREVENTERS

A. 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. Watts Industries, Inc.; Water Products Div.
2. Dual Check Valves shall be ASSE approved dual check valve backflow preventers, bronze constructed with dual check assemblies and replaceable seals and union end.

B. Hose-Connection 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. Woodford Manufacturing Company.
2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water back pressure.
4. Inlet Size: NPS 3/4.
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm flow.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Cash Acme.
   b. Conbraco Industries, Inc.
   c. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size: As shown on plans.
5. Body: Bronze body construction with removable strainer, threaded connections and renewable seats. Provide stainless steel spring, stainless steel adjusting screw and stainless-steel screws and fasteners throughout.
6. Flow rates and reduced pressure fall-off shall be within limits set by the applicable plumbing code.

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. ITT Industries; Bell & Gossett Div. – circuit setter plus
   b. Taco - Accu-flo
   c. Armstrong – CBV-S
2. Type: Ball valve with differential readout ports, internal EPT inserts, check valve, and memory stop with name plate for set point feature. Valve shall be leak tight at full rated working pressure of 175 psig at 250 degrees.
3. Body: Brass or bronze.
4. Size: Same as connected piping, but not larger than NPS 2.

2.5 THERMOSTATIC WATER MIXING VALVES (TV)

A. Water-Temperature Limiting Devices:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Conbraco Industries, Inc.
b. Leonard Valve Company.
c. Powers; a Watts Industries Co.
d. Symmons Industries, Inc.
e. Lawler Mfg. Co.

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 inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 90 deg F.
9. Tempered-Water Design Flow Rate: As shown on plans.
10. Valve Finish: Rough bronze
11. Unit shall be factory tested.
12. Install per manufacturers' recommendations.
13. Install thermometer, if not part of unit, on tempered water discharge line.

2.6 INDIVIDUAL FIXTURE, WATER TEMPERING VALVES

A. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Lawler Manufacturing Company, Inc. – 911E/F
   b. Leonard Valve Company. – TA-300
   c. Powers; a Watts Industries Co. – ES 150
2. Standard: ASSE 1071 and ANSI Z358.1, 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: 60-95 degree F. range adjustable with internal cold water bypass.
6. Inlets and Outlet: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 85 deg F.

2.7 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating 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. Drain: Factory-installed, hose-end drain valve.

2.8 HOSE BIBBS

A. Hose Bibbs (HB):

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 Mechanical Closets or Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Hose bibbs shall not be used in finished rooms. Interior wall hydrants shall be used.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Include operating key with each operating-key hose bibb.
14. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.9 WALL HYDRANTS

A. Exterior Non-freeze Wall Hydrants (NFWH):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Woodford Manufacturing Company
   e. Watts Industries
   f. Wade Industries
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.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, cast bronze, flush mounting with cast bronze cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): One with each wall hydrant.

B. Interior Wall Hydrants (WH):

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

a. Josam Company.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Woodford Manufacturing Company.
e. Watts Industries
f. Wade industries

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants, less non-freeze features.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Inlet: NPS 3/4.
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, cast bronze, flush mounting with cast bronze cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Keys(s): One 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 (WHA or SA):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.
   b. Jay R. Smith Mfg. Co.
   c. Zurn
   d. Watts Industries
   e. PPP Inc. SBHA series
2. Standard: PDI-WH 201.
3. Type: Metal bellows.
4. Size: PDI-WH 201, Sizes A through F.

2.12 TRAP-SEAL PRIMER VALVES (TP)

A. Supply-Type, Trap-Seal Primer Valves, electronically operated delivering potable water across an air gap funnel:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MIFAB, Inc.; M1-200-24 AC
   b. PPP Inc.; SP-500-24V
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
8. Distribution units shall be compatible with manufactured product and include 1/2" compression connections for trap primer piping downstream of unit.
9. See plans for application and locations.
10. Coordinate purchase and installation of stepdown transformers with electrical and/or controls contractor.
11. 24V power and control to unit shall be coordinated with controls contractor.

2.13 TRAP PRIMER DISTRIBUTION SYSTEMS (TPDU)

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. PPP Inc. Prime-Time PT Series
   b. Zurn Industries. Z-1020
   c. Mifab MI-100
2. Standard: ASSE 1044,
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Surface-mounting steel box with steel cover.
5. Electric Controls: solenoid valve on EMS control, and manual switch for 24 V ac power.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: As shown on plans.
8. Size Outlets: NPS 1/2.
9. 24V power and control to unit shall be coordinated with controls contractor.

2.14 ROOF HYDRANTS

A. Non-freeze, Automatic Draining Roof Hydrants with Roof Mounting System

1. Standard: ASSE 1052
2. Manufacturers:
   a. Woodford Model RHY2-MS
   b. Zurn

c. Watts

3. Operation: Lever piston operating mechanism with drain port designed to discharge into the drainage system automatically via 1/8" NPT thus not requiring a flushing maintenance procedure.
4. Roof attachment: Separate mounting system consisting of cast iron basin to be installed by the roofing contractor.
5. Length: Valve body inlet to be located in heated area.
6. Inlet: 1" NPT.
7. Outlet: Dual check vacuum breaker compliant with ASSE 1052
   a. Garden-hose thread complying with ASME B1.20.7 on outlet.

B. Install on roof in pre-manufactured pipe curb assembly flashed to roof with weather-proof penetration where required in existing roof. Unit shall be secured to roof deck.

2.15 SANITARY ROOF HYDRANTS

B. Sanitary Roof Hydrants with Roof Mounting System

1. Standard: ASSE 1052
2. Manufacturers:
   a. Woodford Model SRH-MS
   b. Zurn
   c. Watts
3. Operation: Lever piston operating mechanism.
4. Roof attachment: Separate mounting system consisting of cast iron basin to be installed by the roofing contractor.
5. Length: Valve body inlet to be located in heated area.
6. Inlet: 1" NPT.
7. Outlet: Dual check vacuum breaker compliant with ASSE 1052
   a. Garden-hose thread complying with ASME B1.20.7 on outlet.
8. Provide metal tag/signage for winterizing procedure affixed to hydrant. Hydrant is not auto draining.
9. Install on roof in pre-manufactured pipe curb assembly flashed to roof with weather-proof penetration where required in existing roof. Unit shall be secured to roof deck.

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 water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

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.
3. Install on wall accessible from floor.

F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve, solenoid valve.

G. Install water hammer arresters in water piping according to PDI-WH 201 and accessible above ceilings. Install access panels where required in hard ceilings.

H. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow. Valve shall be installed above accessible ceilings.

I. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

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."

C. Connect wiring according to Division 26 Section "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. Dual-check-valve backflow preventers.
2. Water pressure-reducing valves.
3. Calibrated balancing valves.
4. Primary, thermostatic, water mixing valves.
5. Domestic Water Heaters.

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 "Mechanical Identification."

3.4 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.

D. Set field-adjustable temperature limit stops on faucets.

END OF SECTION 221119

SECTION 221316

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1. Pipe, tube, and fittings.

B. PERFORMANCE REQUIREMENTS

C. 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.

1.3 SUBMITTALS

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

B. Shop Drawings:

1. Include plans, elevations, sections, and details.

C. Field quality-control inspection and test reports.

1.4 QUALITY ASSURANCE

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

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 74, above floor for sanitary waste and vent. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF.

1. Manufacturers:
   a. Charlotte Pipe
   b. Tyler Pipe
   c. AB&I

B. Shielded Couplings: ASTM 1540 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
   a. Manufacturers:
      1) Clamp-All Corp. - Model 80
      2) Husky – SD-2000
      3) Tyler Pipe; Soil Pipe Div.
      4) Mifab

2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
   a. Manufacturers:
      1) Cambridge Lee
      2) Howell Metal
      3) Cerro Flow Products

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILL

A. Perform all excavation and backfilling for work included in Division 22 of the specifications.

3.2 EXCAVATION

A. Excavations shall be performed in strict accordance with latest OSHA regulations. Sheeting, bracing, barricades and fencing shall be installed wherever necessary to avoid undue hazards to workmen or passersby.

B. During excavation, material shall be piled at a distance from the banks of the excavation that will avoid overloading and will prevent slides and/or cave-ins. Water accumulating in excavations shall be removed by pumping. Unless otherwise indicated, excavation shall be by open cut except that short sections of a

trench may be tunneled under sidewalks and curbs where pipe can be installed as specified and back-fill can be tamped. All trenches and pit excavations shall be shored and/or braced as required to prevent slides and/or cave-ins.

C. The bottom of the trenches shall be graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length, except for the portions of the pipe sections where it is necessary to excavate for bell holes and the making of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded. Over-depths shall be backfilled as specified and with materials for backfilling as specified.

3.3 BACKFILLING

A. The trenches shall not be backfilled until all required pressure and/or leak tests on piping are performed and until the mechanical systems as installed conform to requirements specified in the several sections covering the installation of the various systems. Trenches shall be backfilled to the ground surface with clean, selected excavated material or other material that meets compaction requirements and as hereinafter specified. Pavement and base course disturbed by trenching operation shall be restored to its original condition.

B. Backfill material shall be deposited in 6-inch thick layers and compacted with mechanical tamps to the density of the adjacent soil or grade until there is a cover of not less than 2 feet over pipes. The backfill material in this portion of the trench shall consist of earth, sandy clay, soft shale, or other materials free from objects larger than 1 inch in any direction.

C. The remainder of the trench shall be backfilled with clean, select material that is free of stones larger than 3 inches in any direction. Backfill material shall be deposited in layers not exceeding 6 inches thick, and each layer shall be compacted mechanically. Settling of granular, non-cohesive material with water will be permitted. The surface shall be mounded over for settling and left in a uniform condition.

3.4 COMPACTION AND TESTING

A. Areas under building locations, paving, walks or other structures which may be placed on site at a future date shall be compacted to 95% minimum dry proctor.

3.5 PIPING APPLICATIONS

A. Aboveground, soil and waste piping 6" and smaller shall be the following:

1. Hubless cast-iron soil pipe and fittings heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
2. Copper DWV tube, copper drainage fittings, and soldered joints.

B. Underground, soil, waste, and vent piping 10" and smaller shall be the following:

1. Service weight, cast iron soil piping; hub and spigot, compression gaskets or lead and oakum joints.

3.6 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 33 Section "Site Sanitary Sewer Construction."

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

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

D. 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."

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

F. 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.

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

1. Building Sanitary Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller or 2 percent where called for on plans; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 1 percent downward in direction of flow or 2 percent where called for on plans.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

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

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

3.7 JOINT CONSTRUCTION

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

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

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.8 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.9 HANGER AND SUPPORT INSTALLATION

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

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer than 100 feet: MSS Type 43, adjustable roller hangers.
   c. Longer than 100 feet, if indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

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

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

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

E. 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.

F. Install supports for vertical cast-iron soil piping every 15 feet.

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

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

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

3.10 CONNECTIONS

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

B. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.11 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. Water 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.

E. Video camera testing shall be performed on under floor sanitary waste systems to the sanitary sewer manhole connection. Refer to section 227000 "Plumbing Systems Testing" requirements, procedures and reporting.

1.1 PIPING IDENTIFICATION

F. All above ground sanitary piping shall be identified with pipe identification labels as specified in Division 22 Section "Identification for Plumbing Piping and Equipment".

1.
2. B. All underground piping installed outside the building pad shall have continuous warning identification tape installed 12" above the top of the pipe and a minimum of 6" below finished grade.

3.12 CLEANING

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

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

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

END OF SECTION 221316

SECTION 221319

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 drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Roof drains.
4. Overflow roof drains.
5. Roof flashing assemblies.
6. Through-penetration firestop assemblies.
7. Miscellaneous drainage piping specialties.

B. Related Sections include the following:

1. Division 22 Section "Plumbing Fixtures" for hair interceptors.

1.3 DEFINITIONS

A. PE: Polyethylene plastic.

B. PVC: Polyvinyl chloride plastic.

1.4 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 and storm piping specialty components.

1.5 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.

C. Coordinate locations of wall cleanouts so as not to be located behind casework or cabinets.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Cleanouts shall be provided where shown on the drawings, and as required by the applicable plumbing code. All wall and floor cleanouts shall have access cover and cleanout plugs removed, at time of final project review.

B. Cleanouts on under floor drainage piping shall have piping extended to the floor and finished with cleanout plug and removable floor plate.

C. Cleanouts installed in carpeted areas shall have carpet marker and securing screw.

D. Cleanouts in waterproofed floors or overhead slabs shall have flashing clamps.

E. Cleanouts in vertical piping shall be roughed with centerline not more than 1'-6" above the finished floor, but high enough for escutcheon cover to clear the baseboard.

F. For Walls: Cleanouts shall be no-hub cleanout tee with bronze countersunk plug tapped for machine screw with shallow stainless-steel face-of wall access cover.

1. Jay R. Smith 4510-Y
2. Josam 58790
3. Wade 8560E
4. Zurn Z-1446-BP
5. Watts Drainage CO 460 RD

G. For Concrete Floors: Cleanouts shall have cast iron body, adjustable round scoriated nickel bronze cover and rim and countersunk taper threaded bronze plug.

1. Jay R. Smith 4028C-U-PB
2. Josam 56000-15-22
3. Wade W-6010-75
4. Zurn Z-1405-2
5. Watts Drainage CO 200 R

H. Yard Cleanouts: Cleanouts shall have tractor weight cast iron housing and countersunk bronze plug. Cleanouts shall be set in a 16" X 16" X 6" deep poured concrete pad set flush with grade.

1. Jay R. Smith 4243-U
2. Josam 56050-22
3. Wade 7030-2
4. Zurn Z1450-1
5. Watts Drainage CO 200 RX-4-34B

I. A cleanout plug and cleanout cover removal tool for each type cleanout plug and cleanout cover shall be installed on wall of main mechanical room at close-out of project for use by school personnel. Cleanout tools shall be turned over to the Architect and signed for prior to substantial completion.

J. Immediately prior to Owner's final review, all wall and floor cleanout plugs shall be removed from cleanouts on the final project review to assure the Owner that cleanout plugs can be removed without any obstructions. Apply anti-seize lubricant to all threads of cleanout plugs and replace cleanout plugs and access covers immediately following Owner's final review.

1. Acceptable manufacturers of anti-seize lubricants:

a. Fel-Pro C5-A
b. Rectorseal Break-out
c. Lub-O-Seal Never-seez

2.2 FLOOR DRAINS

A. FD-1:

1. Floor drains shall have a cast iron body and flashing flange with adjustable 6" round nickel bronze strainer attached with stainless steel philips head screws, sediment bucket, and trap primer connection.
2. Drains shall be: Jay R. Smith 2010-A-B-P050 or approved equal by Josam, Mifab, Zurn, Wade or Watts Drainage.

B. FD-2:

1. Floor drain shall have coated cast iron body and flashing flange, 7" round nickel bronze strainer with anti splash collar.
2. Drains shall be: Jay R. Smith 2010-A-F-37 or approved equal by Josam, Mifab, Zurn, Wade or Watts Drainage.

C. FD-3: (Mechanical Rooms):

1. Drain shall be coated cast iron body and cast-iron flashing clamp, 9" diameter adjustable cast iron grate with sediment bucket and 1/2" trap primer tapping.
2. Drains shall be: Jay R. Smith 2350-B-P050 or approved equal by Josam, Mifab, Zurn, Wade or Watts Drainage.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Acorn Engineering Company; Elmdor/Stoneman Div.
   b. Thaler Metal Industries, Ltd
   c. Zilla Flashing Products, Inc.

B. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 10 inches from pipe, with galvanized-steel boot reinforcement and counter flashing fitting.

2.4 ROOF DRAINS

A. Metal Primary Roof Drains (RD):

1. Basis-of-Design Product: Jay R. Smith 1015-C-R-CID or a comparable product by one of the following:
   a. Josam Company; Josam Div.
   b. Zurn Plumbing Products Group; Specification Drainage Operation
   c. Watts Drainage
2. Standard: ASME A112-21.2M
3. Pattern: Roof drain.
4. Body Material: Cast iron
5. Dimensions of Body: Nominal 15" drain

6. Combination Flashing Ring and Gravel Stop: Required
7. Flow-Control Weirs: Not required
8. Outlet: Bottom
9. Dome Material: Cast iron
10. Extension Collars: Required
11. Underdeck Clamp: Required
12. Sump Receiver: Required

B. Metal Secondary Roof Drains (OFD):

1. Basis-of-Design Product: Jay R. Smith 1015-C-R-CID or a comparable product by one of the following:
   a. Josam Company; Josam Div.
   b. Zurn Plumbing Products Group; Specification Drainage Operation
   c. Watts Drainage
2. Standard: ASME A112-21.2M
3. Pattern: Roof drain.
4. Body Material: Cast iron
5. Dimensions of Body: Nominal 15" drain
6. Combination Flashing Ring and Gravel Stop: Required
7. Flow-Control Weirs: 3” high water dam
8. Outlet: Bottom
9. Dome Material: Cast iron
10. Extension Collars: Required
11. Underdeck Clamp: Required
12. Sump Receiver: Required

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 3 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.
5. Cleanouts shall not be located behind casework or cabinets.

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. Install high enough for escutcheon cover to clear baseboard.

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.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

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

G. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 7.

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.

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

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.

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

J. 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.

K. Install trap primer lines below slab on grade to pitch to drains. No joints shall be installed in trap primer lines below slab on grade. Trap primer lines below grade shall be wrapped and coated.

3.2 CONNECTIONS

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

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

3.3 PROTECTION

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

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221413

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.

B. Related Sections include the following:

1. Division 22 Section "Drainage Piping Specialties."

1.3 DEFINITIONS

A. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

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

1. Storm Drainage Piping: 10-foot head of water above the highest connection point in the system.

1.5 SUBMITTALS

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

B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. 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 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, below floor for storm drain piping. All pipe and fittings shall be marked with the collective trademark of the Cast iron Soil Pipe Institute (CISPI) and be listed by NSF.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

D. Manufacturers:

1. Charlotte Pipe
2. Tyler Pipe
3. AB&I

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, for above floor storm drainage and overflow roof drain piping. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF.

1. Manufacturers:
   a. Charlotte Pipe
   b. Tyler Pipe
   c. AB&I

B. Shielded Couplings: ASTM 1540 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
   a. Manufacturers:
      1) Clamp-All Corp. - Model 80
      2) Husky – SD-2000
      3) Tyler Pipe; Soil Pipe Div.
      4) Mifab

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILL

A. Excavations shall be performed in strict accordance with latest OSHA regulations. Sheeting, bracing, barricades and fencing shall be installed wherever necessary to avoid undue hazards to workmen or passersby.

B. During excavation, material shall be piled at a distance from the banks of the excavation that will avoid overloading and will prevent slides and/or cave-ins. Water accumulating in excavations shall be removed by pumping. Unless otherwise indicated, excavation shall be by open cut except that short sections of a trench may be tunneled under sidewalks and curbs where pipe can be installed as specified and back-fill can be tamped. All trenches and pit excavations shall be shored and/or braced as required to prevent slides and/or cave-ins.

C. The bottom of the trenches shall be graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length, except for the portions of the pipe sections where it is necessary to excavate for bell holes and the making of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded. Over-depths shall be backfilled as specified and with materials for backfilling as specified.

3.2 BACKFILLING

A. The trenches shall not be backfilled until all required pressure and/or leak tests on piping are performed and until the mechanical systems as installed conform to requirements specified in the several sections covering the installation of the various systems. Trenches shall be backfilled to the ground surface with clean, selected excavated material or other material that meets compaction requirements and as hereinafter specified. Pavement and base course disturbed by trenching operation shall be restored to its original condition.

B. Backfill material shall be deposited in 6-inch thick layers and compacted with mechanical tamps to the density of the adjacent soil or grade until there is a cover of not less than 2 feet over pipes. The backfill material in this portion of the trench shall consist of earth, sandy clay, soft shale, or other materials free from objects larger than 1 inch in any direction.

C. The remainder of the trench shall be backfilled with clean, select material that is free of stones larger than 3 inches in any direction. Backfill material shall be deposited in layers not exceeding 6 inches thick, and each layer shall be compacted mechanically. Settling of granular, non-cohesive material with water will be permitted. The surface shall be mounded over for settling and left in a uniform condition.

3.3 COMPACTION AND TESTING

A. Areas under building locations, paving, walks or other structures which may be placed on site at a future date shall be compacted to 95% minimum dry proctor.

3.4 PIPING APPLICATIONS

A. Aboveground storm drainage piping 10" and smaller shall be the following:

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

B. Underground storm drainage piping below building pad 15" and smaller shall be one of the following:

1. Service weight, cast iron soil piping; hub and spigot, compression gaskets or lead and oakum joints.

C. Underground, storm drainage piping outside of building pad 15" and smaller shall be the following:

1. Service weight, cast iron soil piping; hub and spigot, compression gaskets or lead and oakum joints.

3.5 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 33 Section "Storm Drainage."

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

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

D. 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."

E. 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.

F. 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.

G. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

H. Install engineered controlled-flow storm drainage piping in locations indicated.

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

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

3.6 JOINT CONSTRUCTION

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

B. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

C. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

3.7 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.

1. Install full-port ball valve for piping NPS 3" and smaller.
2. Install gate valve for piping NPS 4" and larger.

3.8 HANGER AND SUPPORT INSTALLATION

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

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer than 100 feet, if indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

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

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

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

E. 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.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8 to NPS 12: 48 inches with 7/8-inch rod.

H. Install supports for vertical piping every 48 inches.

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

3.9 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.

3.10 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 testing has been completed.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

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

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

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

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.11 PIPING IDENTIFICATION

A. All above ground downspout/rainwater piping shall be identified with pipe identification labels as specified in Division 22 Section "Identification for Plumbing Piping and Equipment".

1.

2. B. All underground piping installed outside the building pad shall have continuous warning identification tape installed 12" above the top of the pipe and a minimum of 6" below finished grade.

3.12 CLEANING

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

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

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

END OF SECTION 221413

SECTION 223300

ELECTRIC 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. This Section includes the following electric water heaters:

1. Commercial, storage electric water heaters.
2. Water heater accessories.

1.3 SUBMITTALS

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

B. Product Certificates: For each type of commercial electric water heater, signed by product manufacturer.

C. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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

D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period. Contractor shall warrant the entire unit for the entire 3-year warranty period in addition to the following:

1. Failures include, but are not limited to:
   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 Period(s): From date of Final Completion:
   a. Commercial Electric Water Heaters:
      1) Storage Tank: Three years.
      2) Controls and Other Components: One year.

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 ELECTRIC WATER HEATERS

A. Commercial, Storage Electric Water Heaters: Comply with UL 1453 requirements for storage-tank-type water heaters.

1. Manufacturers:
   a. Bradford White Corporation.
   b. Smith, A. O. Water Products Company.
   c. Rheem/Rudd
2. Storage-Tank Construction: Non-ASME-code, steel vertical arrangement.
   a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
      1) NPS 2 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. Pressure Rating: 150 psig.
   c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
3. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.

c. Insulation: Comply with ASHRAE/IESNA 90.1.
d. Jacket: Steel with enameled finish.
e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
   1) Staging: Input not exceeding 60 kW per step.
f. Temperature Control: Adjustable thermostat.
g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
h. Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3, for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank. Relief valves shall be shipped with the heater from the factory.

4. Special Requirements: NSF 5 construction.
5. Capacity and Characteristics for water heaters are scheduled on the plans.

2.3 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: Factory supplied, ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.

C. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

2.4 SOURCE QUALITY CONTROL

A. Hydrostatically test commercial water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

B. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install commercial water heaters on level surfaces or concrete pads.

1. Exception: Omit concrete pads for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor as indicated on plans.
2. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls nameplate and devices needing service are accessible.

C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap into closest floor drain or mop receptor.

D. Install combination temperature and pressure relief valves in water piping for water heaters without storage. 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 into closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.

F. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

G. Set water storage temperature to 140 degrees farenheight.

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 water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial electric water heaters. Refer to Division 01 Section "Closeout Procedures."

END OF SECTION 223300

SECTION 224000

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. Refer to "Plumbing Fixture Schedule" found at the end of this section for basis of design and Owner preferred fixtures and model numbers.

1. Lavatory Faucets
2. Sink Faucets
3. Flushometers.
4. Toilet seats.
5. Protective shielding guards.
6. Fixture supports.
7. Water closets.
8. Urinals.
9. Wall-hung Lavatories.
10. Sinks.
11. Mop receptors.
12. Mop receptor faucets.
13. Dishwasher Air Gap Fittings
14. Interceptors

B. Related Sections include the following:

1. Division 10 Section "Toilet and Bath Accessories."
2. Division 22 Section "Drinking Fountains and Water Coolers."
3. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers and specialty fixtures not included in this Section.
4. Division 22 Section "Drainage Piping Specialties" for floor drains, cleanouts and other indirect waste specialties.

1.3 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. 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, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.4 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. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

1.5 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. Regulatory Requirements: Comply with requirements in the Georgia Accessibility Code for plumbing fixtures for people with disabilities.

C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

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

E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

F. 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. Stainless-Steel Residential Sinks: ASME A112.19.3.
4. Vitreous-China Fixtures: ASME A112.19.2M.

G. 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. Supply Fittings: ASME A112.18.1.
11. Brass Waste Fittings: ASME A112.18.2.

H. 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. Manual-Operation Flushometers: ASSE 1037.
4. Plastic Tubular Fittings: ASTM F 409.
5. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Flexible Water Connectors: ASME A112.18.6.
2. Floor Drains: ASME A112.6.3.
3. Grab Bars: ASTM F 446.
4. Hose-Coupling Threads: ASME B1.20.7.
5. Off-Floor Fixture Supports: ASME A112.6.1M.
6. Pipe Threads: ASME B1.20.1.
7. Plastic Toilet Seats: ANSI Z124.5.
8. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

A. All fixtures and accessories shall be warranted against defects in materials and workmanship for a period of one year from date of acceptance by the Owner.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Lavatory Faucets: P301H, P302H:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Symmons Ultra Sense S-6080-SSUP (Basis of Design)
   b. Chicago Faucets.
   c. T & S Brass and Bronze Works, Inc.
2. Description: Single-control mixing valve with brass stems and ½" threaded inlet shanks. Provide .5 gpm flow limiting aerators. Include hot and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor. Connect cold water to both inlet shanks where only cold water is called for on plans.

2.2 SINK FAUCETS

A. Sink Faucets, P602H:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Chicago Faucets 430-ABCP (Basis of Design)
   b. Elkay Manufacturing Co.
   c. Just Manufacturing Company.

d. Delta
e. T & S Brass and Bronze Works, Inc.
f. Zurn
g. Encore

2. Description: Kitchen faucet, three or four-hole fixture, Kitchen faucet with or without hand spray. Include hot and cold-water indicators where required; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

B. Sink Faucets, P603H, P604H:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. T & S Brass and Bronze Works, Inc. B-1142-04 (Basis of Design)
   b. Chicago Faucets
   c. Elkay Manufacturing Co.
   d. Just Manufacturing Company.
   e. Delta
   f. Zurn
   g. Encore

2. Description: Gooseneck faucet with 4" wrist action handles. Include hot and cold-water indicators where required; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

2.3 FLUSHOMETERS

A. Flushometers, P101, P101H, P201, P201H:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Sloan Royal 111-1.28 (Basis of Design)
   b. American Standard
   c. TOTO
   d. Zurn Plumbing Products Group; Commercial Brass Operation.

2. Description: Flushometer for closet-type fixtures. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, polished chrome-plated finish on exposed parts. Provide ADA handle on accessible fixtures.
3. Provide solid ring supports on water closet flush valves. Solid ring supports are not required on urinal flush valves.
4. Basis of design – water closet flush valve; Sloan Royal 111-1.28
5. Basis of design – urinal flush valve; Sloan Royal 186-0.5
6. Flush valves for water closets shall be 1.28 gpf.
7. Flush valves for urinals shall be 0.5 gpf.
8. Coordinate installation of flushometer rough-in with grab bars in handicap stalls.

2.4 TOILET SEATS

A. Toilet Seats, P101, P101H:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bemis Manufacturing Company. 1955 SSCT (Basis of Design)
   b. Church Seats. 295 SSCT
   c. Olsonite Corp. 10 SSCT
2. Description: Toilet seat for water-closet-type fixture.
   a. Material: Molded, solid plastic.
   b. Configuration: Open front without cover.
   c. Size: Elongated.
   d. Hinge Type: SC, self-sustaining, check, with Sta-Tite commercial fastening system with slow close feature.
   e. Class: commercial.
   f. Color: White.

2.5 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Guards, (Pipe Covers) P301H, P302H, P602H, P603H, P604H:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. TRUEBRO, Inc. Lav Guard 2E-Z (Basis of Design)
   b. McGuire Manufacturing Co., Inc.
   c. Plumberex Specialty Products Inc.
   d. Zurn Industries
2. Description: Manufactured plastic wraps for covering plumbing fixture hot and/or cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.6 FIXTURE SUPPORTS

A. All wall hung lavatories, urinals, and drinking fountains shall be supported independently of the wall by a commercial floor mounted carrier consisting of rectangular steel uprights with welded feet and secured to floor with lead anchor inserts or self drilling expansion shields and lag bolts at each location. Wall brackets and conceal arms shall be provided where appropriate for fixture being supported. Leveling and locking hardware shall be provided for lavatory carrier concealed arm supports.

B. 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. Zurn Plumbing Products Group; Specification Drainage Operation.
5. Watts Drainage
6. Wade

2.7 WATER CLOSETS

A. Water Closets, P101, P101H:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Sloan
   c. Kohler Co. (Basis of Design)
   d. Zurn
2. Description: Accessible, floor-mounting, floor-outlet, white, elongated, 1.28 gpf vitreous-china fixture designed for flushometer valve operation, top spud with brass floor mounting hardware and bolt caps.
3. All water closet bowl gaskets between floor and waste pipe connection shall be a combination of wax seal with plastic or urethane reinforced flanged polyethylene sleeve permanently molded into gasket assembly.
   a. Oatey Model No. 31194
   b. Hercules Plumbing Products Johni-Ring Model No. 90-220
   c. Plastic Oddities Inc. Model BG-7k.

2.8 URINALS

A. Urinals, P201, P201H:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard
   b. Zurn
   c. Kohler Co.
   d. Sloan
2. Description: Accessible, wall-mounting, 2" back-outlet, vitreous-china fixture mounted on commercial floor carrier. 3/4” top spud, 1/8 gallon per flush.
3. Urinal waste arms from fixture outlet to connection at stack shall be 2” schedule 40 to extend 2” beyond face of finished wall with FERNCO 2”x1-1/2” reducing coupling.

2.9 WALL HUNG LAVATORIES

A. Wall Hung Lavatories, P301H, P302H:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Standard Companies, Inc.
   b. Kohler Co. (Basis of Design)
   c. Zurn
   d. Sloan
2. Description: Accessible, wall-mounting, white, vitreous-china fixture with 1 or 3-hole drilling, nominal 20" x 18" with backsplash and drilled for concealed arm supports and mounted on commercial floor carrier.

2.10 SINKS

A. Sinks, P602H, P603H, P604H:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkay Manufacturing Co.
   b. Just Manufacturing Company.
   c. Kohler Co.
   d. Moen, Inc.
2. Description: One or Two compartment, drop-in, self rimming, 18-gauge, 300 series stainless steel sink. Drilling, depth and size as scheduled. See basis of design fixture schedule at the end of this section for specific sink requirements.

2.11 MOP RECEPTOR BASINS

A. Mop Basins, P501:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fiat (Basis of Design)
   b. Acorn Engineering Company.
   c. Crane Plumbing, L.L.C./Fiat Products.
   d. Florestone Products Co., Inc.
   e. Precast Terrazzo Enterprises, Inc.
   f. Stern-Williams Co., Inc.
2. Description: Flush-to-wall, floor-mounting, precast terrazzo fixture with rim guard. 24" x 24" with 12" high curbs all around. 3" drain outlet with grid strainer.

2.12 MOP RECEPTOR FAUCETS

A. Mop Receptor Faucets: P501:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Symmons
   b. Speakman Company; SC-5812.
   c. T & S Brass and Bronze Works, Inc.; B-0665-BSTP (Basis of Design)
   d. Zurn Plumbing Products Group; Commercial Brass Operation; Z843M1-CS.
   e. American Standard; 8344012.002
2. Description: Cast brass, polished chrome, wall mounted fitting with integral check stops, cast brass nozzle with ¾” hose thread and pail hook, brass top brace with wall flange. ½” supplies with chrome wall flanges. Vandal resistant handles lever or four arm with color coded indexes. ASSE-1001 compliant.
3. DISHWASHER AIR-GAP FITTINGS
   a. Dishwasher Air-Gap Fittings:
      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) Brass Craft Mfg. Co.; a Subsidiary of Masco Corporation.
b) Dearborn Brass; a div. of Moen, Inc.
c) Geberit Manufacturing, Inc.
d) Sioux Chief Manufacturing Company, Inc.

3) Description: Fitting suitable for use with domestic dishwashers and for deck mounting; with plastic body, chrome-plated brass cover; and capacity of at least 5 gpm and inlet pressure of at least 5 psig at a temperature of at least 140 deg F. Include 5/8-inch-ID inlet and 7/8-inch- ID outlet hose connections.
4) Hoses: Rubber and suitable for temperature of at least 140 deg F.

2.13 DISHWASHER AIR-GAP FITTINGS

A. Dishwasher Air-Gap Fittings:

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. Brass Craft Mfg. Co.; a Subsidiary of Masco Corporation.
   b. Dearborn Brass; a div. of Moen, Inc.
   c. Geberit Manufacturing, Inc.
   d. Sioux Chief Manufacturing Company, Inc.
3. Description: Fitting suitable for use with domestic dishwashers and for deck mounting; with plastic body, chrome-plated brass cover; and capacity of at least 5 gpm and inlet pressure of at least 5 psig at a temperature of at least 140 deg F. Include 5/8-inch- ID inlet and 7/8-inch- ID outlet hose connections.
4. Hoses: Rubber and suitable for temperature of at least 140 deg F.

2.14 INTERCEPTORS

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. Zurn.
5. Wade

B. Description: Manufactured unit with removable screen or strainer and removable cover; designed to trap and retain hair and solids.

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. Coordinate countertop heights with Architectural plans and elevations.

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

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. 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.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to roughing-in drawings.

H. 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, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system. Cleanout plug in trap shall be accessible for removal of plug.

J. Install flushometer valves for accessible water closets with handle mounted on wide side of compartment as applicable. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install toilet seats on water closets.

L. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves. Faucet assemblies shall be set square to sinks and lavatories, with paired faucet handles set symmetrical in the off position.

M. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

N. Install deep escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

O. 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."

P. Miscellaneous wall mounted items such as hose bibs, wash down fittings and flush valves shall have supplementary steel angles and a steel mounting plate securely attached to the wall framing to provide rigid support.

Q. Set mop receptor basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

R. Install 1/2" check valve on all mop receptor faucets above ceiling between isolation ball valve and 1/2" hot and cold-water pipe drop in wall or chase to faucet.

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.

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.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers, cartridges and/or seals of leaking and dripping faucets and stops.

E. Adjust faucet valve temperature limit stops to 105 F maximum.

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.
3. Clean all floor drain grate tops and floor cleanout covers to like new condition.

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.

END OF SECTION 224000 (EXCEPT FOR THE ATTACHED PLUMBING FIXTURE SCHEDULE)

PLUMBING FIXTURE SCHEDULE

P101 Water Closet - Floor Mounted - Flush Valve - 1.28 GPF - Kohler "Welcomme Ultra" No. K-96053 white vitreous china toilet, elongated siphon jet action bowl, two bolt caps, flush valve with solid ring stanchion secured to wall, white solid plastic open front heavy duty seat.

P101H Water Closet - Floor Mounted - Flush Valve - Handicap - 1.28 GPF - Kohler "Highcliff Ultra" No. K-96057, white vitreous china toilet, elongated siphon jet action bowl, two bolt caps, flush valve with solid ring stanchion secured to wall, and ADA handle, white solid plastic open front heavy-duty seat.

P201 Urinal - Wall Hung – 0.5 GPF – Kohler "Bardon" No. K-4991-ET-0, white vitreous china, siphon jet action with 3/4" top spud, 2" I.P.S. outlet, and flush valve, 3/4" spud, wall and spud flanges. Provide concealed floor mounted carrier, mount rim at 24" above finished floor.

P201H Urinal - Wall Hung – 0.5 GPF – Handicap - Kohler "Bardon" No. K-4991-ET-0, white vitreous china, siphon jet action with 3/4" top spud, 2" I.P.S. outlet, and flush valve, 3/4" spud, wall and spud flanges. Provide concealed floor mounted carrier, mount rim at 17" above finished floor.

P301H Lavatory - Wall Hung - Handicap - Kohler "Greenwich" No. K-2032 (20"x18") white vitreous china lavatory with concealed overflow, Delta 22C151 center set single lever handle faucet with .50 gpm aerator, McGuire Model No. 155WC offset grid drain assembly, McGuire No. 8872C-DF 1-1/4" chrome plated P-Trap with brass nuts, cleanout plug and deep wall escutcheon, and 12" braided hoses. McGuire No. H170LK supplies with angle stops, loose tee keys, deep wall

escutcheons. Provide floor mounted carrier with concealed arms. Connect both faucet inlet shanks with cold water for fixtures indicated with cold water only. Provide handicapped covers on offset drain, p'trap and supplies. Mount rim at 34" AFF and provide ADA required knee clearance.

P302H Lavatory - Wall Hung - Handicap - Kohler "Greenwich" No. K-2032 (20"x18") white vitreous china lavatory with concealed overflow, Delta 22C151 center set single lever handle faucet with .50 gpm aerator, McGuire Model No. 155WC offset grid drain assembly, McGuire No. 8872C-DF 1-1/4" chrome plated P-Trap with brass nuts, cleanout plug and deep wall escutcheon, and 12" braided hoses. McGuire No. H170LK supplies with angle stops, loose tee keys, deep wall escutcheons. Provide floor mounted carrier with concealed arms. Connect both faucet inlet shanks with cold water for fixtures indicated with cold water only. Provide handicapped covers on offset drain, p'trap and supplies. Mount rim at 34" AFF and provide ADA required knee clearance. Where supply water temperature exceeds 110°F, fixture shall be provided with individual tempering valve.

P501 Mop Receptor - Fiat Model TSB-100 24" x 24" x 12" terrazzo mop basin with stainless steel caps on all curbs, faucet, Model 899CC-CC Mop Hanger, Model 1453-BB Strainer, Model 832-AA hose and hose bracket. Mount faucet 48" AFF.

P602H Sink – Countertop – Handicapped - Single Compartment –Elkay Model No. LRAD-2219-3; 18 gauge type 304 series stainless steel sink punched with 3 faucet holes on 4" centers, 6-1/2" deep bowl, Elkay No. LK-35 cup strainer, 1-1/2" chrome plated tailpiece and McGuire No. 8912C-DF - 1-1/2" chrome plated p-trap with brass nuts, cleanout plug and deep wall escutcheon, 8" center set sink faucet with cover plate, swing spout and 1/2" inlet shank connections, McGuire No. H170LK loose key chrome plated angle stops with supplies, deep wall escutcheons, and 12" braided hoses. Install in countertops provided by others; coordinate required roughing heights with countertop heights as indicated. Connect both faucet inlet shanks with cold water for fixtures indicated with cold water only. Provide handicapped covers on offset drain, p'trap and both supplies where ADA skirt is not installed as part of casework. Provide with dishwasher drain tailpiece and air gap fitting where required for installation of undercounter dishwasher. Where supply water temperature exceeds 110°F, fixture shall be provided with individual tempering valve.

P603H Sink – Countertop – Handicapped - Single Compartment –Elkay Model No. LRAD-2219-3; 18 gauge type 304 series stainless steel sink punched with 3 faucet holes on 4" centers, 6-1/2" deep bowl, Elkay No. LK-35 cup strainer, 1-1/2" chrome plated tailpiece and McGuire No. 8912C-DF - 1-1/2" chrome plated p-trap with brass nuts, cleanout plug and deep wall escutcheon, Gooseneck faucet with 4" wrist action handles, swing spout and 1/2" inlet shank connections, McGuire No. H170LK loose key chrome plated angle stops with supplies, deep wall escutcheons, and 12" braided hoses. Install in countertops provided by others; coordinate required roughing heights with countertop heights as indicated. Connect both faucet inlet shanks with cold water for fixtures indicated with cold water only. Provide handicapped covers on offset drain, p'trap and both supplies where ADA skirt is not installed as part of casework.

P604H Sink - Countertop - Single Compartment - Handicap - Elkay Model No.LRAD-2219-65-3, 18 gauge type 304 stainless steel sink punched with 3 faucet holes on 4" centers, drains centered at rear, Elkay LKAD-35 basket strainers, 1-1/2" offset chrome plated tailpieces and tubing to interceptor, with Zurn Z1180-81 coated interceptor with aluminum strainer and removable strainer bucket, Gooseneck faucet with 4" wrist action handles, swing spout and 1/2" inlet shank connections, McGuire No. H170LK loose key chrome plated angle stops with supplies, deep wall escutcheons, and 12" braided hoses. Install in countertops provided by others; coordinate required roughing heights with countertop heights as indicated. Provide with Zurn Z1180-81 coated interceptor with aluminum strainer and removable strainer bucket. Arrange waste piping and interceptor to provide required handicap clearances below sink. Provide handicapped covers on offset drain, p'trap and both supplies where ADA skirt is not installed as part of casework. Where supply water temperature exceeds 110°F, fixture shall be provided with individual tempering valve.

P609 Science Classroom Sink – Fixture and faucet by architectural; 1-1/2" acid resisting tailpiece and piping. See plans. McGuire No. 2167 LK angle stop w/loose key and chrome plated copper tube supply risers for faucet connection. Install 1/2" AGA rated ball valve and union at all countertop gas cock locations. Install and connect fixtures and trim provided under casework contract. Arrange waste piping and supply piping under counters to maintain ADA required clearances where required for accessible stations. Provide handicapped covers on offset drain, p'trap and both supplies where ADA skirt is not installed as part of casework. Where supply water temperature exceeds 110°F, fixture shall be provided with individual tempering valve.

P903 Washing Machine Service Box - Guy Gray Model B200 recessed service box for residential grade washers, (2) 1/2" hose bibbs, 2" drain outlet. Hose bibbs shall be provided with vacuum breakers on threaded outlets. Mount bottom of box 40" AFF. Install Environmental Enhancements Model LUV-R washing machine discharge filter box between washer drain and inlet to waste line on utility box.

SECTION 224700

DRINKING FOUNTAINS & 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. This Section includes the following related components:

1. Water Coolers.
2. Fixture supports.
3. Bottle Filling Stations.

1.3 DEFINITIONS

A. Accessible Drinking Fountain: Fixture that can be approached and used by people with disabilities.

B. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

C. Fitting: Device that controls flow of water into or out of fixture.

D. Fixture: Drinking fountain or water cooler unless one is specifically indicated.

1.4 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.

B. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.

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

C. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

1.1 WARRANTY

D. The complete water cooler and packaged water chiller unit inclusive of compressor, hermetically sealed refrigeration unit, water system, water regulator and electrical components shall be warranted be free from defects in material and workmanship for (1) year from the date of installation. Contractor shall submit the warranty data sheet to the Architect within 3 days of completed installation for record. For the second thru fifth years, the manufacturer shall warrant the compressor and the hermetically sealed refrigeration system, inclusive of the tank assembly when the part of the hermetically sealed refrigeration unit for an additional four years from the end of the initial one-year warranty period.

PART 2 - PRODUCTS

2.1 HI/LOW WITH BOTTLE FILLING STATION

A. Bottle Filling Stations, P401BH:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Oasis Model No. PG8FEBF or a comparable product meeting the following requirements:

2. Description: Accessible, wall-mounting water cooler.
   a. Material: Stainless steel top, stainless steel cabinet finish.
   b. Receptor Shape: Rectangular.
   c. Bubblers: One, with flexible guard and with adjustable stream regulator, located on deck.
   d. Control: Push button.
   e. Bottle filler: Electronic sensor, no touch activation, automatic 20 second shutoff timer.
   f. Supply: NPS 3/8, Stop valve with isolation ball valve above ceiling.
   g. Drain: Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.2.
   h. Support: Type I, water cooler carrier. Refer to "Fixture Supports" Article.
   i. Filter: Filter located in top portion of bottle filler with hinged access.
   j. Additive: Silver-based antimicrobial compound to protect surfaces from discoloration, odors, and degradation caused by the growth of micro-organisms and mildew.

2.2 FIXTURE SUPPORTS

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

1. Josam Co.
2. MIFAB Manufacturing, Inc.
3. Smith, Jay R. Mfg. Co.
4. Zurn Plumbing Products Group; Specification Drainage Operation.
5. Watts Drainage.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

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

3.2 APPLICATIONS

A. Use floor mounted carrier supports for wall-mounting fixtures, unless otherwise indicated.

B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

C. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

D. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

E. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

F. Fixtures shall be supported at bottom with toggle bolts thru wall.

3.4 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. See plans for where new drinking fountains are to replace existing units. Coordinate with existing conditions. Modify waste rough is as required for new fixture setting height.

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

3.6 CLEANING

A. After completing fixture installation, 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.

END OF SECTION 224700 (EXCEPT FOR THE ATTACHED PLUMBING FIXTURE SCHEDULE)

PLUMBING FIXTURE SCHEDULE

P401BH Electric Water Cooler - Wall Hung - Handicapped – Bottle Filling Station - vandal resistant unit with a minimum capacity of 8.0 gph of 50 degree water at A.R.I. standard conditions, bottle filling station, with wall hanger, vandal resistant push button control, 1-1/4" tailpiece, McGuire No. 2158LK angle stop and supply with deep escutcheon, McGuire No. 8872C-DF 1-1/4" p-trap with brass nuts, cleanout plug and deep wall escutcheon. Provide floor mounted concealed carrier.

SECTION 227000

PLUMBING SYSTEMS TESTING

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 video testing to confirm design objectives for the following:

1. Sanitary Waste Piping Systems

PART 2 - PRODUCTS AND PROCEDURES

2.1 VIDEO INSPECTION OF UNDERGROUND SEWER MAINS

A. The work specified in this section shall be performed by an independent contractor/consultant, who has had no involvement in the installation process. The contractor/consultant shall have had a minimum of three years experience in this type of work. The party performing the test shall indicate compliance in writing with these specifications and shall sign the report developed. To facilitate the work in this specification, the contractor will be provided with a drawing showing the interior building layout with the layout of the underground sanitary piping system.

B. The contractor will provide a video pipe inspection of all sanitary sewer mains where installed below slab on grade 4” and larger. “Mains” shall be considered to be any sewer collecting effluent from more than one group of plumbing fixtures, or whose run from one group of plumbing fixtures is over fifty feet. Inspections will begin at accessible points to the system, such as wall and/or floor cleanouts or manholes. For pipe sizes 4-6 inch, accessible openings shall be no more than 100 feet apart, and for larger diameter piping no more than 300 feet apart.

C. For lines 4 inch – 6 inch in diameter, a color push camera system with a centering collar to raise the camera to the center of the pipe shall be used that has VCR and voice over capability. The information on the screen will include displaying at the start of each segment the name of the contractor, date, time of day, and during the inspection the footage counter and most importantly the identification of from which point to which point (C.O. A-1 to B-1) the inspection is being done. The point references shall match the identifiers on the as-built drawings. The final video shall be delivered on DVD or CD in a common format that can be played on a PC computer. Some of the common formats include MPEG, AVI, or similar.

D. For lines 8-inch and up, a main line camera system shall be used. This system shall have a pan and tilt camera and be equipped to provide the same display information as the push camera. The camera head shall be positioned as close to the centerline of

the pipe as required to obtain a clear picture of the piping. The tractor moving the camera in the piping shall move at a speed no more than 0.5 feet per second.

E. A transmitter will be attached to the camera head to provide above ground location of underground problems.

F. The video pipe inspection shall observe and provide information on the condition of the pipe, joints, alignment, lateral locations, manholes, pipe size, pipe material and any pipe obstructions for new and existing conditions. The location of any underground problems shall be located above ground, and exact above ground location noted on the drawing and in the report. Any under floor and/or below grade problems encountered in existing sanitary waste piping system shall be brought to the Architects attention before any new connections are made to the existing system.

G. Submit a final inspection report comprised of a DVD or CD of the inspection, a written inspection report, and a marked-up drawing showing the above ground locations of any underground problems. The written report shall identify each pipe segment inspected, pipe size and material of that segment, footage, laterals, detailed description of damages or other problems, summary of pipe condition, and counter time. The responsible person in charge of the project shall sign this report.

H. The under-slab video inspection report shall consist of a marked-up drawing showing the location and notes of any problems found within the underfloor piping systems as a result of the video test. Format shall utilize the contractor's under ground piping shop drawings with the same floor and wall cleanout reference tags. Report shall be submitted for review within 60 days after the last building pad slab on grade is poured.

I. Notification of camera testing of underground lines shall be sent to Architects office 48 hours prior to actual test. The Owner's representative shall be present during the actual camera documentation of lines. A separate drawing shall be prepared showing all camera points of each area and submitted to the Owner. All retests of systems not properly cleaned and installed shall be at the expense of the Contractor.

J. The report shall be submitted 45 days prior to Substantial Completion.

PART 3 - EXECUTION

3.1 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality bond paper, in three-ring binder, tabulated and divided into sections by tested systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing Engineer.

C. Final Report contents: In addition to certified field report data, include the following:

1. DVD or CD(s).
2. Drawings with corresponding data related to preparation of DVD or CD(s).

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of testing firm.
3. Project Name.

4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of testing firm who certifies.
10. Table of Contents with the total number of pages defined for each section of the report.

E. System Diagrams: Include schematic layouts of Sanitary piping systems. Present each system with single-line diagram and include the following:

1. Start point of each segment.
2. Stop point of each segment.
3. System tag related to tape footage.
4. Pipe sizes and locations.

3.2 SITE OBSERVATIONS

A. The Contractor shall notify the Architect’s office 48 hours in advance of a Video Testing Inspection. The Owner’s representative shall be present and witness the testing.

END OF SECTION 227000

SECTION 230500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. HVAC demolition.
   3. Equipment installation requirements common to equipment sections.
   4. Painting and finishing.
   5. Concrete bases.
   6. Supports and anchorages.

1.3 DEFINITIONS

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

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

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

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

1. PVC: Polyvinyl chloride plastic.

1.4 QUALITY ASSURANCE

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

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

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

1.6 COORDINATION

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

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

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

D. Coordinate locations of floor drains and floor cleanouts with HVAC Equipment pads and units in all mechanical equipment rooms, closets and platform areas. Coordination layout drawings shall be prepared and coordinated by all trades.

E. No mechanical, plumbing or fire protection equipment, ductwork or piping shall be located overhead of electrical switchboards or panelboards.

F. No water piping (HVAC, domestic, storm, sanitary, or sprinkler) shall be located above electrical switchboards or panelboards. If the governing authority requires fire sprinklers in the electrical rooms, spray shields shall be fabricated and installed to protect the live panels or switchboards from spray from sprinkler discharge.

G. Coordinate sanitary waste and vent stub ups and rainwater/downspout stub ups at slab on grade installations with structural plans to ensure that footings and/or grade beams are dropped or stepped to avoid piping penetrations thru footings and grade beams.

1.7 CODES AND REGULATIONS

A. All materials and workmanship shall comply with the latest editions of the following codes and standards, as applicable:

Manufacturer's Standardization Society (MSS) Standard Practice (SP) 58: Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69: Pipe Hangers and Supports - Selection and Application

MSS SP-69: Pipe Hangers and Supports - Fabrication and Installation Practices

National Fire Protection Association (NFPA) Pamphlet 13: Installation of Automatic Sprinkler Systems

NFPA 13: Installation of Sprinkler Systems

NFPA 24: Installation of Private Fire Service Mains and Their Appurtenances

NFPA 30: Flammable and Combustible Liquids Code

NFPA 90A: Installation of Air Conditioning and Ventilating Systems

NFPA 90B: Installation of Warm Air Heating and Air Conditioning Systems

NFPA 96: Installation of Equipment for the Removal of Smoke and Grease Laden Vapors from Commercial Cooking Equipment

NFPA 101: Safety to Life from Fire in Buildings and Structures

NFPA 211: Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances

NFPA 231: General Storage

National Electrical Code, 2017 Edition

International Mechanical Code, 2012 Edition, with Georgia Amendments

International Energy Conservation Code, 2009 Edition, with Georgia Amendments

International Building Code, 2012 Edition, with Georgia Amendments

International Plumbing Code, 2012 Edition, with Georgia Amendments

International Fuel Gas Code, 2012 Edition, with Georgia Amendments

International Fire Code, 2012 Edition, with Georgia Amendments

All local prevailing County codes and Ordinances

B. All workmanship and materials shall comply with all ordinances and regulations of all local authorities having jurisdiction.

C. Contractor shall obtain all permits and licenses, and pay all fees, as required for execution of the contract. Arrange for necessary inspections required by City, County, State and other authorities having jurisdiction, and deliver certificates of approval to the Owner. In compliance with the Georgia State Boiler Code, it is the responsibility of the Contractor (at his expense) to have each boiler and/or applicable pressure vessel inspected by a State of Georgia certified inspector upon installation of this equipment.

D. This inspection report shall be submitted to the Georgia Department of Labor, Safety Engineering Section, 501 Pullman Street, Room 210, Atlanta, Georgia 30312, Attention Chief Safety Engineer.

E. Upon the Georgia Department of Labor review of the inspection report and their inspection, they will place a tag indicating the State Serial Number on the inspected piece of equipment and issue a certificate of boiler or pressure vessel inspection. The original certificate issued is to be posted in the main Mechanical Room, with a copy sent to Cherokee County Schools and one copy is to be included in the closeout documents.

1.8 RECORD DRAWINGS

A. As the work progresses, the Contractor shall maintain records and record all changes made daily on a set of contract mechanical drawings (HVAC, Plumbing & Fire Protection) during the progress of the work. The in-progress set of marked-up drawings, clearly showing the nature and extent of all changes, shall be maintained in the construction office at the site and clearly marked "Record Drawings". The "Record Drawings" shall be up to date and available for use at the time of any job site visit by the Engineer or Architect. The completed "Record

Drawings" shall be presented to the Architect upon completion and acceptance of the work. Final payment and "close-out" of the project shall be dependent upon receipt and acknowledgment of the completed "Record Drawings".

B. The Engineer shall furnish to the Contractor electronic files of the Contract Drawings in AutoCAD format for the Contractors' use in preparing a final electronic copy of the record drawings which shall incorporate all of changes made including all project addenda. Drawing changes shall be identified as follows:
   1. The affected change shall be identified in an enclosed clouded area of a consistent color not used to indicate the noted change.
   2. Each cloud shall have an identifier adjacent to the cloud identifying the date and origin of the change. (i.e., 1-12-06, Construction Directive, 1-12-06, Change Proposal, 1-12-06, Field Coordination, etc.).

C. Submission of electronic Record Drawings shall be made on compact disk in AutoCAD format and accompany one (1) full size set of bond plots in color on white background. Plots shall be generated from the CD of electronic files. Electronic file names and plot sheet numbering shall match Contract Document format.

1.9 ACCESS DOORS & PANELS

A. Furnish an access door and panels for each pipe and duct chase for each floor, fire dampers, etc. Size as required for access, 16" X 16" minimum.

B. Also, provide access doors in all non-removable ceilings and in partitions and walls where necessary to maintain access to fire dampers, manual dampers, valves, shock arrestors, and other mechanical devices requiring access.

C. Any access door installed in fire rated surface or assembly shall carry a U.L. Listing and an approved fire rating for that construction type.

D. Provide access doors/panels as required to test and reset automatic fire dampers.

E. Provide all access doors to the General Contractor for the timely inclusion in the building construction.

F. Refer to architectural section "083113 – ACCESS DOORS AND FRAMES" for product's construction and installation requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

PART 3 - EXECUTION

3.1 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 HVAC 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.

3.2 PAINTING

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

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

3.3 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

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

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

D. Provide factory start up on all major pieces of equipment, with letter of certification stating proper installation is present for the following components:

Boilers
Cooling tower & Heat exchanger
Water Source Heat Pump Units
Roof mounted A/C units
Condensing units
Air-handling Units
Fan-Coil Units
Kitchen Hood
Controls System
Energy Management System
Energy Recovery Units
Pumps
Fans
Fuel Fired Domestic Water heaters
Variable Refrigerant Flow Systems
Outside Air Units

3.5 SHOP DRAWINGS

A. Submit a minimum of three hard copy sets of shop drawings along with an electronic formatted submittal for approval prior to commencing work. Hard copy shop drawings shall be bound in a three ring binder and shall include an index page with each item listed and referenced to sections with tabs. Tabs shall be cross referenced to index page. All shop drawings shall be prepared and submitted as a single package. **NO SHOP DRAWINGS WILL BE CHECKED UNTIL ALL HAVE BEEN**

SUBMITTED. (HVAC controls submittals and any items with exceptionally long lead times that may affect the project completion date, as determined by the Engineer may be submitted separately). **Electronic shop drawings shall be a single PDF file and formatted as required for hard copy submittals. Each section shall be a bookmarked (tabbed) link named to describe the section. (ELECTRONIC SHOP DRAWINGS NOT PROPERLY FORMATTED WILL BE RETURNED UNCHECKED.)**

B. The following format shall be followed:
   1. The submittal cover sheet shall include-

Project Name
Type of Shop Drawing including trade (HVAC, Plumbing, Fire Protection)
Mechanical Contractor's Company Name
Date of Submittal

   2. The first sheet inside the submittal shall include all items on the cover sheet plus the following-
      a. Owner
      b. Architect
      c. Engineer
      d. Mechanical Contractor's Project Manager's Name

   3. The supervising license holder(s) shall be identified, and a copy of their current valid license shall be included.
   4. The second sheet shall include the following typed statement, signed and dated by the mechanical contractor's project manager-a.

"The enclosed submittal (shop drawings) has been reviewed for accuracy of equipment and system quality and component quantities. The available voltages have been coordinated with the electrical contractor. All coordination items with other trades have been completed including structural, electrical, and other mechanical division disciplines prior to ordering any equipment."

C. The Contractor shall review the information prepared by his suppliers and note any changes required prior to submitting the information to the Engineer and shall include the form (found at the end of this section), Exhibit 1, entitled "Certification of Compliance - Shop Drawings" with each submittal prior to the index page and submittal data sheets. Failure to complete and execute this form will result in rejection of the submittal without review.

D. Each individual submittal item shall be marked to show Specifications Section and Paragraph number which pertains to the item. Shop Drawings shall clearly indicate location, fixture no. or equipment designation, etc., so that the intended use of the equipment can be readily identified. Failure to make submittals accordingly shall be considered cause for rejection of shop drawings.

E. Submittals shall be supported by descriptive material, such as catalog cuts, diagrams, certified performance curves and charts published by

the manufacturer to show conformance to specification and drawing requirements, model numbers alone will not be acceptable. All literature shall clearly indicate the specified model number, options to be included, dimensions, arrangement, rating and characteristics of the proposed equipment. Capacities and ratings shall be based on conditions indicated or specified herein. Any deviations from specified equipment shall be clearly noted in red.

F. The Engineer will review the shop drawings for errors in the Contractor's interpretation of the design intent only. Corrections or comments made on shop drawings during review shall not relieve the Contractor from compliance with requirements of the contract documents, plans and specifications. Review of shop drawings shall not relieve the Contractor from the responsibility for conforming and correlating all quantities and dimensions, coordinating his work with that of other trades, and performing his work in a safe and satisfactory manner.

G. Review of shop drawings shall not permit any deviations from the plans and specifications nor shall it permit changes to the plans and specifications by the Engineer. Changes to or deviations from the contract documents are subject to the provisions of the General Conditions of the contract. Any required changes will then be issued by the Architect and executed by both the Owner and Contractor.

H. Each individual submittal item shall be marked to show Specifications Section and paragraph number which pertains to the item. Shop Drawings shall clearly indicate location, fixture no. or equipment designation, etc., so that the intended use of the equipment can be readily identified. Shop drawings shall be submitted for each of the following items:

Fans
Air Distribution Devices
Roof Mounted Air Intake/Relief Hoods
Electric Heaters
Fire & Smoke Dampers
Automatic Dampers
Flexible Ductwork
Ductwork & Ductwork Construction
Duct Access Panels
Gas Flues
Air-handling Units
Manual Dampers
Pumps
Boilers
Chillers
Thermometers
Relief Valve
Hot Water Unit Heaters
Backflow Preventers
Plumbing Fixtures & Fittings
Valves & Unions
Shock Arrestors
Valve Schedules and Diagrams
Floor Drains
Sheet Lead Flashing
Vibration Isolation Equipment
Roof Mounted A/C Units
Condensing Units
Roof Curbs
Automatic Flow Control Valves
Heat Exchangers
Centrifugal Sediment Separator
Pressure Gauges
Kiln Hood
Pipe Identification Systems
Manholes and Accessories
Water Heaters & Accessories
Cleanouts & Accessories
Access Covers & Panels
Wall Hydrants & NFWH's
Gauges
Energy Recovery Units

Pressure Reducing Valves
Pipe Accessories
Pipe Hangers, Supports & Accessories
Flexible Pipe Hose Kits w/ Valves & Fittings
Kitchen Rangehood & Associated Fire Suppression System
Controls & Control Diagrams including Wiring Plans
Pipe & Duct Insulation & Accessories
Fire Protection: AHJ Approved Shop Drawings with Complete Hydraulic Analysis
Fire protection system valves and accessories
Supervisory switches & Flow switches
Precast concrete drainage structures and vaults
All equipment and systems training forms with a sign off blank
Underground piping systems
HVAC Pipe Accessories
Bi-Polar Ionization Units
Contractor Start up forms
Fan-coil Units

I. For miscellaneous items not listed here, contractor shall submit shop drawings for approval, unless the item is to be provided and installed **exactly** as specified, without variance.

J. Contractor shall provide a sign in sheet for each piece of equipment requiring Owner training noted in division 23. Training required for all equipment including the following: Water heaters, tempering valves, circulating pumps, HVAC pumps, electric heaters, boilers, cooling towers, water source heat pump units, condensing units, heat pump units, air handling unit, fan-coil units, rooftop units, split systems, energy recovery units, commercial kitchen hood, residential and commercial hood fire suppression systems and HVAC controls (controls shall include Reliable as well as any non- Reliable controls, i.e. wall mounted timers and wall mounted switches).

K. Submit evidence of welders' qualifications prior to performing any welds.

L. In addition, contractor shall prepare and submit dimensioned shop drawings (drawn at minimum 1/4"=1'-0" scale) of all ductwork, piping and equipment (HVAC) on the entire project. The drawings shall be created with computer aided drafting software. This shall also include actual mechanical room layouts, typical sections through corridors, pipe sleeves and other penetrations through slabs and walls for HVAC including fire and smoke walls. These shop drawings shall be submitted as PDF, along with a set of prints equal to the number of copies of submittals required by the Contract Documents.

END OF SECTION 23 0500

SECTION 230500 - Exhibit No. 1

CERTIFICATION OF COMPLIANCE - SHOP DRAWINGS

To:

Project:

I have reviewed the contract documents, including but not limited to specifications, drawings, addenda, and change orders. To the best of my knowledge the materials described by the enclosed shop drawings are consistent with and meet the requirements of the aforementioned documents. I further recognize that; 1) the engineers review is to assist me in complying with the documents by checking for errors in my interpretation of the requirements set forth in the contract documents, 2) review of shop drawings, by the engineer, shall not relieve me of my responsibility for confirming and correlating all quantities, dimensions and work with that of other trades, and for performing the work in a safe and satisfactory manner, and 3) review of shop drawings, by the engineer, shall not permit any deviations from plans and specifications.

I understand that I will be required to remove and replace at no additional cost to the owner any item found to be inconsistent with or not meet the requirements of the contract documents.

The undersigned states that the above is true to the best of his knowledge and that he has the authority to legally bind his firm to the above terms. Failure to provide a legally binding signature shall void submittal.

Sub Contractor:

By: _____ Date: _____

Ga. State License No (Required): _____

Title: _____

Company: _____

General Contractor:

By: _____ Date: _____

Title: _____

Company: _____

SECTION 230500 - Exhibit No. 2

A/C Contractor shall make out start-up cards for all heat and cool units as per start up card furnished below and shall furnish same before substantial completion inspection for each phase of construction.

A/C CONTRACTOR'S START-UP CARD

Cherokee County Schools

School Name _____

HVAC Contractor _____

Unit #_____

Unit Model Number _____ Unit Serial Number _____

A/C EQUIPMENT

Rated Volts - _____
Rated Amps - _____

	COOLING	HEATING
Discharge Pressure	_____	_____
Suction Pressure	_____	_____
Return Air Temp.	__	_____
Supply Air Temp.	_____	_____

GAS FIRED EQUIPMENT

(Boilers, etc.)

Unit # _____ Actual Manifold Pressure: Mfg. Rated Manifold Pressure:

_____ _____

Actual Stack Pressure: Rated Stack Pressure:

_____

ELECTRIC HEAT

Unit #_____	Actual Volts	Rated Volts	Rated Amps	Actual Amps
	_____	_____	_____	_____

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes 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.

1.4 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Operation and Maintenance Data: For motors to include in emergency, operation, and maintenance manuals.

C. Warranties: Warranties specified in this Section

1.5 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of motors that fail in materials or

workmanship within specified warranty period. All repairs shall be by the manufacturer's approved representatives.

PART 2 - PRODUCTS

2.1 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.

C. Acceptable Manufacturers: Baldor, Marathon, US.

2.2 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.

2.3 POLYPHASE MOTORS

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

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

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

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

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

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

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

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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

B. Motors Used with Variable Frequency Controllers: All motors used with VFD drives shall be suitable for inverter duty usage and comply with the following:
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
   5. Provide pre-installed Aegis SGR bearing protection rings (grounding rings) or equal on motor shaft for all motors with variable frequency drives. Ring shall be sized to protect motor bearings. Rings shall be maintenance free, conductive microfiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge damaging shaft voltages away from the bearings to ground.

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

D. Manufacturers
   1. Baldor
   2. Marathon
   3. U.S.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

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

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

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

E. 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.

2.6 STARTERS

A. Power controllers shall be provided for the equipment furnished under this specification. When not provided as a component of the equipment specified, external starters shall be provided under this division to control the equipment as outlined in the control specifications. Starters and contactors shall be constructed in accordance with the NEMA Standards. Starters shall have overload and running protection in each power phase.

B. Voltage for holding coils shall not exceed 120 volts, unless otherwise specified: provide built-in transformers with fuses. Provide auxiliary contacts as required by control circuits.

C. Starters shall be furnished with individual phase thermal overload protection, and with two (2) normally open auxiliary contacts, "Hand-Off-Auto" switch, 24 VAC coil, 24 VAC control transformer, and pilot light.

D. All external starters shall have NEMA-4 rated enclosures for weatherproof operation and stainless steel enclosure finish.

E. Motor starters shall be manufactured by Furnas, Square D, Westinghouse, Siemens, and General Electric.

F. Each starter shall be provided engraved laminated plastic nameplates describing the piece of equipment being served.

2.7 VARIABLE SPEED DRIVE

A. Variable speed frequency drives shall be provided for the equipment furnished under this specification. When not provided as a component of the equipment specified, external VFD shall be provided under this division to control the equipment as outlined in the control specifications.

B. Drives shall be specifically manufactured for HVAC application. The drives shall digitally control both voltage and frequency to standard induction motors.

C. Standard features include PID control, DC link reactor for harmonics control, and energy optimizing capabilities.

D. The entire package shall be factory engineered for low noise and high energy efficiency, and shall be factory assembled and tested, and carry the U.L. label.

E. Drives shall be provided with built-in disconnect.

F. Units shall be rated for and comply with the following minimum criteria:
   1. Displacement factor: 0.98 or greater
   2. Drive efficiency: 97% or greater
   3. Inline voltage range for full load:Nominal 10% + or -
   4. Adjustable maximum speed:to 120 Hz
   5. Adjustable minimum speed :to 0 Hz
   6. Adjustable acceleration time: to 3,600 seconds
   7. Adjustable deceleration time: to 3,600 seconds
   8. Maximum number of preset speeds:16
   9. Maximum number of frequency stepovers:4
   10. Maximum number of accel rates:4
   11. Maximum number of decel rates:4
   12. Number of programmable digital inputs:8
   13. Number of programmable analog inputs: 3, 2 for voltage, 1 for current
   14. Number of programmable analog outputs: 2
   15. Number of relay outputs: (1) 50 VAC, 1 A standard, (1) Form C 240 VAC, 2 A standard, (4) additional
   16. Relay ON delay and Relay OFF delay:0 to 600 seconds
   17. Display Languages: 9

G. Standard features:
   1. DC link reactor on both DC bus lines for control of harmonic distortion and line-coupled electrical noise
   2. Built-in two setpoint PID controller
   3. Built-in N2 communication
   4. Built-in FLN communication
   5. All parameters can be uploaded to keypad and downloaded to all drives
   6. "Flying Start" synchronizes drive with a motor rotating in either direction
   7. Auto ramping ensures no-trip acceleration and deceleration
   8. Signal loss detection
   9. Loss of load/broken belt detection
   10. Safety interlock provides external fault indication
   11. Sleep mode stops drive at predetermined operating condition and restarts drive at specified demand to maximize savings and reduce wear of the driven equipment

12. Constant torque start always available to provide easy starting of high inertia and high friction loads.

H. Variable speed drives shall contain automatic by-passes to allow operation of equipment on drive failure. Bypass shall include an adjustable time delay to automatically bypass after cycle has expired and drive has not started. Additional contacts to interlock with building management and control system shall be included, and shall indicate drive and line operation.

I. Unit shall be manufactured by ABB, Graham, Eaton, Reliance.

J. Provide remote pressure sensor for each drive for input to controller.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive field-installed motors for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before motor installation.

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

3.2 FIELD-INSTALLED MOTOR INSTALLATION

A. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and align with load transfer link.

B. Install motors on concrete bases complying with Division 3.

C. Install wiring between starter and motor in accordance with NEC requirements, and in accordance with the requirements of Division 26.

3.3 VARIABLE SPEED DRIVE INSTALLATION

A. Installation of drives shall be certified in writing by a representative of the manufacturer.

B. Manufacturer’s representative shall verify proper programming, installation and interface with related equipment, and confirm proper operation of device.

C. Drives shall maintain all manufacturers and code required clearances.

D. Install wiring between drive and motor in accordance with NEC requirements, and in accordance with the requirements of Division 26.

E. Certification letters for each drive shall be included in the project closeout documents.

3.4 STARTER\VFD INSTALLATION

A. Installation of starters and drives shall be in accordance with the requirements of the latest NEC, and conform to the conditions indicated on the electrical documents.

B. Installation shall be coordinated with work of other divisions to provide adequate clearances for service and operation.

C. Starters and VFDs shall be mounted a maximum of 48” above finished floor

END OF SECTION 23 0513

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SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Equipment supports.
   7. Pipe Stands.

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 23 Section " Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
   3. Division 23 Section(s) " Metal Ducts" and "Nonmetal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

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

1.4 PERFORMANCE REQUIREMENTS

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

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

C. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

A. Product Data: For the following:
1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to 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

2.1 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. B-Line Systems, Inc.; a division of Cooper Industries.
2. Carpenter & Paterson, Inc.
3. ERICO/Michigan Hanger Co.
4. Grinnell Corp.
5. National Pipe Hanger Corporation.

6. PHD Manufacturing, Inc.

C. Galvanized, Metallic Coatings: Pre-galvanized 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. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. Power-Strut Div.; Tyco International, Ltd.
4. Thomas & Betts Corporation.
5. 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. Pipe Shields, Inc.
4. Rilco Manufacturing Company, Inc.
5. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.

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. ITW Ramset/Red Head.
      c. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, 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. B-Line Systems, Inc.; a division of Cooper Industries.
      b. Hilti, Inc.
      c. ITW Ramset/Red Head.
      d. Powers Fasteners.

2.7 EQUIPMENT SUPPORTS

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

2.8 PIPE STANDS

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

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

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

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Plastic.
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:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
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-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.9 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.
3.

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. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
   3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   4. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
   5. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

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. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

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. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
   5. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
   6. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
   7. 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.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

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

3.2 HANGER AND SUPPORT INSTALLATION

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

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

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

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

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

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

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

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

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment. Maximum pipe hanger spacing shall be 8'-0".

L. 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.

M. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Clamp may not project through insulation.
      b. 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 40, protective shields on piping with vapor barrier. Shields shall span an arc of 180 degrees.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 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.
   4. Pipes NPS 8 and Larger: Include wood inserts.
   5. Insert Material: Length at least as long as protective shield.
   6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

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

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

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

3.4 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1 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 23 0529

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Piping Labels
3. Valve Tags

1.3 SUBMITTALS

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

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. Labels for Equipment:
1. Material: Adhesive film suitable for outdoor use.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F .

5. Minimum Label Size: Labels shall be a minimum of 2-1/4” inches tall.
6. Minimum Letter Size: Letters and numbers shall be a minimum of 2 inches tall.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches : Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipe with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Self-Adhesive Pipe Markers not acceptable.

C. Plastic Tape not acceptable.

D. Acceptable Manufacturers:
1. T&B/ Westline
2. Seton
3. MSI (Marking Services, Inc.)
4. Brimar Identification & Safety Products
5. Mifab

2.3 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping sys tem abbreviation and 1/2-inch numbers, with numbering scheme. Pro vide 5/32-inch hole for fastener.
1. Material: 19 gauge minimum brass, 1-1/2" minimum size.
2. Valve-Tag Fasteners: Self locking cable ties.

B. Acceptable Manufacturers:
1. T&B/ Westline
2. Seton
3. MSI (Marking Services, Inc.)
4. Brimar Identification & Safety Products
5. Mifab

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.

C. Labeled items shall include as a minimum the following:
1. Unitary HVAC Equipment
2. Energy Recovery Equipment
3. Pumps
4. Starters
5. Heat Exchangers
6. Boilers
7. Towers
8. Fans
9. Heaters
10. Air Handlers
11. Split Systems
12. VAV Terminals

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.
1. Pipes with OD, Including Insulation, Less Than 4 Inches : Snap-on/self coiling pipe markers. Use color-coded markers lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.
2. Pipes with OD, Including Insulation, 4 Inches and Larger: Snap-on/self coiling pipe markers. Use color-coded markers with permanent nylon fastener straps, one on each end.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:
1. Near each valve and control device. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

2. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
3. At access doors, manholes, and similar access points that permit view of concealed piping.
4. Near major equipment items and other points of origination and termination.
5. Spaced at maximum intervals of 20 feet along each run or otherwise at each wall.
6. Pipe markings on piping more than 7'-0" above floor shall be rotated to allow full observation from floor.

C. Band and letter sizes shall conform to the following table:

O.D. of Piping of Covering:	Color Band	Width of Size of Letter/Numbers
1" and smaller	6"	1/2"
1-1/4" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
8" and larger	18"	2"

D. Band legend and color and letter color shall conform to the following table:

Piping	Band Legend	Letters	Band Color
Non Potable Water	NPW	Black	Green
Domestic Makeup Water	CW	Black	Green
Heating Hot Water	HHW	Black	Yellow
Heat Pump Supply	HPS	Black	Green
Heat Pump Return	HPR	Black	Green
Tower Water Supply	TWS	Black	Green
Tower Water Return	TWR	Black	Green
Natural Gas	G	Black	Yellow
Condensate Drain	CD	Black	Green

3.4 VALVE-TAG INSTALLATION

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

SYSTEM	IDENTIFICATION SHAPE	NUMBERS
Heat Pump Loop	Circle	HP-1,2,3....
Tower Water	Circle	TW-1,2,3.....
Boiler Hot Water	Circle	HWH-1,2,3…..

   2. Each valve tag shall be attached to the handwheel with self-locking cable ties.
   3. A valve chart, framed under glass and wall mounted, shall be located in the main mechanical room and shall list each valve by identification number, its location in the piping system - (i.e., hot

water, fire main, water heater, etc.) and its function -(i.e., shut-off, balancing, drain, etc.).

4. Gas valves at the meter, generator and on the roof shall not have valve tags.
5. All ceiling tiles which provide access to valves shall be identified with a color coded valve identification number affixed to the permanent ceiling grid immediately below the valve.

END OF SECTION 230553

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

A. Test and Balance Agency will be retained under separate contract by the Owner.

B. The contractor responsible for installing the HVAC equipment shall perform preliminary testing and balancing of all equipment including fan rotation, pump rotation, control valve operation, start-up on all equipment, etc., as required to assist the test and balance contractor.

C. The Test & Balance Agency in conjunction with the control sub-contractor shall check out each system for control function through the entire sequences specified. All device set points, damper positions, actuator travel, relay actions, etc. shall be verified for proper operation.

D. Contractor shall manipulate the control devices thru the sequences specified, or as required to achieve conditions necessary for the complete testing and balancing of the installed systems.

E. Coordinate the test and balance to provide sufficient time before final completion date so that tests and balancing can be accomplished. Testing and balancing shall be accomplished prior to installation of security ceilings, or other types of closures.

F. Provide immediate labor and tools to make corrections, when required, without undue delay.

G. The Contractor shall put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of same during each working day of testing and balancing.

H. Testing and balancing personnel shall be kept informed of any major changes made to the system(s) during construction and shall be provided with a complete set of as-built drawings.

1.3 CONTRACT DOCUMENTS

A. Within 60 days of acceptance of contract, the contractor shall provide the designated TAB Agency with a complete set of Construction Documents, Equipment Specifications, and Equipment Submittals including all pertinent addenda items.

B. The TAB Agency shall be provided by the General Contractor or Mechanical Contractor the following items when issued or received:
   1. Copies of all Addenda
   2. Change Orders
   3. Equipment Manufacturer's Submittal Data
   4. Mechanical Shop Drawings
   5. Temperature Control Shop Drawing
   6. Project Schedule

1.4 NOTIFICATION AND SCHEDULING

A. Before testing and balancing commences, the TAB Agency shall receive notification in writing from the Mechanical Contractor stating that the HVAC system(s) is operational, complete and ready for balancing. A complete system means more than just physical installation. The Mechanical Contractor shall certify that all prime movers: fans, pumps, refrigerant machines, boilers, etc., are installed in good working order, and that full load performance has been preliminarily tested. Mechanical Contractor shall certify in writing that all equipment has been checked, started, adjusted and operated per the manufacturer's recommendations. Mechanical Contractor shall include copies of factory start-up reports for specified equipment.

B. The schedule for testing and balancing of the HVAC systems shall be established once notification has been received by the TAB Agency.

1.5 COORDINATION WITH OTHER TRADES

A. The Contractor, Mechanical Contractor, Temperature Control Subcontractor and the supplier of the HVAC equipment shall cooperate with the TAB Agency to provide all necessary data on design and proper application of the system components. In addition, they shall furnish all labor and materials required to eliminate any system deficiencies.

B. The TAB Agency shall coordinate the location and type of all taps, valves, sensors, damper, etc., as required for proper system testing and balancing with the Mechanical Contractor prior to beginning work.

C. The TAB Agency shall visit project before beginning initial testing and balancing to inspect installation of HVAC system, location and testing of all testing taps, etc., and provide a written report of all deficiencies to the Mechanical Contractor, Mechanical Engineer and Architect.

D. To bring the HVAC system(s) into a state of readiness for testing, adjusting and balancing, the installing Mechanical Contractor shall perform the following:

PART 2 - PRODUCTS

2.1 TESTING AND BALANCING INSTRUMENTS

A. Instruments used for final testing and balancing will be provided by the designated TAB agency. All final test analysis reports will include a letter of certification listing instrumentation used and last date of calibration.

B. Contractor shall provide all additional instruments, devices, etc. as required for the initial start-up and balancing of the systems.

PART 3 - EXECUTION

3.1 GENERAL

A. The contractor shall provide the following conditions prior to the services of the designated TAB agency:
   1. AIR SYSTEMS
      a. Ensure that all splitters, extractors, volume, smoke and fire dampers are properly located and functional. Dampers serving the requirements of smoke, outside air, return air and exhaust air shall provide tight closure and full opening, with smooth, free operation.
      b. Verify that all supply, return, exhaust and transfer grilles, registers, diffusers are installed properly and free of objectionable noise.
      c. Verify that all fans are operating and free of vibration. All fans and drives shall be checked for proper rotation and belt tension.
      d. Install clean filters in all units prior to testing.
      e. Make all necessary changes as required by the TAB Agency, at no additional charge to the owner.
   2. TEMPERATURE CONTROLS
      a. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, and fire and smoke dampers.
      b. Verify that all sensors are calibrated and set for design operating conditions.
      c. Make available to the TAB Agency any needed unique instruments for setting of D.D.C. controls.
      d. Provide assistance and instruction to the TAB Agency in the proper use and settings of control components.

B. The contractor shall provide assistance and support services to the designated TAB agency as required to perform the scope or work listed below:
   1. PRECONSTRUCTION PLAN CHECK AND REVIEW

a. The TAB Agency shall perform a preconstruction review of the contract documents and equipment submittals for their effect on the testing and balancing process. Review shall include location and type of volume dampers, air valves, balancing valves, flow metering stations, automatic control valves, pressure sensors, sheet metal and piping shop drawings.
b. Submit any recommendations for enhancements or changes to the system within 30 days of document review.

2. ON-GOING JOB SITE INSPECTIONS
   a. During construction, the test and balance agency shall inspect the installation of pipe systems, sheet metal work, temperature controls and other component parts of the HVAC systems. Inspections shall be performed when 60% of the piping and or sheet work is installed and again when 90% of the total HVAC system is installed and prior to insulation of piping systems.
   b. The balancing agency shall submit a written report of each inspection to the owner's representative, the Mechanical Engineer and the contractor responsible for correcting any noted deficiencies.
   c. Inspections shall check for all necessary balancing hardware (dampers, flow meters, valves, pressure taps, thermometer wells, etc) to determine if they are installed properly and readily accessible.
   d. Identify and evaluate any variations from system design.
   e. Identify and report possible restrictions in systems (closed dampers, long runs of flexible ductwork, poorly designed or connected duct fittings, excessive piping losses, etc.).
3. RECORD & REPORT DATA
   a. The Test and Balance report shall be complete with logs, data and records as required herein. Air and water flow quantities shall be balanced within 5% of the values specified in the contract documents. All logs, data and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the Testing and Balancing Agency's registered Professional Engineer.
   b. Six copies of the Certified Test and Balance Reports shall be submitted to the Architect for review and acceptance.
   c. The report shall include, but not be limited to, the following data.
      1) Project Number
      2) Contract Number
      3) Project Title
      4) Project Location
      5) Project Architect
      6) Project Mechanical Engineer
      7) General Contractor
      8) Mechanical Contractor
      9) Date tests were preformed
      10) Certification
      11) General discussion of system(s) and any abnormalities or problems encountered

Test and Report Forms	AABC Form No.
Cover Sheet	89010
Instrument List	89020
Air Moving Equipment Test Sheet	89030
Exhaust Fan Data Sheet	89031
Return/Outside Air Data	89033
Air Distribution Test Sheet	89040
Temperature Readings	89043
Electric Heater Report	89050
Cooling Coil Data	89101
Combustion Test	89600
Other Forms as Required	-----

d. The following items shall be tested, balanced, adjusted as required for proper system operation:

Adjust all diffusers, grilles and registers to minimize drafts in all areas
Energy Recovery Units
Rooftop Units
Supply and Return Air Grilles and Diffusers
Supply & Exhaust Fans
Fan-coil and Air-handling Units
Unit Heaters
Electric Heaters

e. Overall system(s) and installation for compliance with contract drawings and specifications.

4. CONTROL SYSTEM VERIFICATION
   a. Verify that all control devices are properly connected
   b. Verify that all dampers, valves and other controlled devices are operated by the intended controller.
   c. Verify that all dampers and valves are in the position indicating by the controller (open, closed and modulating).
   d. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions.
   e. Check that all valves are properly installed in the piping system in relation to direction of flow and location.
   f. Check the calibration of all controllers
   g. Check the locations of all sensors to determine whether their position will allow them sense only the intended temperatures or pressures. Control contractor shall relocate as deemed necessary by the TAB Agency.
   h. Check locations of all sensors, thermostats, etc., for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.
   i. Verify the operation of all interlocked systems.
   j. Verify that all controller set points meet the design intent.
   k. Perform all system verification to assure the safety of the system and its components.
5. SYSTEM PERFORMANCE VERIFICATION
   a. a. At the time of final inspection, the Test and Balance Contractor shall recheck, in the presence of the owner's

representative random selections of data, air and hydronic quantities and other items recorded in the Certified Report.

b. Points and areas for recheck will be selected by the Owner's representative and shall not exceed 25 percent of the total number tabulated in the Certified Report.

c. If random tests indicate a measured deviation in air or hydronic flow of ten percent or more from that recorded in the Certified Report, the complete report is rejected, all systems shall be readjusted and tested, new data recorded, new Certified Reports prepared and submitted, and new inspection tests made, all at no additional cost to the owner.

d. Following system verification of the Certified Report by the Owner's Representative, the settings of all valves, splitter dampers, and other devices shall be permanently marked by the Test and Balance Agency, so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after system verification.

6. OPPOSITE SEASON TEST

a. Testing and Balancing Agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The TAB Agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

b. The T & B Agency shall resubmit six (6) copies of the complete test and balance reports to the Engineer for approval prior to final acceptance of the project.

7. ADDITIONAL TESTS

a. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

3.2 SYSTEM ACCEPTANCE

A. Reference section 01770 for general requirements.

3.3 CLOSEOUT DOCUMENTATION

A. Properly completed start-up forms, including equipment marks and serial numbers, documenting proper field quality control and proper system demonstration to the Owner prior to the testing and balancing by the Owner's agency shall be received by the Owner prior to granting of substantial completion. Also, correction of deficiencies found by the Owner's testing and balancing agency shall be completed prior to the Owner's granting of substantial completion.

END OF SECTION 230593

SECTION 230700

HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Mineral fiber.
      b. Polyisocyanurate.
      c. Polyolefin.
   2. Fire-rated insulation systems.
   3. Insulating cements.
   4. Adhesives.
   5. Sealants.
   6. Factory-applied jackets.
   7. Field-applied jackets.
   8. Tapes.

B. Related Sections:
   1. Division 22 Section "Plumbing Insulation."
   2. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

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

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 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

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. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Duct Wrap.
      d. Owens Corning; All-Service Duct Wrap.

G. Duct Internal Lining
   1. All supply & return ductwork a min. of 10 feet from unit or greater as indicated on floor plans shall be insulated internally with 1.5" thick, 3.0 lb. / cu. ft. density with an "R" value of 6, acoustical duct liner with an acrylic coating on the air stream side that will not support or promote fungal or bacterial growth as rated in accordance with ASTM C 1071, G21 & G22. Acrylic coating shall be treated with an EPA registered anti-microbial agent. Insulation conductivity, or "K" value, shall not exceed 0.25 BTU/In. sq. ft. per degree F per hour at 75 degrees F per ASTM C 158. The lining noise reduction coefficient shall be a min. of 0.70 based on "Type A mounting" as tested in accordance with ASTM C 423. Insulation shall be rated for a minimum velocity to prevent surface fiber erosion of 4,000 FPM.
   2. All exterior supply, return ductwork and ductwork noted on plans shall be lined with a minimum "R" value of 8.

H. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
   1. Products: Subject to compliance with requirements:
      a. Apache Products Company; ISO-25.
      b. Dow Chemical Company (The); Trymer.
      c. Duna USA Inc.; Corafoam.
      d. Elliott Company; Elfoam.
   2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.

3. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches as tested by ASTM E 84.
4. Fabricate shapes according to ASTM C 450 and ASTM C 585.

I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
1. Products: Subject to compliance with requirements:
   a. Armacell LLC; Tubolit.
   b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
   c. RBX Corporation; Therma-cell.

J. Mineral-Fiber, Preformed Pipe Insulation:
1. Products:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000 Pipe Insulation.
   d. 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-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Insulco, Division of MFS, Inc.; Triple I.
   b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

2.3 ADHESIVES

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

B. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F .
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-96.
   b. Foster Products Corporation, H. B. Fuller Company; 81-33.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements:
      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.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements:
      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. 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:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

2.4 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements,:
      a. Childers Products, Division of ITW; CP-76.
      b. Foster Products Corporation, H. B. Fuller Company; 30-45.
      c. Marathon Industries, Inc.; 405.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Pittsburgh Corning Corporation; Pittseal 444.
      f. Vimasco Corporation; 750.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 100 to plus 300 deg F .
   5. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements:
      a. Childers Products, Division of ITW; CP-76-8.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc.; 405.
   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.

2.5 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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
   3. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.6 FIELD-APPLIED JACKETS

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

B. Metal Jacket:
   1. Products: Subject to compliance with requirements:
      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.
      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.

2.7 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,:
      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,:
      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. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Products: Subject to compliance with requirements,:
      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.

D. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

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

E. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
2. Width: 3 inches .
3. Film Thickness: 6 mils .
4. Adhesive Thickness: 1.5 mils .
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

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. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F . Consult

coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature 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.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

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

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

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

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

G. Keep insulation materials dry during storage, application and finishing. Insulation that gets wet shall be replaced.

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

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

C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. 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" for firestopping and fire-resistive joint sealers.

3.5 MINERAL-FIBER INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with staples, tape, and stainless steel wire 24” on center.
   1. Install capacitor-discharge-weld pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides and bottoms 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.
      b. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      c. Do not over compress insulation during installation.
      d. Impale insulation over pins and attach speed washers.
      e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   2. For ducts and plenums, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 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 2 times the insulation thickness but not less than 3 inches.

3. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
4. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return.
4. Indoor, exposed return.
5. All duct associated with energy recovery unit.

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. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.7 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. All return air, outdoor air intake, supply air, ERU supply, ERU return and any ducts with an internal temperature below 65 degrees F shall be insulated with mineral-fiber blanket: minimum "R" value of R-6. Where noted on the plans, the ductwork shall be insulated with 2-1/2" thick R-8 duct wrap.

3.8 PIPING INSULATION

A. All HVAC piping, other than heat pump loop piping, shall be insulated with minimum ½" thickness fiberglass or flexible Elastomeric insulation unless noted otherwise below.

B. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber Pipe Insulation, Type I: 1/2 inch thick.

C. External Chilled Water:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Cellular Glass: Preformed, rigid cellular glass material intended for use as thermal insulation Pipe Insulation, Type I: 1-1/2 inch thick, with aluminum jacket – electric heat tracing beneath.

D. Heating-Hot-Water (Boiler) Supply and Return, 200 Deg F and below:
   1. NPS 12 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I, 1-1/2 inches thick for piping up to 1-1/2", 2 inches thick, for piping 2" and greater.

E. Chilled Water:
   1. NPS 12 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I, 1-1/2 inches thick for piping up to 1-1/2", 2 inches thick, for piping 2" and greater.

F. Refrigerant Suction and Hot-Gas Tubing:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1 inch thick.
      b. Polyolefin: 1 inch thick.

3.9 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, Exposed:
   1. PVC: 20 mils thick.
   2. Aluminum, Smooth or Corrugated: 0.020 inch thick.

3.10 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. Install jacket over all outdoor refrigerant piping. For insulation with factory-applied jacket, install the

field-applied jacket over the factory-applied jacket. This includes refrigerant piping.

B. Piping, Exposed:
1. Aluminum, Smooth or Corrugated: 0.020 inch thick.

3.11 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.

3.12 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of 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 services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, 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 cut sections of cellular-glass block insulation of same thickness as pipe 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 and density as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

E. Insulation Installation on Piping below grade:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. A vapor barrier jacket shall be provided at all longitudinal seams, end joints, and protrusions sealed with vapor-barrier mastic and joint sealant.
3. Pipe with insulation shall be installed on undisturbed ground, which provides full support for the entire length of piping. Where elbows are not properly supported, concrete thrust blocks shall be provided. Thrust blocks shall be provided at the discretion of the engineer if the piping is not sufficiently supported.
   Piping shall have adequate space between other piping and obstructions to allow back filling and compacting. The spacing should be a minimum of 8 inches between insulated pipes.

END OF SECTION 230700

SECTION 230900

HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 OVERVIEW

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

B. This document contains the specification and input/output summaries for a Building Automation System (BAS) for: **Cherokee County Board of Education**

C. The system shall provide the Direct Digital Control (DDC), Energy Management and Building Automation System (BAS) for the air conditioning, heating and ventilating systems and shall interface with other microprocessor based building subsystems as detailed in the Input/Output Summaries and as specified herein. All damper and valve actuators shall be electronic.

1.2 INSTRUCTIONS TO BIDDERS

A. The system specified in this document shall be native BACnet architecture providing full operator access via the Internet or Local Area Network utilizing only a browser for full operator access and control in through a thin-client architecture. The system shall be the **Automated Logic WebCTRL system furnished and installed by ALC Controls Inc.** The requirements are described in this specification. No deviations from this specification are acceptable.

1.3 SCOPE OF WORK

A. Contractor's Responsibilities
   1. The Contractor shall furnish and install all necessary software and hardware, wiring, and computing equipment in compliance with this specification. Any variances from this specification or related documentation shall be submitted in writing at the time of bid.

B. System Requirements
   1. Standard Material/Products. All material and equipment used shall be standard components, regularly manufactured and available, and not custom designed especially for this project
   2. Modular Design. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.

3. Performance. The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.

C. Equipment
1. System Hardware
a. The Contractor shall provide the following:
1) PC's, server(s), routers, modems and control modules as specified.
2) All sensing devices, relays, switches, indicating devices, and transducers required to perform the functions as listed in the sequence of operations.
3) All monitoring and control wiring.
2. System Software
a. The Controls Contractor shall provide all software identified in Part 2 of this specification, including the BAS Server, fully configured database, graphics, reports, alarm/events. The Graphical User Interface (GUI) shall be completely Web based as specified herein.

D. Codes and Regulations
1. Standards Authority. All electrical equipment and material, and its installation, shall conform to the current requirements of the following authorities:
a. Occupational Safety and Health Act (OSHA)
1) National Electric Code (NEC)
2) National Fire Code
3) International Mechanical Code
4) International Building Code
5) International Plumbing Code
2. Product Applicable Standards. All distributed, standalone and unitary controllers supplied shall be in compliance with the following listings and standards:
a. UL916 for Open Energy Management (for U.S. and Canada)
b. FCC Part 15, Sub-Part B, Class A
c. CE Electro Magnetic Compatibility
3. Manufacturer's Quality System. The control system manufacturer shall be ISO9001 listed for design and manufacture of environmental control systems for precise control and comfort, indoor air quality, HVAC plant operation, energy savings and preventative maintenance. ISO Certification shall be by a registrar that is accredited by an internationally recognized organization such as RAB. Copy of ISO9001 certificate shall be submitted with bid.
4. Conflict of Codes. Where two or more codes conflict, the most restrictive shall apply. Nothing in this specification or related documentation shall be construed to permit work not conforming to applicable codes.

1.4 GENERAL CONDITIONS

A. Changes in Scope of Work
1. Any changes in the scope of work must be authorized by a written Change Order.
2. Correction of Work

a. Contractor's Responsibility. The Contractor shall promptly correct all work found defective or failing to conform to the Contract Documents. The Contractor shall bear all cost of correcting such work.
b. During Warranty. If, within the warranty period required by the Contract Documents, any of the work is found to be defective or not in accordance with the Contract Documents, the Contractor shall correct it promptly after receipt of a written notice to do so.

B. Coordination of Work During Construction
1. The Contractor shall coordinate any necessary changes in work scheduling to minimize disruption.
2. The Contractor shall protect the installed works by other trades.
a. The Contractor shall coordinate with other trades.
b. The Contractor shall repair any damage caused by his work to building(s) and equipment at no additional cost to the owner.

C. Warranty
1. The Contractor shall warrant, from the date of final acceptance**,** that all systems, subsystems, component parts, and software are fully free from defective design, materials, and workmanship for a period of one year or longer as indicated in this specification.
2. In addition, contractor shall provide an additional 5-year parts warranty on all energy management system components.
3. All Manufacturer's software/firmware for web server/workstation and controllers shall be updated to the latest versions that are available from the manufacturer within 30 days from the date of end of the warranty. These updates shall be installed and checked out before the end of the warranty.

1.5 SUBMITTALS, DOCUMENTATION, ACCEPTANCE AND TRAINING

A. Submittals
1. Shop Drawings. Shop drawings shall be submitted (PDF) and shall consist of a complete list of equipment, materials, manufacturer's technical literature, cut-sheets, and installation instructions. Drawings shall contain proposed layout, complete wiring, routing, schematic diagrams, tag number of devices, software descriptions, calculations, installation details, and any other details required to demonstrate that the system will function properly.
2. Graphical Programming Documentation: The Contractor shall provide a printout all Graphical Programs, identifying the specific HVAC or mechanical/electrical subsystem being controlled
3. Drawing Approval. Shop drawings shall be approved before any equipment is installed. Controls contractor shall allow a minimum of fourteen (14) days for drawing approval.
4. As Built Drawings. All drawings shall be reviewed after the final system checkout and updated or corrected to provide 'as-built' drawings to show exact installation. All shop drawings will be acknowledged in writing before installation is started and again after the final checkout of the system. The system will not be considered complete until the 'as-built' drawings have received their final approval. The Contractor shall deliver PDF set of

'as-built' drawings. Load into the control system for access by the operator through any operator workstation as-built drawings. There shall be a menu or navigation tab to access the as-built drawings. The as-built drawings shall be loaded into the control system in a pdf format.

B. Documentation
   1. Operating and Maintenance (O&M) manuals for the system shall be made available electronically using Acrobat (PDF) format and include the following categories: Workstation User's Manual, Project Engineering Handbook, Software Documentation.
   2. BAS User's Manual shall contain as a minimum:
      a. System overview
      b. Networking concepts
      c. Launching a web browser from a networked PC/PDA and login
      d. Graphical User Interface (GUI) screen menus and their definitions
      e. Creating, modifying or deleting schedules
      f. Uploading and downloading software to the field hardware
      g. Creating historical trends, collecting trend data and generating trend graphs
      h. Enabling and assigning alarms and messages to reporting actions/groups
      i. Report generation and 'third party software'
      j. Backing up software and data files
   3. Project Engineering Manual shall contain as a minimum:
      a. System architecture overview
      b. Hardware cut-sheets and product descriptions
      c. The Contractor shall deliver six (6) sets of 'as-built' drawings. All drawings shall be reviewed after the final system checkout and updated to provide 'as-built' drawings. The system will not be considered complete until the 'as-built' drawings have received their final approval.
      d. Installation, mounting and connection details for all field hardware and accessories
      e. Commissioning, setup and backup procedures for all control modules/accessories, BAS server software, and database.
      f. Listing of basic terminology, alarms/messages, error messages and frequently used commands or shortcuts.
   4. BAS Software Documentation shall contain as a minimum:
      a. The Contractor shall provide a printout all Graphical Programs, detailing their application to specific HVAC equipment and electrical/mechanical subsystems, together with a glossary or icon symbol library detailing the function of each graphical icon. Revisions made as a result of the submittal process, during the installation, start-up or acceptance portion of the project, shall be accurately reflected in the "as-builts".
      b. Graphical representation of the mechanical equipment hierarchy for the project including all equipment controlled by the BAS. For example: a VAV terminal box may be the source for increased cooling demand and require the primary VAV AHU to operate which, in turn, requires the chillers to operate.
      c. Detailed listing of all alarm and event messages programmed for designated mechanical/electrical equipment and required operator action.

C. Acceptance Test
   1. Acceptance Testing. Upon completion of the installation, the Contractor shall start up the system and perform all necessary calibration, testing, and debugging operations. The Contractor in the presence of the Owner's representative shall perform an acceptance test.
   2. Notice of Completion. When the system performance is deemed satisfactory, the system parts will be accepted for beneficial use and placed under warranty. At this time, a "notice of completion" shall be issued and the warranty period shall start.

D. System Training
   1. System Use Instructions: Controls Contractor shall provide 8 Hours of training for designated personnel in the operation, maintenance, and programming of the system.

PART 2 - PRODUCTS - BAS SERVER & WEB BROWSER GUI

2.1 SYSTEM OVERVIEW

A. The BAS contractor shall provide system software based on a server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using ASHRAE's BACnet/IP protocol. Server shall be accessed using a web browser over the DDC system intranet provided under this contract and remotely over the Internet.

B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support Microsoft Internet Explorer browsers (6.x or later versions), and Windows as well as non-Window operating systems. No special software, (active-x components or fat java clients) shall be required to be installed on the PC's / PDA's used to access the BAS via a web browser.

C. The BAS server software must support at least the following server platforms (Windows NT, Sun Solaris and Linux). The BAS server software shall be developed and tested by the manufacturer of the system standalone controllers and network controllers/routers. Third party manufactured and developed BAS software is not acceptable.

D. The web browser GUI shall provide a completely interactive user interface and must offer the following features as a minimum:
   - Trending
   - Scheduling
   - Downloading Memory to field devices
   - Real time 'live' Graphic Program Diagnostics for troubleshooting
   - Tree Navigation
   - Parameter change of properties
   - Setpoint Adjustments
   - Alarm / Event information

- Configuration of operators
- Execution of global commands

E. Software Components
1. All software components of the BAS system software shall be installed and completed in accordance with the specification. BAS system components shall include:
   a. Server Software, Database and Web Browser Graphical User Interface
   b. System Configuration Utilities for future modifications to the system
   c. Graphical Programming
   d. Direct digital control software
   e. Application Software

F. BAS Server Database
1. The BAS server software shall utilize a Java DataBase Connectivity (JDBC) compatible database such as: MS SQL, My SQL, Apache Derby, PostgreSQL and Oracle. BAS systems written to Proprietary databases are **NOT** acceptable.

G. Database Open Connectivity
1. The BAS server database shall be Java DataBase Connectivity (JDBC) compatible, allowing real time access of data via the following standard mechanisms:
   a. Common Object Request Broker Architecture (CORBA)
   b. OLE/OPC (for Microsoft Client's/Server platform only)
   c. Import/Export of the database from or to XML (extensible Mark-up Language)

H. Communication Protocol(s)
1. The native protocol for the BAS server software shall be BACnet as defined by ASHRAE standard SPC135. In addition, the software shall be able to support concurrent operation of multiple standard and non-standard protocols such as:
   a. MODBUS
   b. SMNP

I. Cross Platform Capability
1. The BAS system software (client and server) shall be operating system and hardware agnostic, being able to run on Microsoft Windows 8.1 or 10, Windows Server 2012 R2 or 2016 or 2019 or 2020, Red Hat Enterprise Linux 8.3, or Ubuntu Desktop 18.04 or 20.04 TLS.

J. Thin Client – Web Browser Based
1. The GUI shall be thin client or browser based and shall meet the following criteria:
   a. Web Browser's for PC's: Only the latest versions of Microsoft Internet Explorer or Edge, Google Chrome, Mozilla Firefox, and Apple Safari browsers will be required as the GUI, and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet. A firewall shall be installed (as necessary) to protect the customer's Intranet.

b. Security: The web server application shall support Transport Layer Security (TLS) 1.3 capable of encryption of up to 256 bit elliptical curve for transmitting private information over the Internet using HTTPS. Additionally, the web server shall have SHA-2 certificate support capability.

2.2 WEB BROWSER GRAPHICAL USER INTERFACE

A. Web Browser Navigation

1. The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish **2.2 B thru 2.2 J** of this specification. The Web Browser GUI shall (as a minimum) provide a Navigation Pane for navigation, and a Action Pane for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic setpoint controls, configuration menus for operator access, reports, and reporting actions for events.

B. Login

1. On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and password. Navigation in the system shall be dependent on the operator's role privileges, and geographic area of responsibility (see 3.2 J below).

C. Navigation Pane

1. The Navigation Pane shall comprise a Navigation Tree which defines a geographic hierarchy of the proposed BAS system. Navigation through the GUI shall be accomplished by clicking on appropriate level of a navigation tree (consisting of expandable and collapsible tree control like Microsoft's Explorer program), and/or by selecting dynamic links to other system graphics. Both the navigation tree and graphic pane defined in 2.2 D shall be displayed simultaneously, enabling the operator to select a specific system or equipment, and view the graphic corresponding to the highlighted position in the navigation tree. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.
2. Geographic View shall display a logical geographic hierarchy of the system including cities, sites, buildings, building systems, floors, equipment and BACnet objects.
3. Network View shall display the hierarchy of the actual BACnet IP Intranet network. This can include: Systems, Site, Networks, Routers, Half-Routers, Devices, Equipment and all the BACnet Objects in a device.
4. Groups View shall display Scheduled Groups and custom reports.
5. Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).

D. Action Pane

1. The Action Pane shall provide several functional views for each HVAC or mechanical/electrical subsystem specified. By clicking on a button, an

operator shall be able to select the following system page, corresponding to the highlighted area/equipment in the navigation tree:

2. Graphics: Using animated gifs or other graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings of each individual piece of equipment with live variable statuses, active graphic setpoint controls, web content, and other valid HTML elements. The data on each graphic page shall automatically refresh at a rate defined by the operator.
3. Properties: Shall include graphic controls and text for the following: Locking or overriding BACnet objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress a 'accept/cancel' button.
4. Schedules: Shall be used to create, modify/edit and view schedules based on the systems geographical hierarchy (using the navigation tree) and in compliance with section 2.2.G
5. Events: Shall be used to view alarm event information geographically (using the navigation tree), acknowledge events, sort events by category, actions and verify reporting actions.
6. Trends: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling
7. Logic - Live Graphic Programs: Shall be used to display a 'live' graphic programs of the control algorithm for the mechanical/electrical system selected in the navigation tree. All control outputs and inputs shall displayed on the program giving real-time statuses for use in operator troubleshooting.

E. The following actions shall be accomplished by clicking appropriate buttons/menu's in the graphic window: Log In/Out, Print and Hide/Show Navigation Pane.

1. Color Graphics
   a. The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to setpoints and comfort. Animated gif's, active setpoint graphic controls and valid web content (like local weather forecast) shall be used to enhance usability:
   b. Display Size: The GUI workstation software shall graphically display in 1024 by 768 pixels 24 bit True Color.
   c. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
   d. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, which provide a visual display of temperature relative to their respective setpoints (see section 3.2 F below). The colors shall be updated dynamically as a zone's actual comfort condition changes in real-time. Locations of space sensors shall also be shown for each zone. The intent of the specification is to enable the operator to readily assess problems at a glance.
   e. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment

shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.

f. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
   1) Each piece of equipment monitored or controlled including each terminal unit
   2) Each building
   3) Each floor and zone controlled

F. Zone Setpoint Adjustments
   1. Color floor plans displayed via a web browser shall utilize a contiguous band of colors, each corresponding to actual zone temperatures relative to the desired heating and cooling setpoints. The ideal temperature shall be shown as a green color band. Temperatures slightly warmer than ideal shall be shown in yellow, and even warmer temperature band shall be shown in orange. Temperatures slightly cooler than ideal shall be light blue, and even cooler temperatures shall be shown as dark blue. All alarm colors shall be in red.

G. Hierarchical Schedules
   1. Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with password access) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area.
   2. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.

H. BACnet Schedules: Schedules shall comply with the BACnet standard, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
   1. Types of schedule shall be Normal, Holiday or Override
   2. A specific date,
   3. A range of dates,
   4. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any)
   5. Wildcard (example, allow combinations like second Tuesday of every month).

I. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.

J. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an 'individual tenant' group – who may occupy different areas within a building or buildings. Schedules applied to the 'tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the 'tenant group'

K. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler, and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.

L. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator.

M. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules, and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

N. Schedule Distribution: For reliability and performance, instead of maintaining a single schedule in a field device that writes over the network to notify other devices when a scheduled event occurs, field devices will only keep their part of the schedule locally. The BAS server software shall determine which nodes a hierarchical schedule applies to and will create/modify the necessary schedule objects in each field device as necessary.

O. Events (& Alarms)
   1. Events and alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an 'Events' view. Events, alarms, and reporting actions shall have the following capabilities:
      a. Events View: Each event shall display an Event Category (using a different icon for each event category), date/time of occurrence, current status, event report, and a URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
      b. Event Categories: The operator shall be able to create, edit or delete event categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each Event category, enabling the operator to easily sort through multiple events displayed using a built-in filter.
      c. BACnet Event Templates: BACnet Event template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of event, acknowledgement requirements, high/low limit and out of range information.
      d. Event Areas: Event Areas enable an operator to assign specific Event Categories to specific Event Reporting Actions.
      e. Event Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
      f. Event Configuration: Operators shall be able to define the type of events generated per BACnet object. A 'network' view of the

Navigation Tree shall expose all BACnet objects and their respective Event Configuration. Configuration shall include assignment of event, alarm, type of Acknowledgement and notification for return to normal or fault status.

g. Event Summary Counter: The view of events in the Graphic Pane shall provide a numeric counter, indicating how many events are active (in alarm), require acknowledgement, and total number of events in the BAS Server database.

h. Event Auto-Deletion: Events that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.

i. Event Reporting Actions: Event Reporting Actions specified shall be automatically launched (under operator defined conditions) after an event is received by the BAS server software. Operators shall be able to fully define these Reporting Actions using the Navigation Tree and Graphic Pane in the web browser GUI. Reporting Actions shall be as follows:

1) Print: Alarm/Event information shall be printed to the BAS server's PC or a networked printer.

2) Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts.

2. **Note:** Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.

a. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).

b. Write Property: The write property reporting action updates a property value in a hardware module.

c. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an event.

d. Run External Program: The Run External Program reporting action launches specified program in response to an event.

3. Event Simulator: The web browser GUI user shall provide an Event Simulator to test assigned Reporting Actions. The operator shall have the option of using current time or scheduling a specific time to generate the Event. Utilizing the Navigation Tree and drop-down menus in the Graphic Pane, the operator shall be able to select the Event Type, Status, Notification, Priority, Message, and whether acknowledgement is required.

4. External Injection of Events. The BAS server software shall provide a CORBA interface for external injection of events, allowing the system to receive/report events generated from external source other than the BAS system.

P. Trends

1. Trends shall conform to the BACnet Trend Log Object specification. The system shall be able to trend and display graphically all analog, digital or

calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.

2. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
3. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the BACnet object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory
4. Resolution. Sample intervals shall be as small as one (0.1) second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for display that have different trend intervals, the system will automatically scale the axis.
5. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
6. Zoom. It shall be possible to zoom-in on a particular section of a trend for more detailed examination.
7. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.

Q. Security Access

1. Systems that Security access from the web browser GUI to BAS server shall require a Login Name and Password. Access to different areas of the BAS system shall be defined in terms of Roles, Privileges and geographic area of responsibility as specified:
   a. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges. Systems that use cryptic Boolean numbers to define system access are not acceptable.
      1) View Privileges shall comprise Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
      2) Edit Privileges shall comprise Setpoint, Tuning and Logic, Manual Override, and Point Assignment Parameters.
      3) Function Privileges shall comprise Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print, and Alarm/Event Maintenance.
2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree.

2.3 GRAPHICAL PROGRAMMING

A. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in standalone control modules. Any system that does not use a drag and drop method of graphical icon programming as described herein shall be unacceptable. GPL is a method used to create a sequence of operations by assembling graphic microblocks that represent each

of the commands or functions necessary to complete a control sequence of operation. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors, etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.

B. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

C. Graphic Sequence
   1. The clarity of the graphic sequence must be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming must be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.

D. Simulation
   1. Full simulation capability shall be provided with the graphic programming. Operator shall be able to fully simulate the constructed control sequence prior to downloading into field control modules. Simulation capabilities shall include step-by-step, accelerated time, and operator defined simulation criteria like outside weather, demand, and communication status. Multiple graphic programs shall be simulated and displayed in split screens at the same time.

E. GPL Capabilities
   The following is a minimum definition of the capabilities of the Graphic Programming software:

   1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
   2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
   3. BACnet Points: Shall be points that comply with the BACnet structure as defined in the BIBB's Addendum B1/B2, and the BACnet standard.
   4. Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
   5. Wires: Shall be graphical elements used to form logical connections between microblocks and between logical I/O. Different wire types shall be used depending on whether the signal they conduct is analog or digital.
   6. Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by

reference instead of a visual connection; i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.

7. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
8. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields and shall contain 'push buttons' for the purpose of selecting default parameter settings.
9. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes it function.
10. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
11. Live Graphical Programs: The Graphic Programming software must support a 'live' mode, where all input/output data, calculated data, and setpoints shall be displayed in a 'live' real-time mode. For each piece of HVAC equipment, the graphic program shall be complete and viewed on one screen. For example, a graphic program used for an Air Handling Unit shall not be broken down into separate components and require an operator to view only one component at any one time.

PART 3 - PRODUCTS HARDWARE

3.1 BAS SERVER HARDWARE

A. Computer Configuration: The system shall be connected to the existing Cherokee County WebCTRL server. The existing WebCTRL server shall be updated with the latest version of the WebCTRL application the existing database shall be updated to include changes made with this project.

B. Standard Client (Hardware Independent)
1. The thin-client browser interface shall be hardware agnostic, meaning it will support the latest versions of Microsoft Internet Explorer or Edge, Google Chrome, Mozilla Firefox, and Apple Safari browsers. No special software, (active-x components or fat Java clients) shall be required to be installed on the PC's / PDA's used to access the BAS via a web browser.
2. No client hardware is required under this project if the BAS server can act as client in addition to the BAS server applications. Any owner/customer computers may act as client if the client computer has a browser (as specified above) and has connection capability to the DDC intranet/server.

3.2 NETWORK ROUTERS & BRIDGES

A. The DDC/BAS controller network shall use BACnet as its native communication protocol. Network bridges and routers must be of a modular design to ensure reliability and system performance.
1. BACnet Router

2. The central system shall use the DDC/BAS Local Area Network (LAN) provided under this contract for communication. The communication between the central server and the controllers shall be BACnet/IP. A router shall be provided, as required, to bridge BACnet/IP and the data link used between the controllers (BACnet ARCNET and BACnet MS/TP). Proprietary networks and proprietary protocols are not acceptable.
   a. Firmware Updates: The BACnet Router must utilize FLASH memory to allow firmware updates to be performed remotely.

3.3 STANDALONE CONTROLLERS

A. General Purpose Multiple Application Controllers
   1. BACnet BIBBS: General Purpose Multiple Application controllers must use BACnet as the native communication protocol between controllers.
   2. Communication Speed: Controllers shall communicate at a minimum of 38.4 Kbps using MS/TP or ARCNET implemented over EIA-485 using an unshielded twisted pair at the Data Link Layer.

B. General Specification: Each General Purpose Multiple Application Controller must be capable of standalone direct digital operation utilizing its own 32 bit processor, non-volatile flash memory, input/output, 12 bit A to D conversion, hardware clock/calendar and voltage transient and lightning protection devices. A separate co-processor shall be used for communications to the controller network. All non-volatile flash memory shall have a battery backup of at least five years. Firmware revisions to the module shall be made from the BAS server or remotely over the Intranet or Internet. Controllers that require component changes to implement firmware revisions are not acceptable.

C. Point Expansion: The General Purpose Multiple Application Controllers shall be expandable to the specified I/O point requirements. Each controller shall accommodate multiple I/O Expander Modules via a designated expansion I/O bus port. These expander modules shall expand the total point capacity of each controller up to 192 points where specified. The controller, in conjunction with the expansion modules, shall act as one standalone controller.

D. Point Programming: All point data, algorithms and application software within a controller shall be custom programmable from the operator workstation.

E. Program Execution: Each General Purpose Multiple Application Controller shall execute application programs, calculations, and commands via a 32-bit microcomputer resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/writ able nonvolatile flash memory within the controller and will be able to upload/download to/from the BAS Server.

F. Self-Test Diagnostics: Each controller shall include self-test diagnostics, enabling the controller to report malfunctions to the router and BAS Server.

G. PID Loops: Each General Purpose Multiple Application Controller shall contain both software and firmware to perform full DDC Proportional, Integral, Derivative (PID) control loops and programs.

H. Input-Output Processing:
1. Digital Outputs shall be relays, 24 Volts AC or DC maximum, 3-amp maximum current. Each configured as normally open or normally closed using jumpers and either dry contact or bussed. Each output shall have a manual Hand-Off-Auto switch to allow for override and an LED to indicate the operating mode of the output.
2. Universal Inputs shall be Thermistor (BAPI Curve II) 10K Ohm at 77°F (25°C), 0-5VDC, 10K Ohm maximum source impedance, 0-20mA - 24 VDC loop power, 250 Ohm input impedance, dry contact - 0.5mA maximum current.
3. Analog Output shall be electronic, voltage mode 0-10VDC or current mode 4-20mA.

I. General Purpose Single Application Controllers
1. BACnet BIBBS: The General Purpose Single Application Controllers must use BACnet as the native communication protocol between controllers.
2. Communication Speed: Controllers shall communicate at a minimum of 38.4 Kbps using MS/TP or ARCNET implemented over EIA-485 using an unshielded twisted pair at the Data Link Layer.
3. General Specification: General Purpose Single Application controllers must be capable of stand-alone DDC operation utilizing its own 32 bit processor, nonvolatile flash memory, input/output, 8 bit A to D conversion, hardware clock/calendar and voltage transient protection devices. A separate co-processor shall be used for communications to the controller network. All RAM memory shall have a battery backup of at least five years. Firmware revisions to the module shall be made from the BAS server, or remote locations over the Internet. Controllers that require component changes to implement Firmware revisions are not be acceptable.
4. Point Programming: All point data, algorithms, and application software within the controllers shall be custom programmable from the Operator Workstation.
5. Program Execution: Each General Purpose Single Application Controller shall execute application programs, calculations, and commands via a 32-bit microcomputer resident in the controller. All operating parameters for the application program residing in each controller shall be stored in read/writ able nonvolatile flash memory within the controller and will be able to upload/download to/from the Operator Workstation.
6. Self-Test Diagnostics: Each controller shall include self-test diagnostics, enabling the controller to report malfunctions to the router and BAS Server input.
7. PID Loops: Each General Purpose Single Application Controller shall contain both software and firmware to perform full DDC PID control loops.
8. Rooftop Mounting: The General Purpose Single Application Controllers shall be capable of being mounted directly in or on rooftop AHU equipment.
9. Operating Temperature: The General Purpose Single Application Controllers shall be capable of proper operation in an ambient temperature environment of -20°F to +150°F (-28.9° to 65.6°C).
10. Input-Output Processing:
    a. Digital Outputs shall be relays, 24 Volts AC or DC maximum, 3 amp maximum current. Each output shall have a manual Hand-Off-Auto

switch to allow for override and an LED to indicate the operating mode of the output.

b. Universal Inputs shall be Thermistor (BAPI Curve II) 10K Ohm at 77°F (25°C), 0-5VDC - 10K Ohm maximum source impedance, 0-20mA - 24 VDC loop power, 250 Ohm input impedance, Dry Contact - 0.5mA maximum current.

c. Analog Electronic Outputs shall be voltage mode 0-10VDC or current mode 4-20mA.

d. Enhanced Zone Sensor Input shall provide one thermistor input, one local setpoint adjustment, one timed local override switch, and an occupancy LED indicator.

3.4 FIELD HARDWARE/INSTRUMENTATION

A. Temperature Sensing Devices

1. Type & Accuracy. Temperature sensors shall be of the type and accuracy indicated for the application. Sensors shall have an accuracy rating within 1% of the intended use temperature range.
2. Outside Air Temperature Sensors. Outside air temperature sensors accuracy shall be within +1°F (0.5°C) in the range of -52°F to 152°F (-46.6°C to 66.6°C).
3. Room Temperature Sensors. Room temperature sensors shall have an accuracy of +0.36°F (0.25°C) in the range of 32°F to 96°F (0°C to 35.5°C).
4. Chilled Water and Condenser Water Sensors. Chilled water and condenser water sensors shall have an accuracy of +0.25°F (0.15°C) in their range of application.
5. Hot Water Temperature Sensors. Hot water temperature sensors shall have an accuracy of +0.75°F (0.3°C) over the range of their application.

B. Pressure Instruments

1. Differential Pressure and Pressure Sensors: Sensors shall have a 4-20 MA output proportional signal with provisions for field checking. Sensors shall withstand up to 150% of rated pressure, without damaging the device. Accuracy shall be within $\pm$2% of full scale. Sensors shall be manufactured by Leeds & Northrup, Setra, Robertshaw, Dwyer Instruments, Rosemont, or be approved equal.
2. Pressure Switches: Pressure switches shall have a repetitive accuracy of $\pm$2% of range and withstand up to 150% of rated pressure. Sensors shall be diaphragm or bourdon tube design. Switch operation shall be adjustable over the operating pressure range. The switch shall have an application rated Form C, snap-acting, self-wiping contact of platinum alloy, silver alloy, or gold plating.

C. Flow Switches

1. Flow switches shall have a repetitive accuracy of $\pm$1% of their operating range. Switch actuation shall be adjustable over the operating flow range. Switches shall have snap-acting Form C contacts rated for the specific electrical application.

D. Humidity Sensors

1. Sensors shall have an accuracy of $\pm$25% over a range of 20% to 95% RH.

E. Current Sensing Relays
   1. Relays shall monitor status of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for the application. The setpoint of the contact operation shall be field adjustable.

F. Output Relays
   1. Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap-acting Form C contacts, enclosed in dustproof enclosure. Relays shall have silver cadmium contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression devices.

G. Solid State Relays
   1. Input/output isolation shall be greater than 10 billion ohms with a breakdown voltage of 15 V root mean square, or greater, at 60 Hz. The contact operating life shall be 10 million operations or greater. The ambient temperature range of SSRs shall be 20^{O}F-140^{O}F. Input impedance shall be greater than 500 ohms. Relays shall be rated for the application. Operating and release time shall be 10 milliseconds or less. Transient suppression shall be provided as an integral part of the relays.

H. Valve and Damper Actuators
   1. Electronic Direct-Coupled: Electronic direct-coupled actuation shall be provided.
   2. Actuator Mounting: The actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assemble shall be of a 'V' bolt design with associated 'V' shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a 'V' clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable
   3. Electronic Overload Sensing: The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
   4. Power Failure/Safety Applications: For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
   5. Spring Return Actuators: All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
   6. Proportional Actuators: Proportional actuators shall accept a 0 to 10VDC or 0 to 20mA control input and provide a 2 to 10VDC or 4 to 20mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10VDC position feedback signal.
   7. 24 Volts (AC/DC) actuators: All 24VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not

require more than 10VA. Actuators operating on 230VAC shall not require more than 11VA.

8. Non-Spring Return Actuators: All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque shall have a manual crank for this purpose.
9. Modulating Actuators: All modulating actuators shall have an external, built-in switch to allow reversing direction of rotation.
10. Conduit Fitting & Pre-Wiring: Actuators shall be provided with a conduit fitting and a minimum 3ft electrical cable, and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
11. U.L. Listing: Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.
12. Warranty: Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be ISO9001 certified.

PART 4 - DDC SOFTWARE

4.1 OVERVIEW

A. The system shall continuously perform Direct Digital Control (DDC) functions at the local control module in a stand-alone mode. The operator shall be able to design and modify the control loops to meet the requirements of the system being operated. The operators shall use system provided displays for tuning of PID loops. These displays shall include the past three input variable values, the setpoint for the loop as well as the sample interval and the results of the proportional, integral and derivative effects on the final output.

B. Minimum Function - Each control module shall perform the following functions:
   1. Identify and report alarm conditions
   2. Execute all application programs indicated on the I/O Summary table
   3. Execute DDC algorithms
   4. Trend and store data

C. Control Failure Mode
   1. In the event of a control module failure, all points under its control shall be commanded to the failure mode as indicated on the I/O Summary Table. All DDC software shall reside in the respective control module.
      a. Orderly Shutdown: Power failures shall cause the control module to go into an orderly shutdown with no loss of program memory.
      b. Automatic Restart: Upon resumption of power, the control module shall automatically restart and print out the time and date of the power failure and restoration at the respective Workstation system.
      c. Automatic Restart: The restart program shall automatically restart affected field equipment. The operator shall be able to define an automatic power up time delay for each piece of equipment under control.

PART 5 - APPLICATIONS SOFTWARE

5.1 GENERAL

The following applications software shall be provided for the purpose of optimizing energy consumption while maintaining occupant comfort:

A. Time of Day Scheduling (TOD) - The system shall be capable of the following scheduling features:
   1. Schedule by Type. Scheduling by building, area, zone, groups of zones, individually controlled equipment and groups of individually controlled equipment. Each schedule shall provide beginning and ending dates and times (hours: minutes). A weekly repeating schedule, i.e. between 8:00 a.m. and 5:00 p.m., Monday through Friday shall constitute one schedule, not five.
   2. Schedule in Advance. Dated schedules shall be entered up to nine (9) years in advance.
   3. Self-Deleting. Schedules shall be self-deleting when effective dates have passed.
   4. Leap Year. Leap years shall be adjusted automatically without operator intervention.

B. Optimum Start/Stop (OSS)/Optimum Enable/Disable (OED)
   1. This application provides software to start and stop equipment on a sliding schedule based on the individual zone temperature and the heating/cooling capacity in °F/hour of the equipment serving that zone. The heating/cooling capacity value shall be operator adjustable. Temperature compensated peak demand limiting shall remain in effect during morning start up to avoid setting a demand peak.

C. Source Temperature Optimization (STO)
   1. The system shall automatically perform source optimization for all air handling units, chillers and boilers in response to the needs of other downstream pieces of equipment, by increasing or decreasing supply temperature setpoints, i.e. chilled water, discharge air, etc. using owner defined parameters. In addition to optimization, the STO capability shall also provide for starting and stopping primary mechanical equipment based on zone occupancy and/or zone load conditions.

D. Demand Limiting (DL) - Temperature Compensated
   1. The DL application shall be programmable for a minimum of six separate time of day KW demand billing rate periods. The system shall be capable of measuring electrical usage from multiple meters serving one building and each piece of equipment being controlled on the LAN shall be programmable to respond to the peak demand information from its respective meter.
      a. Sliding Window: The demand control function shall utilize a sliding window method with the operator being able to establish the kilowatt threshold for a minimum of three adjustable demand levels. The sliding window interval shall be operator selectable in increments of one minute, up to 60 minutes. Systems that incorporate rotating shed tables will not be acceptable.

b. Setpoints for Defined Demand Level: The operator shall have the capability to set the individual equipment temperature setpoints for each operator defined demand level. Equipment shall not be shed if these reset setpoints are not satisfied; rather the setpoint shall be revised for the different established demand levels. The system shall have failed meter protection, such that when a KW pulse is not received from the utility within an operator adjustable time period, an alarm will be generated. The system software will automatically default to a predetermined fail-safe shed level.

c. Information Archiving: The system shall have the ability to archive demand and usage information for use at a later time. System shall permit the operator access to this information on a current day, month to date and a year to date basis.

E. Day/Night Setback (DNS)

1. The system shall allow the space temperature to drift down [up] within a preset [adjustable] unoccupied temperature range. The heating [cooling] shall be activated upon reaching either end of the DNS range and shall remain activated until the space temperature returns to the DNS range. (Occupied Set Point should be 73°F Cooling with a Night Setback to 85°F. Occupied Set Point should be 72°F Heating with a Night Setback to 65°F. – This is an initial setting which should be coordinated with the Owner prior to the Owner taking possession of the building.)

F. Timed Local Override (TLO)

1. The system shall have TLO input points that permit the occupants to request an override of equipment that has been scheduled OFF. The system shall turn the equipment ON upon receiving a request from the local input device. Local input devices shall be push button (momentary contact), wind-up timer, or ON/OFF switches as detailed in the I/O summary.

G. Space Temperature Control (STC)

1. There shall be two space temperature setpoints, one for cooling and one for heating, separated by a dead band. Only one of the two setpoints shall be operative at any time. The cooling setpoint is operative if the actual space temperature has more recently been equal to or greater than the cooling setpoint. The heating setpoint is operative if the actual space temperature has more recently been equal to or less than the heating setpoint. There are two modes of operation for the setpoints, one for the occupied mode (example: heating = 72°F or 22°C, cooling = 76°F or 24.4°C) and one for the unoccupied mode (example: heating = 55°F or 12.7°C, cooling = 90°F or 32°C).

a. Schedule: The occupied/unoccupied modes may be scheduled by time, date, or day of week.

b. Color Code: One of seven colors shall be generated to represent the comfort conditions in the space, and shall be displayed graphically at the operator station.

1) If the actual space temperature is in the dead band between the heating setpoint and the cooling setpoint, the color displayed shall be green for the occupied mode, representing ideal comfort conditions. If in the unoccupied mode, the color displayed shall be gray representing 'after-hours' conditions.

2) If the space temperature rises above the cooling setpoint, the color shall change to yellow. Upon further rise beyond the cooling setpoint plus an offset, the color shall change to orange. Upon further rise beyond the cooling setpoint plus the yellow band offset, plus the orange band offset, the color shall change to red indicating unacceptable high temperature conditions. At this point an alarm shall be generated to notify the operator.
3) When space temperature falls below the heating setpoint, the color shall change to light blue. Upon further temperature decrease below the heating setpoint minus an offset, the color shall change to dark blue. Upon further space temperature decrease below the heating setpoint minus the light blue band offset minus the dark blue band offset the color shall change to red indicating unacceptable low temperature conditions. At this point an alarm shall be generated to notify the operator.

c. Operator Definable: All setpoints and offsets shall be operator definable. When in the occupied mode, start-up mode, or when heating or cooling during the night setback unoccupied mode, a request shall be sent over the network to other equipment in the HVAC chain, such as to an AHU fan that serves the space, to run for ventilation. The operator shall be able to disable this request function if desired.
d. Additional Cooling: When comfort conditions are warmer than ideal, indicated by the colors yellow, orange, and high temperature red, a request for additional cooling shall be sent over the network to other cooling equipment in the HVAC chain, such as a chiller. This information is to be used for optimization of equipment in the HVAC chain. The operator shall be able to disable this function if desired.
e. Additional Heating: When comfort conditions are cooler than ideal; indicated by the colors light blue, dark blue, and low temperature red; a request for additional heating shall be sent over the network to other heating equipment in the HVAC chain, such as a boiler. This information is to be used for optimization of equipment in the HVAC chain. The operator shall be able to disable this function if desired.
f. Cooling/Heating Setpoints: The cooling [and heating] setpoints may be increased [decreased] under demand control conditions to reduce the cooling (heating) load on the building during the demand control period. Up to three levels of demand control strategy shall be provided. The operator may predefine the amount of setpoint increase [decrease] for each of the three levels. Each space temperature sensor in the building may be programmed independently.
g. Optimum Start: An optimum start-up program transitions from the unoccupied setpoints to the occupied setpoints. The optimum start-up algorithm considers the rate of space temperature rise for heating and the rate of space temperature fall for cooling under nominal outside temperature conditions; it also considers the outside temperature; and the heat loss and gain coefficients of the space envelope (AI: Space Temperature).
h. PID Loop: A PID control loop, comparing the actual space temperature to its setpoint, shall modulate the dampers [and

heating coil valve or heating stages in sequence] to achieve the setpoint target.

PART 6 - EXECUTION

6.1 PREPARATION

A. Protection of Persons and Property
1. Safety Precautions and Programs. The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the work.

2. Safety of Persons and Property. The Contractor shall take all reasonable precautions and provide all reasonable protection to prevent damage, injury or loss to:
a. All employees on the installation sites and all other persons who may be affected.
b. All work, materials, and equipment to be incorporated therein, whether in storage on or off the site, under the care, custody, or control of the Contractor or any Subcontractor or Sub-subcontractor.
c. Other property at the site or adjacent thereto. The Contractor shall comply with all applicable laws, ordinances, rules, regulations and lawful orders or any public authority having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss. It shall erect and maintain, as required by existing conditions and progress of the work, all reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards, promulgating safety regulations and notifying owners and users of adjacent utilities.

6.2 HARDWARE INSTALLATION

A. Utility Company Equipment - Owner shall arrange installation of electric billing meters with demand signal pulses, as indicated on the I/O Summary Table.

B. Wiring
1. The Contractor shall install wires for the room temperature sensors (from sensor to the appropriate control module).
2. The Contractor shall install all sensing devices and the wiring to modules.
3. The Contractor shall install all control and monitoring wiring in Mechanical Room.
4. Low voltage wire shall be not less than 18 AWG. All line voltage wire shall be THHN/TFFN, 600 volt rated plenum rated.
5. All wire in walls, through walls, and exposed shall be run in conduit (EMT). Wire above the ceiling shall be in cable trays. Coordinate cable tray availability with other trades. Where cable trays are not available, wiring shall be in conduit (EMT).

6.3 SMOKE DETECTORS

A. Smoke detectors approved for duct installation shall be provided by Division 16 for all air systems of 2000 cfm capacity or above or as indicated on the drawings, to automatically shut down the supply fan and close all smoke dampers (as required). Each detector shall have an integral relay and be capable of operating a remote. All wiring shall be in conduit.

B. Smoke detectors shall be furnished by Division 26 and installed under Division 23. All wiring between detector and fire alarm system shall be provided and installed under Division 26. All wiring between detector and unit and between detector and BAS shall be provided and installed under Division 23. All wiring shall be in conduit.

6.4 FIRE ALARM INTERLOCK, EQUIPMENT INTERLOCK AND EMERGENCY

A. Provide relays and interlock wiring in the starting circuits of all air moving equipment to stop operation when the building fire alarm system is activated. Contacts shall be installed in the central fire alarm panel for this signal; coordinate with fire alarm panel furnished under Division 16.

B. Provide on the face of the Central Control Panel and remote alarm panel an "Emergency Stop" switch. Switch shall be wired so that all air moving equipment will immediately shut down when switch is depressed.

C. Provide all interlock wiring between air-conditioning units, fans, dampers, space sensors, clocks, and other related equipment as necessary to achieve the specified operating sequence.

6.5 RELAYS

A. Provide relays in power wiring to stop and start exhaust fans, domestic water heaters, pumps, etc., as required. Relays shall be of the voltage and ampere rating required for the load served and shall have NEMA-1 enclosure.

6.6 DAMPER ACTUATORS

A. Damper actuators shall be 24 volt proportional motor operators. Contacts shall be provided for each actuator, which accepts a 24 volt signal for the smoke detector to close the contact. Step down transformer shall be provided and installed by Div 15 to handle 120 volt power.

6.7 VALVES

A. Control valves shall be electric operated. Actuators shall be mounted vertically above piping served or horizontally, no lower than the center line of the piping. Surrounding piping and equipment shall be located and valve location in piping shall be such that a minimum service clearance of 6" (or greater as required by

the manufacturer's recommendations) is provided between the top of the valve actuator and the obstruction to facilitate maintenance and removal of actuator.

6.8 DEMAND METERING

A. An energy pulse signal shall be provided at the building metering point by the utility company. The Contractor shall extend wiring in conduit from the meter location to the control module for demand meter input signal.

6.9 CONTROL PANELS

A. Furnish formed sheet metal control panels as required with locking door and hinges. All necessary relays, switches and peripheral devices shall be located inside panels. All electric devices shall be connected to numbered terminal strips. All control panels shall be centrally located. The main ALC panel shall be provided with space for a data port. Provide a temporary modem in the main control panel located in the main mechanical room.

B. Main ALC communication panel shall be located in main mechanical room.

6.10 CONTROL WIRING AND CONDUIT

A. All control wiring shall be run in metal conduit with outlet boxes and fitting equal to those specified under Division 26. Line voltage wiring shall be no smaller than 14 gauge, 600 volt wire. All conduit shall be located in wall cavity or above ceilings. Wall surface mounted conduit shall be prohibited. Plenum rated cable routed exposed shall be prohibited. Wiring from the main mechanical room ALC panel shall be routed in conduit to the cable tray. All wiring below grade shall be conduit.

B. Conduit shall be run between the main control panel in the mechanical room and the main communication panel data connection located in off the Media Center.

C. Conduit shall be provided in the main control panel cabinet between the exterior cabinet and internal main controller.

PART 7 - SEQUENCE OF OPERATION

7.1 SEQUENCE OF OPERATION

A. Refer to I/O summary for control point description.

B. Control of fan coil and air-handling units shall be as follows:
   1. A control module shall control each unit. **Control modules shall be provided to unit manufacturer for factory installation.**
   2. A wall mounted temperature sensor located in the space shall provide an analog input signal to the control module.

3. Each fan coil unit shall be programmed to start and stop according to the day/night schedule provided by the Owner.
4. The blower fan shall be energized by a relay and shall run continuously in the day cycle.
5. On a drop in space temperature below the heating setpoint, the hot water three way valve shall open to the coil. The valve shall be normally closed to coil.
6. On a rise in space temperature above the cooling setpoint, the chilled water three way valve shall open to the coil. The valve shall be normally closed to the coil.
7. In the night cycle the blower shall be off. On a drop in space temperature below thee set-back temperature of 55 degrees F., the fan shall start and the hot water valve shall be open to the coil.
8. The discharge temperatures shall be monitored.
9. The air handler's fan motor speed shall be modulated by a 1-10 mA signal from the ALC controller. The fan speed shall be balanced to the specified flow rate via the 1-10 mA signal. The balanced full (design flow rate) flow mA shall be set as the maximum flowrate. The following shall be programed, but not enabled. The Owner shall have the ability to enable and disable this feature via software interface. During cooling mode, the supply fan shall reduce air flow to maintain 55F (adjustable) leaving air temperature via the 1-10 mA signal. The fan flow rate shall be modulated from 100% to 30% (adjustable) of the design flow rate.

7.2 CHILLER AND PUMP CONTROL (Existing Controls shall be maintained.)

7.3 COOLING TOWER AND PUMP CONTROL (Existing Controls shall be maintained.)

7.4 BOILER AND HOT WATER PUMP CONTROL (Existing controls shall be maintained.)

A. Pumps P-HW2 and P-HW3 are being replaced. The controls shall be reconnected to the new pumps. The controls shall be modified to use the VFDs being provided in lieu of the motor control center for these pumps.

7.5 SINGLE ZONE ROOF TOP UNITS

A. Control module shall be provided for each roof-top unit to control the fan, compressor, gas heat in the unit. A wall mounted temperature sensor located in the space shall provide an analog input signal to the control module.

B. Each roof-top unit shall be programmed to start and stop according to the day/night schedule provided by the Owner.

C. The unit fan shall run continuously in the day cycle.

D. On a rise in space temperature above the cooling set point, the compressor shall start. Provide stage control for units. Coordinate staging with submitted units. Controls staging shall match submitted units' stages.

E. On a drop in space temperature below the heating set point, the gas heat shall start.

F. In the night cycle the unit fan shall be off. On a drop in space temperature below the night setting of 55 degrees F., the fan and the gas heat shall start. Coordinate staging with submitted units. Controls staging shall match submitted units' stages.

G. Duct mounted smoke detectors, furnished as part of the fire alarm system and installed in the supply duct of each unit, shall shut down the respective roof-top unit on detection of smoke.

H. The heaters shall be interlocked the main mechanical rooms ventilation fan and louver dampers. The heater shall not operate when the ventilation fan is in operation. The heater shall maintain 65F (adjustable).

7.6 RANGE HOOD FANS

A. Range hood exhaust fan and make-up air fans shall be started by an on-off switch in the control panel furnished with the range hood.

7.7 DOMESTIC HOT WATER HEATING

A. Water heaters and respective hot water circulating pumps shall be started and stopped according to a day/night schedule provided by Owner and by the demand control program.

B. Temperature sensor located in the hot water supply piping of kitchen water heater shall provide an analog input signal to the control module to provide temperature indication only.

7.8 GAS UNIT HEATER

A. Gas unit heaters shall be controlled by control modules. A unit mounted temperature sensor located in the space shall provide an analog signal to the module.

B. Gas unit heaters in the main mechanical room shall be provide with a discharge temperature sensor. The discharge temperature shall be monitored remotely. The control panel associated with the temperature sensor shall be located in the main mechanical room and shall be on emergency power. Refer to the electrical plans for emergency power circuits.

7.9 ELECTRIC CEILING HEATERS

A. Electric ceiling heaters shall be controlled by a control module. A thermostat integral to each unit shall provide an analog signal to the module. When a signal is received from the central control system, the electric heater will be

enabled. Heater fan shall be cycled on a call for heating from the integral thermostat.

7.10 STAIRWELL FAN-COIL & CABINET HEATER SYSTEMS

A. Electric cabinet heaters and fan-coil units serving stairwells shall be controlled by a control module. A wall mounted temperature sensor located in the space shall provide an analog signal to the module to allow operation of heater or fan-coil unit fans and valves and prevent simultaneous operation of heater and fan-coil unit. Heating first stage shall be electric cabinet heater operation, second stage shall be opening of fan-coil unit heating valve.

7.11 EXHAUST FANS

A. See fan schedule for type of control for each fan. Fans noted to be controlled through the building energy management system shall be interlocked with control modules, set to operate by a schedule provided by the Owner.

7.12 ENERGY RECOVERY UNITS and OUTSIDE AIR UNITS

A. A control module shall be provided for each unit. Unit shall interface via BACnet. ALC shall work with the unit manufacturer to coordinate interface and control of these units.

B. Unit controls will be provided by the unit manufacturer. ALC shall interface to the unit with the minimum of these control capabilities:
   1. Enable/disable the unit
   2. Read and adjust evaporator discharge temperature
   3. Read and adjust unit discharge temperature (Heating, Cooling and Dehumidification)
   4. Read the temperature and humidity of the air at the following locations:
      a. Supply side: Below energy wheel, after energy wheel, before evaporator, after evaporator and leveling unit after the heating section.
      b. Return side: Entering unit from building, before energy wheel and after energy wheel.
   5. Compressor status
   6. Fans status
   7. Filter status
   8. Heating status
   9. Enable/disable recirculation mode
   10. Enable/disable cooling mode
   11. Enable/disable dehumidification mode

C. Alarms
   1. Critical Alarms(require reset, unit shutoff)
      a. Supply air flow
      b. Exhaust air flow
      c. Reactivation air flow
      d. Supply fan motor overload fault

e. Exhaust fan motor overload fault
f. Reactivation fan motor overload fault
g. Smoke
h. Heat fail & Supply Air Temp < 55°F

2. Non-Critical Alarms(require reset)
   a. DH Wheel motor overload
   b. DH Wheel rotation
   c. Low suction pressure: Comp. A
   d. High discharge pressure: Comp. A
   e. Low differential pressure: Comp. A
   f. Enthalpy Wheel rotation
   g. Enthalpy Wheel motor fault
   h. Low suction pressure: Compressor B
   i. High discharge pressure: Compressor B
   j. Low differential pressure: Compressor B
   k. Sensors
3. Alarm Notes
   a. All resettable alarms can be reset through the BACview display or BMS.
   b. If the alarm persists after resetting it, the root cause remains.
   c. The sensor alarms cannot be reset, as the sensor is reading out of the expected range. The sensor must be put into range to clear the alarm.

D. Each unit shall be programmed to start and stop according to the occupied/un-occupied schedule provided by Owner. The units shall not operate in the un-occupied mode, unless in recirculation mode.

E. A duct mounted smoke detector located in the exhaust air inlet duct of the unit shall shut down both fans in the unit.

7.13 HOT WATER AND CHILLED WATER LOOP MODULATING BY-PASS VALVE CONTROL

A. Measure the differential pressure at the location shown on the plans for the hot water loop and chilled water loop with the system balanced and all units two way valves open. (Full System Flow Pressure Differential) The two way valves shall modulate open to maintain measured Full System Flow Pressure Differential plus 5 psi."

7.14 VARIABLE FREQUENCY DRIVES

A. Variable Frequency Drives shall be started and stopped, shall receive pressure signal from remotely mounted BAS pressure transducer, and shall monitor for alarm condition.

7.15 TRAP PRIMER CONTROL

A. Trap primers shall be activated on an operator assignable schedule for an adjustable on time. The EMS controller shall accumulate the total trap primer

run times. The initial setting shall be requested from the Owner and programmed before the project is turned over to the Owner. The controls contractor shall provide 24v AC power for the trap primer units Coordinate exact number and locations of trap primers with the Plumbing Plans.

7.16 ROOF ACCESS

A. Provide door switches at all roof access doors and hatches. Provide an alarm signal when a door or hatch is opened.

7.17 EMERGENCY OPERATIONS

A. Main control panel (located in the Mechanical Room) shall be connected to the emergency generator. This will be the only panel with emergency power.

B. Provide a remote HVAC shutdown "mushroom button" located in the Administration area. Switch shall be wired so that all air moving equipment, RTUs, ERUs, OAUs including exhaust fans will immediately shut down when switch is depressed. All outside air intake dampers shall close when switch is depressed.

7.18 PROJECT START-UP

A. Controls Contractor shall make out start-up cards for all unit and system controllers, as per start up card furnished below, and shall furnish same before Final Completion of project.

B. Final submittal of start-up cards shall be scanned into PDF format collated with unit start-up cards by unit number. Start-up cards shall be in ascending order by unit number with the unit start-up card located before the programming start-up card. Different types of equipment (fan-coil units, rooftop units, etc.) shall be smart tabs for ease of use.

7.19 LIGHTING CONTROL

A. The requirements of the energy management system shall be expanded to include lighting control functions. Individual lighting control panels shall be provided in remote portions of the building, and shall include multiple output contactors, each rated for a minimum of 5 amps each at 110 volts. Individual panels shall receive inputs from central control over the network, and shall convert these inputs to 110 volt outputs. Panels will be provided a 110 volt, 20 amp service from the electrical division of work. Incoming 110 volt service shall be sub-divided to each output contactor. A control module in each panel shall cycle the 110 contactors in accordance with programming from the central site. The individual panel shall include a transformer for 24 volt service as needed to accomplish the internal panel operations.

B. Scheduling, or on-off operation of each 110 volt output contactor shall be provided by programming from the EMS central site. The central site shall also

be interlocked with the Owner's security system, and fire alarm systems for this project. The Owner's security system will be utilized for controlling access to the occupied lighting functions of the facility. An additional 10 inputs from the security system is estimated.

C. System design is based on lighting contactors and building control sub-panels, all located throughout the building. A lighting control controller shall be installed at each electrical room, which has lighting panel. Coordinate with electrical for exact number and locations of lighting panels to installation of control panels.

D. The building control panel located in the Control Room is the only panel provided with emergency power from the generator.

E. The controls contractor is responsible for running all control wiring conduit. Refer to electrical specifications.

7.20 FIRE ALARM INTERLOCK

A. Contractor shall interlock with the central fire alarm control panel with wiring to contacts, a controller, and programming. Control points for interface with the fire alarm control panel shall be provided for the following:

Monitor
Alarm
Trouble
Supervision

7.21 EMERGENCY GENERATOR INTERLOCK

A. Contractor shall interlock with the emergency generator controller with wiring to contacts, a controller, and programming. Interface shall be through BACnet or Modbus. Coordinate what interface is provided with electrical contractor. Control points for interface with the emergency generator control panel shall be provided for the following:

Alarm
Run
Transfer Switch – Switch from non-emergency to emergency and back.

7.22 EMERGENCY OPERATIONS

A. Rooftop units RTU-4 & 5 shall be interlocked with operation of emergency generator to provide ventilation and heating only. Cooling cycle shall be locked out. Upon building power shutdown, all equipment shall be OFF. When the emergency generator is started, an interlock (wiring by this division) between the generator and a time delay relay (two minutes) shall start RTU-4 & 5 evaporator fan and allow operation of heating cycle as dictated by the unit's temperature sensors.

B. Main control panel (located in mechanical room) shall be connected to emergency generator. This will be the only panel with emergency power.

7.23 SYSTEM ACCEPTANCE

A. Reference section 01770 for general requirements.

7.24 CLOSEOUT DOCUMENTATION

A. Properly completed start-up forms, including the form shown below, documenting proper field quality control and demonstration as outlined in section 1.4 above, shall be received by the Owner prior to granting of substantial completion.

CONTROL CONTRACTOR'S PROGRAMMING CHECKLIST
Cherokee County Schools
ALL INFORMATION IS TO BE TYPED

School Name

Unit No. **EMS Address**

Point Editing (w/correct definition (to include unit number and room number), minimum on/off times, alarms limits, heating & cooling limits, etc.)

Critical Alarms

Event Log Setup

Zone Setpoints

Time of Day Schedules

Freeze Protection

Demand Limiting

Duty Cycle

Freezer Equation

Cooler Equation

GRAPHICS:

Remote Point Status Listings

Floor Plan - Location & Label

Equation Flow Charts (if applicable)

END OF SECTION 230900

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SECTION 231123

FUEL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes fuel gas piping within the building and exterior to the building. Products include the following:
   1. Pipe, tube, fittings, and joining materials.
   2. Piping specialties.

B. Related Sections include the following:
   1. Division 2 Section "Natural Gas Distribution" for additional natural gas service piping, specialties, and accessories outside the building.
   2. Section 220553 "Identification for Plumbing Piping and Equipment" for piping identification.
   3. Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for piping inside the building.

1.3 PROJECT CONDITIONS

A. Gas System Pressures: Single delivery pressure of 0.5 psig or less.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Piping materials, valves, and fittings.

1.5 QUALITY ASSURANCE

A. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage

and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

1.7 COORDINATION

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Architect not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.

B. New Equipment: If gas fired equipment purchased is not basis of design equipment, the Contractor shall coordinate differences in gas demand and adjust pipe sizing and capacity requirements for gas pressure regulators based on equipment purchased at no cost increase to the Owner.

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 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

A. Domestic Steel Pipe: ASTM A 53/A 53M; Type E or S; Grade B; black. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
   2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
   3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.

4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.
9. Acceptable Manufacturers:
   a. Pipe:
      1) Wheatland
      2) Sharon Tube
      3) Allied
   b. Fittings:
      1) Ward
      2) Anvil
      3) Stockham

B. PE Pipe: ASTM D 2513, SDR 11.
1. PE Fittings: ASTM D 2683, socket type or ASTM D 3261, butt type with dimensions matching ASTM D 2513, SDR 11, PE pipe.
2. Transition Fittings: Manufactured pipe fitting with one PE pipe end for heat-fusion connection to PE pipe and with one ASTM A 53/A 53M, Schedule 40, steel pipe end for threaded connection to steel pipe.
3. Service-Line Risers: Manufactured PE pipe fitting with PE pipe inlet for heat-fusion connection to underground PE pipe; PE pipe riser section with protective-coated, anodeless, steel casing and threaded outlet for threaded connection to aboveground steel piping.
4. Components, Tapes, Gaskets, and Bolts and Nuts: Suitable for natural gas and as recommended by piping manufacturer.
5. Acceptable Manufacturers:
   a. Pipe and fittings:
      1) JM Eagle; UAC 2000
      2) Duraline; Polytough1
      3) Endot Industries; PE-2406/2708

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and caulk penetrations thru exterior walls. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing pipe.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.

3.4 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and 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 and below 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 at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      b. Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.

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.
   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. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2″ and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

3.5 VALVE INSTALLATION

A. Install manual gas full port, AGA rated and labeled shutoff valve for each gas appliance.

B. Install plug valves at all exterior locations.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

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

C. Threaded Joints:
1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

E. Heat-fusion Weld Joints: Install as per manufacturers' installation instructions.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
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.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 48 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.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for piping identification.

B. Install tracer wire at gas pipe stub ups accessible and tied off to pipe above grade.

3.10 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, and piping specialties, except components, with factory-applied paint or protective coating.
   1. Alkyd System: MPI EXT 5.1D.
      a. Prime Coat: Alkyd anticorrosive metal primer.
      b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
      c. Topcoat: Exterior alkyd enamel (flat).
      d. Color: Gray.

C. Paint exposed, interior metal piping, 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: Alkyd anticorrosive 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: Alkyd anticorrosive 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.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Test, inspect, and purge natural gas according to NFPA 54 and 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 electronically activated valves.

3.13 OUTDOOR PIPING SCHEDULE

A. Aboveground natural-gas piping shall be one of the following:
1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

B. Underground Piping:
1. PE pipe, PE fittings, and heat-fusion joints.
2. Underground-to-Aboveground Piping Connections: Service-line riser.
3. PE-to-Steel Piping Connections: Transition fitting.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, branch piping NPS 1-1/2" and smaller shall be the following:
1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Distribution piping valves for pipe sizes NPS 2" and smaller shall be one of the following as called for on plans:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.

B. Valves in branch piping for single appliance shall be the following:
   1. Two-piece, full-port, AGA rated and labeled, bronze ball valves with bronze trim.

3.16 EXAMINATION

A. Examine roughing-in for gas piping system to verify actual locations of piping connections before equipment installation.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.17 PREPARATION

A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.

3.18 SERVICE ENTRANCE PIPING

A. Extend fuel gas piping from the meter assembly and connect to fuel gas distribution for service to building.

B. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."

3.19 PIPING APPLICATIONS

A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.

B. Fuel Gas Piping, 5 psig or less:

1. Above ground piping 2-1/2" and smaller: Schedule 40 black steel pipe with malleable-iron threaded fittings.
2. Underground Piping: PE pipe, PE fittings, and heat-fusion joints.

3.20 VALVE APPLICATIONS

A. Appliance Shutoff Valves for Pressure 0.5 to 5 psig: AGA rated and labeled ball valve as called for on plans.

B. Piping Line Valves, NPS 2 and Smaller: Gas cock or plug valve as called for on plans.

3.21 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
   1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums.
   2. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls perpendicular to penetrated walls.
      a. Exception: Tubing passing through partitions or walls.
   3. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
      a. Exception: Accessible above-ceiling space specified above.

B. Drips and Sediment Traps: Install drips at points where condensate or debris may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
   1. Construct drips and sediment traps using threaded tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.

C. 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.

D. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.

E. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down. Concentric reducers may be used in vertical and at unit connections.

F. Connect branch piping from top or side of horizontal piping.

G. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

H. Install strainer on inlet of line pressure regulator to emergency gas generator unit.

I. Install flanges on valves, specialties, and equipment having NPS 3 and larger connections.

J. Install underground, natural gas distribution piping buried at least 30 inches below finished grade.

K. Install underground, PE, natural gas distribution piping according to ASTM D 2774.

L. Install continuous # 12 copper tracer wire attached to the crown of buried exterior gas piping with plastic tie straps at maximum 6 foot spacing and within 18 inches of each change of direction. Tracer wire shall extend 6" above finished grade with one complete wrap around pipe.

M. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tape 12 inches over the top of natural gas distribution piping during backfilling of trenches for piping.

N. Exterior steel gas piping and fittings shall be prime painted at the time of installation. Final painting shall be performed after the system is tested for leaks and prior to system to being placed in service.

3.22 JOINT CONSTRUCTION

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

B. Use materials suitable for fuel gas.

C. Underground-to-Aboveground Piping Connections: Service-line riser.

D. PE-to-Steel Piping Connections: Transition fitting.

3.23 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. 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

3.24 CONNECTIONS

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

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

C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 48 inches of each appliance. Install union downstream from valve.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.25 PIPING IDENTIFICATION

A. All gas piping inside the building shall be identified with pipe identification labels as specified in Division 22 Section "Identification for Plumbing Piping and Equipment".
   1. Where piping is to be primed and painted, pipe identification shall be applied after the painting is completed.

3.26 PAINTING

A. Use materials and procedures in Division 9 painting Sections.

B. Priming of piping and fittings shall be performed at the time of installation. Final painting shall be done after the system has been tested and is free of leaks and prior to being placed in service.

C. Paint exterior service meters, pressure regulators, and specialty valves.
   1. Color: Gray.

3.27 FIELD QUALITY CONTROL

A. Test, inspect, and purge piping according to NFPA 54 and requirements of authorities having jurisdiction.

B. The Architect shall be given 48 hours notice for all scheduled inspections and testing for gas piping system installations.

C. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

D. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.

E. Verify that specified piping tests are complete.

END OF SECTION 23 1123

SECTION 232113

HYDRONIC PIPING AND SPECIALTIES

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 pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping
   3. Makeup-water piping.
   4. Condensate-drain piping.
   5. Air-vent piping.
   6. Tower Water piping.

B. Related Sections include the following:

   1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
   1. Hot-Water Heating Piping: 150 psig at 200 deg F.
   2. Chilled-Water Piping: 150 psig, 200 deg F.
   3. Makeup-Water Piping: 125 psig at 150 deg F.
   4. Condensate-Drain Piping: 150 deg F.
   5. Blowdown-Drain Piping: 200 deg F.
   6. Air-Vent Piping: 200 deg F.
   7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.4 SUBMITTALS

A. Product Data: For each type of the following: Pressure-seal fittings.
   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.

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Welding certificates.

D. Qualification Data: For Installer.

E. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

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

C. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings: ASME B16.22.

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:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Anvil International, Inc.
   b. S. P. Fittings; a division of Star Pipe Products.
   c. Mueller Brass

C. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "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 Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, 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. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 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 maximum thickness unless thickness or specific material is indicated.
   a. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

2.4 DIELECTRIC FITTINGS

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

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

C. Dielectric 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. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180^{O}F.

D. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Perfection Corporation; a subsidiary of American Meter Company.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Company, Inc.
2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F .

2.5 VALVES

A. Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 15 Section "Valves."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 15 Section "HVAC Instrumentation and Controls."

C. Bronze, Calibrated-Orifice, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements:
      a. Armstrong Pumps, Inc.
      b. Bell & Gossett Domestic Pump; a division of ITT Industries.
      c. Flow Design Inc.
      d. Gerand Engineering Co.
      e. Griswold Controls.
      f. Taco
      g. Victaulic/ IMI-TA
      h. Nexus
   2. Body: Bronze, ball, globe or plug type with calibrated orifice or venturi.
   3. Ball: Brass or stainless steel.
   4. Plug: Resin.
   5. Seat: PTFE or EPDM.
   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.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements,
      a. Armstrong Pumps, Inc.
      b. Bell & Gossett Domestic Pump; a division of ITT Industries.
      c. Flow Design Inc.
      d. Gerand Engineering Co.
      e. Griswold Controls.
      f. Taco.
      g. Victaulic/ IMI-TA
   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 or EPDM.
   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.

E. Automatic Flow-Control Valves:
   1. Manufacturers: Subject to compliance with requirements,
      a. Flow Design Inc
      b. Griswold Controls
      c. Bell & Gossett
      d. Nexus
      e. Victaulic/ IMI-TA
   2. Body: Brass or ferrous metal.

3. Piston and Spring Assembly: Stainless steel or bronze, tamper proof, self cleaning, and removable.
4. Combination Assemblies: Include bonze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and low rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations. Minimum CWP Rating: 175 psig.
8. Maximum Operating Temperature: 200 deg F.

F. Gate valves in hydronic piping systems shall be:
1. 2-1/2" and smaller: Class 125 WSP bronze body, rising stem, threaded ends.
2. 3" and larger: Class 125 WSP iron body, outside screw and yoke, flanged ends.

Mfr.	2-1/2" & smaller	3" & larger
Milwaukee	148	F-2885
Stockham	B-100	G-623
Powell	500	1793
Hammond	690	IR-1140

G. Check valves in hydronic piping systems shall be:
1. 2-1/2" and smaller: Class 125 WSP bronze body swing check valves, threaded ends.
2. 3" and larger: Class 125 WSP iron body bronze trim swing check valves, flanged ends:

Mfr.	2-1/2" & smaller	3" & larger
Milwaukee	509	F-2974
Stockham	B-305B G931	
Powell	578	559

H. Plug valves (in exterior gas service lines) shall be iron body AGA certified, threaded ends, Class 150 WOG, Rockwell-Nordstrom Series 143, Resun or equal. Gas valves for low pressure service inside the building shall be shall be U.L. Listed 600 psig WOG rated bronze body large port, chrome plated ball valves, PTFE seat, reinforced packing, equal to Conbraco series 80-100.

I. Butterfly valves in hydronic piping systems shall be threaded or flanged end type, bronze body with streamline bronze disc, resilient seat, stainless steel shaft. Valves shall be designed for minimum of 125 psi steam working pressure.

J. Hand lever operators with pre-set stop device shall be furnished on sizes through 6". Larger valves shall be gear operated.

K. Grooved piping systems: Where grooved piping systems are permitted, grooved end butterfly (Series 761/W761) and check valves (Series 716/779/W715) from Victaulic or engineer approved equals may be used.

2.6 WATER SPECIALTIES

A. Automatic Air Vents (AAV) shall be the float operated type with copper or copper plated float, stainless steel and monel valve parts, cast body (Iron or Brass), disassembling construction, and safety drain connection. Install at all high points in HVAC piping systems where trapped air occurs. All relief vent shall be 1/4" soft copper, individually routed to a point approximately 18" above the mezzanine or mechanical room slab. Relief piping shall not be routed directly to building waste system. Acceptable manufacturers are Armstrong, Amtrol, Wheatley.

B. Manual Air Vents (MAV) shall consist of lever handle brass air cock, male and female screwed ends (1/4").

C. Expansion tanks shall be pre-charged steel tank with replaceable heavy duty BUTYL rubber bladder. Tank shall be constructed in accordance with Section VIII of the ASME Boiler & Pressure Vessel Code and stamped 150 psi working pressure. Tank shall be provided with system connection, charging valve connection, remote air connection and drain. Acceptable manufacturers are Bell & Gossett, Armstrong, Amtrol, Taco, Wheatley, or approved equal.

D. Combination Water Make-Up and Relief Valves shall be water pressure regulating valves with an integral ball-check valve piped in series with a pressure relief valve. Acceptable manufacturers are Bell & Gossett, Thrush, Taco or approved equal.

E. ASME Pressure Relief Valves shall be Watts Series 740, set for 100 psig (unless otherwise indicated), with a discharge capacity in BTU's not less than 125% of the capacity of the heating unit served.

2.7 SUCTION DIFFUSERS

A. Unit shall consist of angle type body with inlet vanes and combination diffuser-strainer-orifice cylinder with 3/16 inch diameter openings. A removable permanent magnet shall be located in the flow stream. The orifice cylinder shall be equipped with a fine mesh strainer which shall be removed after system start-up and a coarse mesh strainer for permanent installation. Orifice cylinder shall have minimum free area equal to five times the cross section area of pump suction opening. Vane length shall be minimum 2-1/2 times the pump connection diameter. Provide with adjustable foot support. All internal components shall be replaceable.

B. Manufacturers shall be Bell & Gossett, Taco, Victaulic, Wheatley, Armstrong or approved equivalent.

2.8 TRIPLE DUTY VALVE

A. Unit shall be a combination straight/angle pattern valve designed to perform the functions of a non-slam check valve, throttling valve, shut-off valve, calibrated valve and system flow meter. Unit shall be heavy duty cast iron construction rated for 175 psig working pressure at 250 degrees F. Unit shall be fitted EPDM or brass seats, replaceable brass disc, brass steam and anti-chatter spring. Each valve shall be equipped with brass readout valves with integral check valves for taking differential pressure readings across the orifice.

B. Manufacturers shall be Bell & Gossett, Taco, Victaulic (Tri-Service Assembly), Wheatley, Armstrong or approved equivalent.

2.9 AIR / DIRT SEPARATOR

A. Combination air / dirt separator shall be a full flow coalescing type system. Air / dirt separator shall be constructed of steel in accordance with ASME Code, Section VIII, Division 1, Pressure Vessels for not less than 150 psi working pressure and shall be stamped accordingly. The entering water velocity shall not exceed 10 feet per second. The unit shall provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installation location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes. The elements must consist of a copper core tube with continuous wound copper medium permanently affixed to the core. A separate copper medium is to be wound completely around and permanently affixed to the internal element. Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill. The air vent shall be able to be closed to allow flushing and purging of dirt via side port without dirt passing through vent on initial system fill. The unit shall have a removal cover for inspection and cleaning. Furnish data sheet specifying air collection efficiency and pressure drop at rated flow.

B. Manufacturers shall be Bell & Gosset (CRS), Armstrong (DAS-R), Taco (4900 series), Spirotherm (VDN series), or approved equivalent.

2.10 BACKFLOW PREVENTER

A. Backflow preventers shall be ASSE approved reduced pressure zone type with bronze body screwed ends and relief valve vented to atmosphere. Provide fixed air gap and route drain piping from vent opening to the nearest sanitary drain with indirect connection. Backflow preventers shall be provided with gate valves or ball valves, replaceable seats and test cocks.

B. Install a resilient seat swing check valve immediately upstream of the number one check valve to eliminate "nuisance" tripping of the relief valve.

C. Manufacturers shall be Watts, Clayton, ITT or approved equivalent.

2.11 PRESSURE REDUCING VALVES

A. Pressure reducing valves shall be field adjustable with outlet pressure set as specified or indicated on drawings. All internal parts subject to wear shall be replaceable without removing valve from piping system. A strainer shall be provided upstream of the valve.

B. Valves shall be installed in the cold water make-up connections to boilers or other equipment as required.

C. Valves shall be set to maintain a terminal pressure of 5 psi above the static head on the system.

D. Manufacturers shall be Armstrong, Thrush, Taco or approved equivalent.

2.12 FLEXIBLE PUMP CONNECTIONS

A. Provide at each pump connection.

B. Description: Spool type rubber connectors designed for flanged connections shall be used on water service.

C. Connectors shall be concentric spool type with a minimum of 1" arch and designed to be secured between two pipe flanges. The lining shall be leakproof, smooth and unaffected by the fluid. The body shall be fabric and rubber with metal reinforcement. The cover shall be neoprene with manufacturer's name and model displayed. Provide metal retaining rings and control rods.

D. Manufacturers shall be Metraflex, Wheatley, Keflex, Twin City Hose, or approved equal.

2.13 STRAINERS

A. All strainers shall be wye type. Baskets shall be brass or bronze with 1/16" openings and be removable through an opening having a blow-down plug. Strainers shall be Sarco Type AT for screw type thru 2-1/2", Sarco Type AF-250 for flange type 3” and larger.

B. Manufacturers: Sarco, McAlear, Hoffman, Muessco, Victaulic, Wheatley or approved equal.

2.14 MANUAL BALANCING VALVES/FLOW METERING FOR PIPING MAINS

A. Balancing valves or plug cocks shall be designed for a minimum of 175 psig water working pressure. Provide adjustable stops for valves to limit open position for valves 3/4" and larger.

B. Balancing valves for 3/4" through 2" lines shall be ball globe, or butterfly type with screwed end.

C. Balancing valves for 2-1/2" and larger shall be lubricated type semi-steel body and grooved or flanged end; Rockwell Nordstrom Figure #143, Powell Figure #2201, Walworth Figure #1797.

D. Manufacturers
1. Through 2": Milwaukee "Butterball #BB-FS100", or approved equal by Conbraco, Victaulic or Apollo.
2. 3" and Larger: Rockwell-Nordstrom, Powell, Wal-worth, Homestead, Victaulic or approved equal.

2.15 COMBINATION FLOW CONTROL AND BALANCING VALVES AND METERING STATIONS

A. Automatic flow control valves shall be installed at each fan-coil, hydronic fan-coil, air-handler or duct coil served by the chilled water, hydronic heating water, or condenser water system to maintain the scheduled GPM within 5% with differential pressure across the valve of 3 to 32 psi. Automatic flow control valves shall be wye body type to allow removal of cartridge without disturbing adjacent piping. Furnish a metal tag at each valve indicating the rate of flow in GPM, the unit number designation, and the differential pressure. Refer to Section 238146 for hose requirements at water source heat pump installations.

B. Valve assemblies in the return line shall consist of a ball valve for shut-off and balancing (for pipe sizes thru 2-1/2"), a butterfly valve for shut-off and balancing (for pipe sizes 3" and larger), a venturi device with two gauge taps and an analog gauge kit to allow direct reading of flow rate in GPM, an automatic flow control valve with pressure taps integral to valve, one pressure and temperature port, and a union.

C. Valve assemblies in the supply line shall consist of a ball valve for shut-off; a wye strainer with drain cock with hose end, cap, and retaining chain; two pressure and temperature ports; and union. Supply line valve shall be a Flow Design type YC or equal by Griswold, Illinois or Victaulic.

D. Flow meter gauge kits shall allow direct reading of flow rate in GPM thru use of two pressure taps integral to venturi flow measurement devices. One differential pressure gauge kit shall be provided for the project. Kit shall be turned over to Owner upon completion of project. The gauge kit shall be a product of the flow control valve manufacturer and shall be equipped with two flexible hoses, valves, and compatible fittings

required to measure water flow, conversion overlay plates, and a carry case. Flow meter gauge kit shall be Flow Design model 300.4 or equal by Griswold, Illinois, or equal.

E. Automatic flow control valves shall be Auto-Flow Type AC, or equal by Griswold or Illinois.

F. Venturi flow measurement device shall be a separate component by Flow Design, Inc. Accu-setter or equal by Griswold, or Illinois.

G. Coil pipe fitting assemblies are acceptable by Griswold, Flow Design, Illinois, Nexus, Victaulic or approved equal.

2.16 MOTORIZED CONTROL VALVES

A. Motorized control valves shall be installed at water source heat pumps per water source heat pump schedule.

B. Valve shall be Belimo B2 series, 2-way, characterized control valve chrome plated with brass ball and brass stem or equal.

C. Actuator shall be Belimo LR…24-3 or equal.

D. Valve shall fail open and have manual override external push button.

2.17 ELECTRIC HEAT TAPE

A. Heat tape shall be self-regulating resistance with conductors embedded in a conductive matrix and encased in a non-conductive jacket. Heat tape shall be U.L. labeled and rate an 8 watts per lineal foot, 120 volts and thermostat control.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be the following:
1. Schedule 40 steel pipe; Class 150, malleable-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 the following:
1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Chilled-water piping, aboveground, NPS 2 and smaller shall be the following:

1. Schedule 40 steel pipe; Class 150, malleable-iron fittings, cast-iron flanges and flange fittings; and threaded joints.

D. Chilled-water piping, aboveground, NPS 2-1/2 and larger shall be the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Chilled-water piping installed belowground and within slabs shall be the following:
1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

F. Condenser\Tower-water piping, aboveground, NPS 2 and smaller shall be the following:
1. Schedule 40 steel pipe; Class 150, malleable-iron fittings, cast-iron flanges and flange fittings; and threaded joints.

G. Condenser\Tower-water piping, aboveground, NPS 2-1/2 and larger shall be the following:
1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

H. Condenser\Tower-water piping installed belowground and within slabs shall be[either of] the following:
1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

I. Makeup-water piping installed aboveground shall be the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

J. Condensate-Drain Piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

K. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

L. Air-Vent Piping:
1. Inlet: Same as service where installed.
2. Outlet: Type L soft-temper copper tubing with soldered or flared joints.

M. 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.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

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

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

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

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 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.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the side the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. All piping shall be adequately supported and guided in accordance with Div. 23.

Q. All piping specialties shown on drawings or specified herein shall be incorporated into the piping systems and located to provide adequate service clearance.

R. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

S. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

T. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

U. Identify piping as specified in Div 23.

V. Piping below grade:
   1. Pipe shall be installed on undisturbed ground, which provides full support for the entire length of piping. Where elbows are not properly supported, concrete thrust blocks shall be provided. Thrust blocks shall be provided at the discretion of the engineer if the piping is not sufficiently supported.
   2. Piping shall have adequate space between other piping and obstructions to allow back filling and compacting. The spacing should be a minimum of 8 inches between insulated pipes.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Section 230553. Comply with the following requirements for maximum spacing of supports.

B. Seismic restraints are specified in Div 23, "Mechanical Vibration Controls."

C. 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.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 or less : Maximum span, 6 feet ; minimum rod size, 3/8 inch .
2. NPS 2 : Maximum span, 8 feet ; minimum rod size, 1/2 inch .
3. NPS 3 & 4 : Maximum span, 8 feet ; minimum rod size, 1/2 inch .
4. NPS 6 : Maximum span, 8 feet ; minimum rod size, 3/4inch .

E. 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, 3/8 inch .
2. NPS 1 : Maximum span, 6 feet ; minimum rod size, 3/8 inch .
3. NPS 1-1/2 : Maximum span, 6 feet ; minimum rod size, 3/8 inch .
4. NPS 2 : Maximum span, 8 feet ; minimum rod size, 3/8 inch .
5. NPS 2-1/2 : Maximum span, 8 feet ; minimum rod size, 1/2 inch .
6. NPS 3 : Maximum span, 8 feet ; minimum rod size, 1/2 inch .

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B

828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

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

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

G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, 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.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install tangential air separator in pump suction. Install gauge glass, install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

E. Install compression tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   1. Install tank fittings that are shipped loose.
   2. Support tank from structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be as shown on plans.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 15 Section "Meters and Gages."

3.8 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.

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.9 HEAT TAPE

A. Install heat tape under insulation on piping above ground and exterior to the building.

B. Heating tape shall be spiraled around the pipe and pump at a minimum of 3 turns per foot. Heating tape shall not cross over itself.

C. Heating tape shall be permanently connected to junction boxes provided on the Elec. Plans.

D. Heating tape shall be tested prior to installation of covering insulation.

E. Heating tape shall be installed in accordance with manufacturer recommendations.

END OF SECTION 232113

SECTION 232300

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 air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig.
   2. Suction Lines for Heat-Pump Applications: 535 psig.
   3. Hot-Gas and Liquid Lines: 535 psig.

1.4 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. Pressure-regulating valves.

B. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding: 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."

1.6 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.

1.7 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type L or ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

2.2 VALVES AND SPECIALTIES

A. Check Valves:
1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig .
8. Working Pressure Rating: 500 psig .
9. Maximum Operating Temperature: 275 deg F .

B. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.

5. Working Pressure Rating: 500 psig .

C. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
   1. Body and Bonnet: Plated steel.
   2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24, 115, or 208-V ac coil.
   6. Working Pressure Rating: 400 psig .
   7. Maximum Operating Temperature: 240 deg F .
   8. Manual operator.

D. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
   2. Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Seat Disc: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Working Pressure Rating: 400 psig .
   6. Maximum Operating Temperature: 240 deg F .

E. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Body, Bonnet, and Seal Cap: Forged brass or steel.
   2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Packing and Gaskets: Non-asbestos.
   4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
   5. Suction Temperature: 40 deg F.
   6. Superheat: Adjustable.
   7. Reverse-flow option (for heat-pump applications).
   8. End Connections: Socket, flare, or threaded union.
   9. Working Pressure Rating: 450 psig.

F. Moisture/Liquid Indicators:
   1. Body: Forged brass.
   2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
   3. Indicator: Color coded to show moisture content in ppm.
   4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
   5. End Connections: Socket or flare.
   6. Working Pressure Rating: 500 psig .
   7. Maximum Operating Temperature: 240 deg F .

G. Mufflers:
   1. Body: Welded steel with corrosion-resistant coating.
   2. End Connections: Socket or flare.

3. Working Pressure Rating: 500 psig .
4. Maximum Operating Temperature: 275 deg F .

H. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig .
4. Maximum Operating Temperature: 275 deg F .

2.3 REFRIGERANTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.

C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

C. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

D. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

E. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

F. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

3.3 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 Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

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

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

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

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

J. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

R. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

S. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

T. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

U. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

V. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 PIPE JOINT CONSTRUCTION

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

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

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. 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.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "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 long.
   2. Roller hangers and spring hangers for individual horizontal runs 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. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2 : Maximum span, 60 inches ; minimum rod size, 1/4 inch .
   2. NPS 5/8 : Maximum span, 60 inches ; minimum rod size, 1/4 inch .
   3. NPS 1 : Maximum span, 72 inches ; minimum rod size, 1/4 inch .
   4. NPS 1-1/4 : Maximum span, 96 inches ; minimum rod size, 3/8 inch .
   5. NPS 1-1/2 : Maximum span, 96 inches ; minimum rod size, 3/8 inch .
   6. NPS 2 : Maximum span, 96 inches ; minimum rod size, 3/8 inch .
   7. NPS 2-1/2 : Maximum span, 108 inches ; minimum rod size, 3/8 inch .
   8. NPS 3 : Maximum span, 10 feet ; minimum rod size, 3/8 inch .
   9. NPS 4 : Maximum span, 12 feet ; minimum rod size, 1/2 inch .

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 2 : Maximum span, 10 feet ; minimum rod size, 3/8 inch .
2. NPS 2-1/2 : Maximum span, 11 feet ; minimum rod size, 3/8 inch .
3. NPS 3 : Maximum span, 12 feet ; minimum rod size, 3/8 inch .
4. NPS 4 : Maximum span, 14 feet ; minimum rod size, 1/2 inch .

E. Support multi-floor vertical runs at least at each floor.

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 . If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig .
4. Charge system with a new filter-dryer core in charging line.

3.7 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:
1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 232500

HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:
   1. Bypass chemical-feed equipment and controls.
   2. Chemical treatment test equipment.
   3. HVAC water-treatment chemicals.

1.3 DEFINITIONS

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

B. RO: Reverse osmosis.

C. TDS: Total dissolved solids.

1.4 PERFORMANCE REQUIREMENTS

A. Work included: The Work of this Section includes initial cleaning of all HVAC piping, providing permanently installed chemical feeding equipment, chemical analyses, and chemical treatment compounds for control of algae, scale, and corrosion in the systems, for start-up of the facility.

B. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

C. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

D. Closed hydronic systems, including hot-water heating and chilled water, shall have the following water qualities:
   1. pH: Maintain a value within 9.0 to 10.5.
   2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
   3. Boron: Maintain a value within 100 to 200 ppm.
   4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
   5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   6. TDS: Maintain a maximum value of 10 ppm.
   7. Ammonia: Maintain a maximum value of 20 ppm.
   8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
   9. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
      c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
      d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
      e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

1.5 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
   1. Pot Feeders
   2. Chemicals.
   3. Chemical test equipment.
   4. Chemical material safety data sheets.

B. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.7 MANUFACTURERS

A. All chemical treatment equipment and chemicals shall be products of a single supplier.

B. Water treatment products and service shall be provided by Cambridge Scientific Industries, Anderson Chemical Company, Culligan, Liquid Metronics, or approved equal.

PART 2 - PRODUCTS

2.1 CHEMICAL FEEDING EQUIPMENT - CLOSED LOOP SYSTEMS

A. A pot feeder shall be installed on each closed loop system including the hot water and chilled water systems as detailed on the drawings. Each pot feeder shall be used to batch feed a corrosion and scale inhibitor into the system.

B. Pot feeders shall be a Cambridge Scientific Industries Model 300961, 2 gallon feeder, or equal by Neptune or Anco. The feeders shall be rated for a working pressure of 300 PSI at 200 degrees. The feeders shall have a 3-1/2" opening and a lid that opens with a quarter turn. The feeders shall be installed on a model 301302 three leg stand.

2.2 WATER TREATMENT CHEMICALS

A. Corrosion/scale inhibitor shall be a molybdenum based blend for the prevention of scale and corrosion of mild steel and yellow metal components of the piping systems. At a dosage rate of 300 ppm, the molybdenum residual shall be 10-14 ppm, the phosphonate residual shall be 10-14 ppm and the TTA residual shall be more than 2-3 ppm.

B. Freeze protection additive shall be ethylene glycol. Manufacturers approved shall be Dow, DuPont, Union Carbide, or engineer approved equal.

C. To insure operator safety all chemical products shall be provided in liquid form for direct feed from shipping container to the cooling system.

PART 3 - EXECUTION

3.1 CLEANING OF PIPING SYSTEM

A. Before operating the heating and cooling equipment, the Contractor shall chemically clean all piping systems.

B. During the cleaning and flushing process, all strainers, which includes but is not limited to air handlers, fan-coil units, and all strainers in the mechanical room shall be cleaned and drain valves shall be open periodically to remove sediments from the systems. Chemical solutions shall be circulated through the piping until the systems are clean, after which the systems shall be flushed with clean water. After the flushing process, the piping system shall be refilled with clean water and charged with operating chemicals as herein specified or as recommended by the unit manufacturer.

C. Strainers shall be disassembled and cleaned after final water treatment. The Owner shall be notified and present for the cleaning of the strainers.

D. Ethylene glycol in chilled water loop shall be applied at a rate of 20% by volume. Verification of the 20% ethylene glycol in the chilled water loop shall be provided to the Owner 45 days prior to substantial completion.

E. Chemical supplier shall demonstrate system to Owner 45 days prior to substantial completion.

F. The chemicals shall not be injected into the system until after the piping systems have been chemically cleaned and flushed. Contractor shall certify in writing upon completion of system cleaning. The Owner's representative shall be contacted immediately after the system is flushed and cleaned. The Owner's representative reserves the right to visually inspect the cleanliness of the water prior to the injection of final chemical solution. The owner’s representative will select random AHU and FCU strainers to be checked for cleanliness. If the quality of the water is deemed unsatisfactory by the Owner's representative, the piping system shall be flushed until the quality of the water is acceptable.

G. After each water test the contractor shall provide the Owner with a “Notice of Water Review”. The “Notice of Water Review” shall include the date of the test, school name, all test performed, results of the test, and who performed the test.

H. All chemical treatments used for cleaning and flushing of the system shall be in accordance with the recommendations of the HVAC equipment manufacturer. Refer to unit manufacturer's written instructions for approved treatments and cleaning requirements.

3.2 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.3 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Pot Feeders: Install in closed hydronic systems, including hot-water heating and chilled water, and equipped with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   2. Install water meter in makeup water supply.

3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
5. Install a swing check on inlet after the isolation valve.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 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 HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 15 Section "Basic Mechanical Materials and Methods."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 15 Section "Valves."

E. Refer to Division 15 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

3.5 WATER TREATMENT PROGRAM

A. Provide permanent apparatus and one year's supply of chemicals and consulting chemist services for water treatment.

B. Provide consulting services for:
1. Inspection of treatment apparatus after installation, prior to equipment start-up.
2. Four field service calls at 120 day intervals, including water analyses of domestic water supply and each circulating water system. First call at start-up. Each service call shall be followed up in writing to Owner documenting findings and adjustments.
3. Training of operating personnel in methods and materials employed in testing water for chemical concentration and for feeding chemicals in treating the system.
4. Log sheets and record forms. The log sheets and record forms shall be copied to the Maintenance Office and Facility Office. Failure to provide log sheets and record forms within 7 days of service will add another service call at 120 days to the contract and extend the warranty period by 120 days for each time the log sheets and record forms are not copied to the Maintenance Office and Facility Office.
5. Any required laboratory and technical assistance.

6. Chemical company shall provide a 24-hour a day 7 days a week contact person and phone number.

C. Provide chemicals for the treatment program for a period of one year. Deliver to site in standard containers and store in mechanical equipment room or as directed by Owner.

3.6 SYSTEM ACCEPTANCE

A. Reference section 01770 for general requirements.

3.7 CLOSEOUT DOCUMENTATION

A. An approved treatment program schedule, documentation of initial equipment start-up completion, documentation of personnel training, and submission of log sheets and record forms shall be received by the Owner prior to granting of substantial completion.

END OF SECTION 15189

SECTION 233113

METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Double-wall round ducts and fittings.
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.
8. Exterior ducts and fittings.
9. Fabric Ductwork

B. Related Sections:
1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. 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".

1.4 SUBMITTALS

A. Product Data: For each type of the following products:
1. Liners and adhesives.
2. Sealants and gaskets.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

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 D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
   3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and

Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements,:
   a. Lindab Inc.
   b. McGill AirFlow LLC.
   c. SEMCO Incorporated.
   d. Sheet Metal Connectors, Inc.
   e. Spiral Manufacturing Co., Inc.
   f. Impulse Air

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL ROUND DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements,:
   1. Lindab Inc.
   2. McGill AirFlow LLC.
   3. SEMCO Incorporated.
   4. Sheet Metal Connectors, Inc.
   5. Impulse Are

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 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent.

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. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
2. Coat insulation with antimicrobial coating.
3. Cover insulation with polyester film complying with UL 181, Class 1.

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections. Minimum gauge of sheet metal shall be as specified below:

GREATEST DIMENSION	MIN. U. S. GAUGE
0" - 12"	26
13" - 30”	24
31" - 54"	22
55" - 84"	20
85" and above	18
Plenum	22

Gauges above are minimum thickness of metal and exceed SMACNA standards in many cases.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. 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.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.5 DUCT LINER

A. Refer to 230700 HVAC INSULATION Duct Internal Lining for material requirements.

B. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- or 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   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.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
   5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
   6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm .
   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.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch wg , positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.
   1. General: Single-component, acid-curing, silicone, elastomeric.
   2. Type: S.
   3. Grade: NS.
   4. Class: 25.
   5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. 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 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.

2.7 HANGERS AND SUPPORTS

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

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel 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.

2.8 EXTERIOR DUCTS

A. Exterior ductwork shall be double wall construction. All exterior exposed ductwork sections shall be connected using a system consisting of minimum 18 gauge galvanized steel outer duct with an integral sealant to create an airtight transverse joint. The inter duct shall be minimum 24 gauge. The system shall utilize a neoprene or extruded butyl gasketing between mating flanges the entire length of the joint. The connection system shall be comparable to a S.M.A.C.N.A. class "J" transverse joint. Each transverse joint shall be weatherproofed using a

continuous U.L. listed metal cleat applied over the entire joint. The system shall be by Ductmate Industries, Inc., Ward Duct Connector, Inc., or Engineer and Owner approved equal.

B. All exterior duct shall be constructed to meet SMACNA standards for min. 4" w.c. static pressure. Intermediate section supports shall be angle iron or tie rod type sized per the S.M.A.C.N.A. HVAC Duct Construction Standards - Metal and Flexible - 1995 edition. Reinforcement shall be provided on all sides of duct.

C. All exterior ductwork joints, reinforcements, and longitudinal seams shall be sealed with Sonneborn "Sonolastic NP-1" urethane sealant. Exterior ductwork shall be sealed, wiped, and cleaned with mineral spirits, and finished with a minimum of two coats of galvanized primer. The color of sealant and primer shall be matched, with color selected by the Owner.

D. All exterior ductwork shall be properly sealed to building at penetrations to prevent water entry to building and duct interior.

E. All exterior ductwork shall be primed and painted with a minimum of 2 coats of architect selected color. Coordinate paint requirements with general division.

2.9 FABRIC DUCT SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products manufactured in the United States, choose one of the following: Ductsox, Uni-Fab, Fabric-Air, Prihoda or KE Fibertec.

B. Air diffusers shall be constructed of a woven fire retardant fabric complying with the following physical characteristics:
   1. Fabric Construction: 100% Flame Retardant and treated with a machine wash-able anti-microbial agent from the manufacturer.
   2. Weight: 5.2 oz. / sq. yd. per ASTM D3776
   3. Color: Standard: Coordinate with Architect
   4. Air Permeability: 2 (+2/-1) cfm/ft2 per ASTM D737, Frazier
   5. Temperature Range: 0 degrees F to 180 degrees F
   6. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the flame spread/smoke developed requirements of NFPA 90-A and ICC AC167.
   7. Antimicrobial agent shall be proven 99% effective after 10 laundry cycles per AATCC Test Method 100.

C. System Fabrication Requirements:
   1. Air dispersion accomplished by linear vent and permeable fabric. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.

2. Size of vent openings and location of linear vents to be specified and approved by manufacturer to provide even air distribution throughout the occupied space. Air distribution system shall provide minimum 10 fpm air flow to within 2’ of floor and 2’ of exterior wall.
3. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener - supplied by contractor.
4. Inlet connection includes zipper for easy removal / maintenance.
5. Lengths to include required zippers as specified by manufacturer.
6. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 - 0.60 in w.g. static pressure.
7. End cap includes zipper for easy maintenance.
8. Fabric system shall include connectors to accommodate suspension system listed below.
9. Fabric duct shall be supported by internal frame system so that duct will maintain inflated shape the entire length of duct run.

D. Design Parameters:
1. Fabric diffusers shall be designed from 0.25” water gage minimum to 3.0” maximum, with 0.5” as the standard.
2. Fabric air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).
3. Design CFM, static pressure and diffuser length shall be designed or approved by the manufacturer.

E. Suspension Hardware:
1. Suspended U-Track: System shall be installed using a tension cable system including a single (1 Row), run of aluminum U-Track. Single (1 Row) located 1-1/2” above top-dead-center. 2 Row supports are required for systems of 32” diameter and larger. Hardware to include 8' sections of track, splice connectors, track endcaps, and vertical cable support kits - consisting of a length of cable with a locking stud end and Gripple quick cable connectors. Radius aluminum track must be included for all horizontal/flat radius sections.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Ductwork, unless noted otherwise, shall be constructed for a positive pressure of 2" W.C. for supply ductwork and a negative pressure of 1.5" W.C. for exhaust and return ductwork. Ductwork reinforcement shall be provided as required by the SMACNA HVAC Duct Construction Standards - Metal & Flexible - Third Edition - 2005 for the pressure class and minimum gauges listed above. **Contractor shall submit a schedule indicating duct gauge and reinforcement methods to be utilized for each duct dimension range outlined above prior to fabricating any ductwork. Minimum metal thickness is listed in Para 2.4A above.** 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 Division 23 Section "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 "Duct Cleanliness for New Construction Guidelines."

M. Sizes of duct indicated as lined shall be adjusted to accommodate liner thickness maintaining interior dimensions.

3.2 SEAM AND JOINT SEALING

A. Seal Classes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements."
   1. For static-pressure classes 2 inch wg , comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class C:

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: 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.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 , "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches 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.

3.4 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.6 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as follows:
   1. Dishwasher Hood Exhaust Ducts:
      a. Type 304, stainless-steel sheet.
      b. Exposed to View: No. 4 finish.
      c. Concealed: No. 2D finish.
      d. Welded seams and welded joints with watertight EPDM gaskets.

B. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel.
   2. Stainless-Steel Ducts: Galvanized steel.

C. Liner:
   1. Supply- and Return-Air Ducts: Fibrous glass, Type I, 1 inch thick.
   2. Transfer Ducts: Fibrous glass, Type I, 1 inch thick.

D. Double-Wall Duct Interstitial Insulation:
   1. Supply- and Return-Air Ducts, 16 Inches and Smaller in Diameter or Rectangular Equivalent: 1 inch thick.
   2. Supply- and Return-Air Ducts, 18 Inches and Larger in Diameter or Rectangular Equivalent: 1 inch thick.

E. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
      a. Velocity 1000 fpm or Lower:
         1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
         2) Mitered Type RE 4 without vanes.
      b. Velocity 1000 to 1500 fpm :
         1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
         2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
         3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
      c. Velocity 1500 fpm or Higher:
         1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm : 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

F. Branch Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
      a. Rectangular Main to Rectangular Branch: 45-degree entry.
      b. Rectangular Main to Round Branch: Spin in.
   2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
      a. Velocity 1000 fpm or Lower: 90-degree tap.
      b. Velocity 1000 to 1500 fpm : Conical tap.
      c. Velocity 1500 fpm or Higher: 45-degree lateral.

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SECTION 233300

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Materials
2. Backdraft and pressure relief dampers.
3. Barometric relief dampers.
4. Manual volume dampers.
5. Control dampers.
6. Fire dampers.
7. Ceiling dampers.
8. Turning vanes.
9. Duct-mounted access doors.
10. Duct access panel assemblies.
11. Flexible connectors.
12. Flexible ducts.
13. Smoke Dampers
14. Sound Attenuators

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and exposed ducts.

D. 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.

E. Extruded Aluminum: Comply with ASTM B 221 , Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

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 .

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. American Warming and Ventilating; a division of Mestek, Inc.
   3. Cesco Products; a division of Mestek, Inc.
   4. Duro Dyne Inc.
   5. Greenheck Fan Corporation.
   6. Lloyd Industries, Inc.
   7. Nailor Industries Inc.
   8. NCA Manufacturing, Inc.
   9. Pottorff; a division of PCI Industries, Inc.
   10. Ruskin Company.
   11. SEMCO Incorporated.
   12. Vent Products Company, Inc.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: 0.052-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:
1. Material: Galvanized steel.
2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Aluminum or Galvanized steel.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball or synthetic pivot bushings.

M. Sleeve: Minimum 20-gage thickness.

2.3 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements:
1. Air Balance Inc.; a division of Mestek, Inc.
2. American Warming and Ventilating; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Duro Dyne Inc.
5. Greenheck Fan Corporation.
6. Lloyd Industries, Inc.
7. Nailor Industries Inc.
8. NCA Manufacturing, Inc.
9. Pottorff; a division of PCI Industries, Inc.
10. Ruskin Company.
11. SEMCO Incorporated.
12. Vent Products Company, Inc.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 2000 fpm.

D. Maximum System Pressure: 2-inch wg.

E. Frame: 0.064-inch- thick, galvanized sheet steel, with welded corners and mounting flange.

F. Blades:
1. Multiple, 0.025-inch- thick, roll-formed aluminum.

2. Maximum Width: 6 inches.
3. Action: Parallel.
4. Balance: Gravity.
5. Eccentrically pivoted.

G. Blade Seals: Neoprene.

H. Blade Axles: Galvanized steel.

I. Tie Bars and Brackets:
1. Material: Aluminum or Galvanized steel.
2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Synthetic.

L. Accessories:
1. Adjustment device to permit setting for varying differential static pressures.

2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements:
a. Air Balance Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. Flexmaster U.S.A., Inc.
d. McGill AirFlow LLC.
e. METALAIRE, Inc.
f. Nailor Industries Inc.
g. Pottorff; a division of PCI Industries, Inc.
h. Ruskin Company.
i. Trox USA Inc.
j. Vent Products Company, Inc.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized-steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel.
7. Bearings:
a. Oil-impregnated bronze or Molded synthetic.

b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:
1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

D. Spin-in fittings:
1. Spin-in fittings shall be used for round take-offs from rectangular duct mains. Spin-ins shall include a scoop extractor and balancing damper with 2" stand-off bracket with locking quadrant and continuous square shaft with end bearings. Scoop extractor shall not be required on return and exhaust fittings. See plan details.

E. Use of "Dove-Tail" fittings or connections is prohibited.

2.5 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements:
1. American Warming and Ventilating; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Duro Dyne Inc.
5. Flexmaster U.S.A., Inc.
6. Greenheck Fan Corporation.
7. Lloyd Industries, Inc.
8. M&I Air Systems Engineering; Division of M&I Heat Transfer Products Ltd.
9. McGill AirFlow LLC.
10. METALAIRE, Inc.
11. Metal Form Manufacturing, Inc.
12. Nailor Industries Inc.
13. NCA Manufacturing, Inc.
14. Ruskin Company.
15. Vent Products Company, Inc.
16. 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. Hat shaped.
2. Galvanized-steel channels, 0.064 inch thick.
3. Mitered and welded corners.

D. Blades:
1. Multiple blade with maximum blade width of 8 inches.
2. Parallel- and opposed-blade design.
3. Galvanized steel.
4. 0.064 inch thick.
5. Blade Edging: Closed-cell neoprene edging.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:
1. Oil-impregnated bronze or Molded synthetic.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements,:
1. Air Balance Inc.; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Greenheck Fan Corporation.
5. McGill AirFlow LLC.
6. METALAIRE, Inc.
7. Nailor Industries Inc.
8. NCA Manufacturing, Inc.
9. PHL, Inc.
10. Pottorff; a division of PCI Industries, Inc.
11. Prefco; Perfect Air Control, Inc.
12. Ruskin Company.
13. Vent Products Company, Inc.
14. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Type: Static; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
   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.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.7 CEILING DAMPERS

A. Manufacturers: Subject to compliance with requirements:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
   3. McGill AirFlow LLC.
   4. METALAIRE, Inc.
   5. Nailor Industries Inc.
   6. Prefco; Perfect Air Control, Inc.
   7. Ruskin Company.
   8. Vent Products Company, Inc.
   9. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. General Requirements:
   1. Labeled according to UL 555C by an NRTL.
   2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

F. Fire Rating: 2 hours.

2.8 TURNING VANES

A. Manufacturers: Subject to compliance with requirements,:
1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. SEMCO Incorporated.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. 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. 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 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

E.

2.9 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements,:
1. American Warming and Ventilating; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Ductmate Industries, Inc.
4. Flexmaster U.S.A., Inc.
5. Greenheck Fan Corporation.
6. McGill AirFlow LLC.
7. Nailor Industries Inc.
8. Pottorff; a division of PCI Industries, Inc.
9. Ventfabrics, Inc.
10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
1. Door:
a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Vision panel.
d. Hinges and Latches: 1-by-1-inch 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: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
   d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.10 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements,:
   1. Ductmate Industries, Inc.
   2. Flame Gard, Inc.
   3. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0428-inch stainless steel.

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.11 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements,:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Inc.
   3. Ventfabrics, Inc.
   4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   1. Minimum Weight: 26 oz./sq. yd. .
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outdoor 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 Element: Molded, oil-resistant rubber or neoprene.
   7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.12 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.
   3. Thermaflex
   4. Atco

B. Insulated, Flexible Duct: UL 181, Class 1, CPE film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
   1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 175 deg F.
   4. Min. R value: R-6 for interior installations, R-8 for exterior installations.

C. Flexible Duct Connectors:

   1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action for sizes 3 through 18 inches, to suit duct size. **Nylon cable straps are not acceptable for securing flexible duct.**

2.13 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements;
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
   3. Greenheck Fan Corporation.
   4. Nailor Industries Inc.
   5. PHL, Inc.

6. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

I. Damper Motors: two-position action.

J. 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.
   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 .

2.14 SOUND ATTENUATORS

A. Manufacturers: Subject to compliance with requirements;
   1. Vibro-Accoustics

2. Ruskin Company
3. Price

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 E84.
   3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Shape:
   1. Rectangular straight with splitters or baffles.

D. Rectangular Silencer Outer Casing: ASTM A653/A653M, G90, galvanized sheet steel, 0.034 inch thick.

E. Inner Casing and Baffles: ASTM A653/A653M, G90 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch- diameter perforations.

F. Connection Sizes: Match connecting ductwork unless otherwise indicated.

G. Principal Sound-Absorbing Mechanism:
   1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
   2. Dissipative 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. Lining: Fiberglas cloth.

H. 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: 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.

I. Accessories:
   1. Factory-installed end caps to prevent contamination during shipping.
   2. Removable splitters.

J. Source Quality Control: Test according to ASTM E477.
   1. Testing sound attenuators to be witnessed by Owner.
   2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.

3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire and smoke dampers according to UL listing.

G. 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. Downstream from manual volume dampers, control dampers, turning vanes, and equipment.
   3. 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 pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   4. At each change in direction and at maximum 50-foot spacing.
   5. Upstream of turning vanes.
   6. Elsewhere as indicated.

H. Install access doors with swing against duct static pressure.

I. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.

J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

K. Install flexible connectors to connect ducts to equipment.

L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

M. Connect variable volume and powered induction terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

N. Connect diffusers or light troffer boots to low-pressure ducts directly or with maximum 72” lengths of flexible duct. Flexible ducts shall be supports at 36” intervals. Supports shall be attached to the structure and shall not crimp or impede proper airflow though the installed ductwork.

O. Connect flexible ducts to metal ducts with stainless steel draw bands.

P. 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.

END OF SECTION 233300

SECTION 233423

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Centrifugal roof ventilators.
   2. Upblast propeller roof exhaust fans.
   3. Ceiling-mounting ventilators.
   4. In-line centrifugal fans.
   5. Propeller fans.
   6. Kiln Ventilation System

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on 1,000 feet above sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

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

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
   1. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

C. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.8 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. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Acme Engineering & Mfg. Corp.
   2. Greenheck.

3. Loren Cook Company.
4. Penn Ventilation.
5. Twin City

B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone. Cabinet and hood shall be painted to match adjacent roofing materials. Color selection to be made by Architect. Forward color selection chart to Architect prior to ordering units.
   1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
   2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
   4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
   1. Configuration: Self-flashing without a cant strip, with mounting flange.
   2. Overall Height: 18 inches.
   3. Curbs on metal roofs shall be painted to match roof.

2.2 CEILING-MOUNTING VENTILATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Acme Engineering & Mfg. Corp.
   2. Greenheck.
   3. Loren Cook Company.
   4. Penn Ventilation.
   5. Twin City

B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Grille: Plastic or painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Isolation: Rubber-in-shear vibration isolators.
   3. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.3 IN-LINE CENTRIFUGAL FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Acme Engineering & Mfg. Corp.
   2. Greenheck.
   3. Loren Cook Company.
   4. Penn Ventilation.
   5. Twin City

B. Description: In-line, direct or belt-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

E. 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.

F. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

G. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Companion Flanges: For inlet and outlet duct connections.
   3. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.4 PROPELLER FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Acme Engineering & Mfg. Corp.
   2. Loren Cook Company.
   3. Penn Ventilation.
   4. Greenheck

B. Description: Direct- or belt-driven propeller fans consisting of fan blades, hub, housing, orifice ring, motor, drive assembly, and accessories.

C. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

D. Steel Fan Wheels: Formed-steel blades riveted to heavy-gage steel spider bolted to cast-iron hub.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: 1.4.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
      a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.
   4. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
   5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   6. Belts: Oil resistant, non sparking, and nonstatic; matched sets for multiple belt drives.
   7. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories:
   1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
   2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
   3. Wall Sleeve: Galvanized steel to match fan and accessory size.
   4. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2.5 WALL MOUNTED PROPELLER FAN

A. Fan assembly shall consist of aluminum blades, totally enclosed permanent split capacitor two-speed motor with built-in thermal over load, poly vinyl coated wire guard, wall mounting bracket and power cord with plug. Note that the fans shall be non-oscillating type.

2.6 MOTORS

A. Comply with requirements in Division 15 Section "Motors."

B. Enclosure Type: Totally enclosed, fan cooled.

2.7 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

2.8 ROOF MOUNTING CURBS

A. Provide a pre-fabricated, insulated, 12 gauge galvanized steel roof mounting curb for all roof mounted equipment. Duct support members shall be provided to allow for pre-hanging of ductwork prior to unit installation. Provide gasketing to form a positive, weather tight seal between the curb and unit base. Design shall comply with all requirements of the National Roofing Contractors Association. Base of curb shall conform to roof slope and provide a level base on which to mount equipment. Curb overall height (from roof structure to top of curb) shall provide a min. 10" clearance between the top of the curb and the finished roof surface or the minimum height required to meet the roofing bond specifications, whichever is greater.

B. Insulation shall be 1-1/2 inch thick, 3-lb. density rigid type. Nailer shall be constructed of pressure treated wood.

C. All roof mounting curbs shall comply with requirements of architectural division of the specifications. All roof curbs shall be approved by the Architect prior to placing order for construction.

D. Curbs on metal roofs shall be painted to match roof.

2.9 KILN HOOD

A. Hood shall be semi-portable type including suspended hood, two speed motor / blower assembly, venting hose, and overhead pulley system, and swinging wall bracket assembly.

B. Hood shall be constructed of spun aluminum alloy. Hood diameter shall be a minimum of 54" diameter.

C. Venting hose shall include aluminum inner and outer surfaces. Unit shall include control switch and plug, venting kit including all necessary clamps. Overhead bracket shall be constructed of 1" square tubing including necessary suspension wire, clips, and steel counterweight.

D. System shall include a nominal 500 CFM exhauster with 1/10 H.P. motor, a spun aluminum hood, 2 speed wall mounted fan controller, overhead counterweight pulley system, wall brackets, 10' of 6" flexible hose, and mounting plates and accessory hardware.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 7 Section "Roof Accessories" for installation of roof curbs.

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops having a static deflection of 1 inch . Vibration-control devices are specified in Division 15 Section "Mechanical Vibration and Seismic Controls."

E. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Division 15 Section "Mechanical Identification."

G. Install kiln ventilation system as recommended by the manufacturer. Verify kiln location prior to installing hood. Trim excess exhaust hose to ensure smooth duct radius. Install wall bracket true and plumb to ensure the hood remains centered over the kiln. Verify exact kiln dimensions prior to ordering hood.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   5. Adjust belt tension.
   6. Adjust damper linkages for proper damper operation.
   7. Verify lubrication for bearings and other moving parts.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   10. Shut unit down and reconnect automatic temperature-control operators.
   11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Refer to Division 15 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 15838

SECTION 233713

DIFFUSERS, REGISTER, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Rectangular and square ceiling diffusers.
   2. Louver face diffusers.
   3. Adjustable bar registers and grilles.
   4. Fixed face registers and grilles.

B. Related Sections:
   1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. 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. Revise subparagraphs below to suit Project.
   2. Ceiling suspension assembly members.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
   5. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
   6. Duct access panels.

C. Source quality-control reports.

D. The reflected ceiling plan shall be referenced to determine air device frame types. Air devices located in gypsum board ceilings shall be installed with steel surface mount adaptor frame.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Krueger.
   b. METALAIRE, Inc.
   c. Nailor Industries Inc.
   d. Price Industries.
   e. Titus.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel or Aluminum.
4. Finish: Baked enamel, white.
5. Face Size: Per schedule and ceiling type.
6. Mounting: Per schedule and ceiling type.
7. Pattern: Fixed.
8. Dampers: Radial opposed blade.
9. Accessories:
   a. Equalizing grid.
   b. Plaster ring.
   c. Safety chain.
   d. Wire guard.
   e. Sectorizing baffles.
   f. Operating rod extension.

B. Louver Face Diffuser:
1. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two subparagraphs and list of manufacturers below. See Division 01 Section "Product Requirements."
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Krueger.
   b. METALAIRE, Inc.
   c. Nailor Industries Inc.
   d. Price Industries.
   e. Titus.
3. Devices shall be specifically designed for variable-air-volume flows.
4. Material: Steel or Aluminum.
5. Finish: Baked enamel, white.
6. Face Size: Per schedule and ceiling type.
7. Mounting: Per schedule and ceiling type.
8. Pattern: Four-way, unless noted otherwise.
9. Dampers: Radial opposed blade.

10. Accessories:
    a. Square to round neck adaptor.
    b. Adjustable pattern vanes.
    c. Throw reducing vanes.
    d. Equalizing grid.
    e. Plaster ring.
    f. Safety chain.
    g. Wire guard.
    h. Sectorizing baffles.
    i. Operating rod extension.

2.2 REGISTERS AND GRILLES

A. Adjustable Bar Register:
1. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two subparagraphs and list of manufacturers below. See Division 01 Section "Product Requirements."
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Krueger.
    b. METALAIRE, Inc.
    c. Nailor Industries Inc.
    d. Price Industries.
    e. Titus.
3. Material: Steel or Aluminum.
4. Finish: Baked enamel, white.
5. Face Blade Arrangement: Vertical spaced 3/4 inch apart.
6. Core Construction: Integral.
7. Rear-Blade Arrangement: Horizontal spaced 3/4 inch apart.
8. Frame: 1-1/4 inches wide.
9. Mounting Frame: Per schedule and ceiling type.
10. Mounting: Per schedule and ceiling type.
11. Damper Type: Adjustable opposed blade.

B. Adjustable Bar Grille:
1. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two subparagraphs and list of manufacturers below. See Division 01 Section "Product Requirements."
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Krueger.
    b. METALAIRE, Inc.
    c. Nailor Industries Inc.
    d. Price Industries.
    e. Titus.
3. Material: Steel or Aluminum.
4. Finish: Baked enamel, white.
5. Face Blade Arrangement: Vertical spaced 3/4 inch apart.
6. Core Construction: Integral.
7. Rear-Blade Arrangement: Horizontal spaced 3/4 inch apart.
8. Frame: 1-1/4 inches wide.

9. Mounting Frame: Per schedule and ceiling type.
10. Mounting: Per schedule and ceiling type.

C. Fixed Face Register:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Krueger.
b. Nailor Industries Inc.
c. Price Industries.
d. Titus.
2. Material: Steel or Aluminum.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches wide.
7. Mounting Frame: Per schedule and ceiling type.
8. Mounting: Per schedule and ceiling type.
9. Damper Type: Adjustable opposed blade.

D. Fixed Face Grille:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Krueger.
b. Nailor Industries Inc.
c. Price Industries.
d. Titus.
2. Material: Steel or Aluminum.
3. Finish: Baked enamel, white.
4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches wide.
7. Mounting Frame: Per schedule and ceiling type.
8. Mounting: Per schedule and ceiling type.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

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SECTION 233814

RESIDENTIAL RANGE HOODS

PART 1 - GENERAL

1.1 GENERAL

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

1.2 SUBMITTALS

A. Contractor shall provide Architect with six (6) copies of signed certifications of approval from all inspection agencies having jurisdiction indicating their acceptance of the system.

1.3 SUMMARY

A. This section includes the following:
   1. Residential Range Hood Systems
   2. Residential Automatic Fire Extinguishing System

PART 2 - PRODUCTS

2.1 RESIDENTIAL RANGE HOOD SYSTEM

A. Range Hood:
   1. Basis-of-Design Product: Model No. 433004 exhaust hood manufactured by Broan Best or comparable product by the following:
      a. General Electric; Model JV367HWW
      b. Viking
      c. Vent-A-Hood
   2. Type: 30-inch undercabinet range hood.
   3. Exhaust Fan: Three-speed fan, built-in hood.
   4. Fan Control:
      a. Hood mounted, multiposition fan switch, with separate hood-light control switch.
      b. Provide wall mounted switches for light and fan at hoods installed over appliances in handicapped stations.
   5. Duct Type: 3-1/4 by 10 inches.
   6. Finish: Stainless steel.
   7. Color: Stainless steel.
   8. Standard features include the following:

a. Permanent, washable aluminum mesh filter(s).
b. Built-in incandescent lighting. Provide with minimum 60W light bulb or manufacturers maximum watt bulb allowed.
c. Provide light bulb for hood.

2.2 FIRE PROTECTION

A. Residential Automatic Fire Extinguishing System:
1. Fire suppression system:
a. Basis-of-Design Product: Model 1384-A Guardian I wet chemical system as manufactured by Twenty First Century. Equal are Pyro-Chem, or Range Guard.
1) Electrically powered and monitored systems shall not be acceptable.
b. General: System shall be capable of detecting a cooking grease fire origination on the range top, extinguish the fire and prevent re-ignition, while at the same time, shut off the fuel supply to surface element on the kitchen range top. Each system shall be provided with all means to distribute the chemical agent, fire detection components, container for storing the chemical, valve assembly with pressure gauge, mounting bracket for container, and appliance shut-off device.
c. Certification: The fire extinguishing system shall have a current UL listing. Wet chemical shall conform to the requirements of NFPA Standard No. 17A for Wet Chemical Fire Extinguishing Systems.
d. Appliance Shut-Down Device:
1) At Electric Ranges: Each system shall be provided with a listed device to automatically shut-off the electric supply to surface burners on the kitchen range top upon activation of the fire extinguishing system. The electric supply shall remain □off□ until manually reset.
2) At Gas Ranges: Each gas supplied kitchen range appliance shall be provided with a U.L. Listed Pneumatic operated gas valve. The shut-off is activated by pressure transmitted to the valve through a teflon tube encased in a stainless steel braided cover that connects to the valve on one end and to the distribution assembly on the other end. The valve shall be designed to close upon activation of the system and remain closed until manually reset. Valve pipe size shall be 3/4 inch unless otherwise specified.

B. Other Materials: Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install hood system in conformance with the latest edition or the applicable standard of the NFPA, Manufacturer's manual, and all applicable State and local codes, by a certified installer, as required by NFPA No. 96 (1980) Paragraph 7-4.1.

B. General:
   1. Comply with manufacturer's written instructions.
   2. Install the work in strict accordance with the pertinent requirements of governmental agencies having jurisdiction, and the manufacturer's recommended installation procedures, anchoring all components firmly into position for long life under hard use.

C. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.

D. The seller warrants that all the materials, labor and equipment furnished under this order shall be free of defects either in design, materials, and workmanship for a period of one year after the date of installation.

E. All roof penetrations and supports shall be coordinated with the roofing contractor and structural components of the building.

F. Provide a shut down button for the hood and cooking equipment under the hood. The shut down button shall be located as shown on the plans. The shut down button shall be protected in a hinged lexan cover.

3.2 CLEANING AND PROTECTION

A. Test each item of residential appliances to verify proper operation. Make necessary adjustments.

B. Verify that accessories required have been furnished and installed.

C. Remove packing material from residential appliances and leave units in clean condition, ready for operation.

D. Touchup scratches and abrasions to be completely invisible to the unaided eye from a distance of two feet.

3.3 CONNECTIONS

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

B. Connect wiring according to Division 26 Section "Conductors and Cables."

C. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

D. 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.

E. Coordinate fire alarm wiring with Division 26.

3.4 DEMONSTRATION

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

B. Operation of the residential fire extinguishing systems shall be demonstrated to the Owner, Architect and local Building Officials.
   1. Contractor shall protect appliances, cabinetry, and other surfaces from damage due to testing.
   2. Balloon testing shall not be acceptable.

3.5 CLOSEOUT DOCUMENTATION

A. Properly completed start-up forms, including equipment marks and serial numbers, documenting proper installation and demonstration shall be received by the Owner prior to granting of substantial completion.

END OF SECTION 15871

SECTION 234100

AIR FILTERS

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 factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.3 SUBMITTALS

A. Product Data: Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Operation and Maintenance Data: For each type of filter rack to include in operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air filters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Comply with ARI 850.

C. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.

D. Comply with NFPA 90A and NFPA 90B.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

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.

1.7 Provide one complete set of filters for each filter bank. If system includes prefilters, provide only prefilters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
   1. Air Filters, Electrostatic Air Cleaners, and Filter-Holding Systems:
      a. AAF International.
      b. Filtration Group.
      c. Airguard Industries, Inc.
      d. Research Products Corp.

2.2 EXTENDED-SURFACE, DISPOSABLE PANEL FILTERS

A. Description: Factory-fabricated, dry, extended-surface filters with holding frames.

B. Media: Fibrous material formed into deep-V-shaped pleats with anti-microbial agent and held by self-supporting wire grid.

C. Media and Media-Grid Frame: Cardboard.

D. Duct-Mounting Frames: Welded, galvanized steel with gaskets and fasteners, and suitable for bolting together into built-up filter banks.

2.3 SIDE-SERVICE HOUSINGS

A. Description: Factory-assembled, side-service housings, constructed of galvanized steel, with flanges to connect to duct system.

B. Access Doors: Continuous gaskets on perimeter and positive-locking devices. Arrange so filter cartridges can be loaded from either access door.

C. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install filter frames according to manufacturer's written instructions.

B. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

C. Install filters in position to prevent passage of unfiltered air.

D. Coordinate filter installations with duct and air-handling unit installations.

E. During construction unit filters shall be periodically changed while the unit is in operation. This shall include unit filter as well as a filter media to be placed over the return grilles. The unit filter and filter media shall be dated at each replacement. If the ductwork or evaporator coil becomes dirty, the contractor shall clean the ductwork and coil. The contractor shall provide the owner a letter stating that all coils have been inspected and are clean at Substantial Completion.

3.2 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems and at accepted substantial completion, clean filter housings and install new filter media.

END OF SECTION 234100

SECTION 235543

WALL & CEILING 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. This Section includes wall and ceiling heaters with propeller fans and electric heating elements.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

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

C. Operation and Maintenance Data: For wall and ceiling heaters to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

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

2. Markel Products.
3. QMark Electric Heating.

2.2 ELECTRIC CEILING MOUNTED HEATERS

A. Provide heavy duty, ceiling mounted, forced air heater of the voltage as specified under the electrical division of work. Units shall be installed and wired in accordance with the manufacturer's recommendations and applicable national and local codes.

B. Heater shall be lay-in ceiling design mounted in the horizontal position. Unit shall contain vertical down discharge designed to supply heated air at the floor with unit mounted at 10'-0" above floor.

C. Fan motor shall be permanently lubricated, totally enclosed, shaded pole type with impedance protection. A protective shield shall surround the motor to separate return air from the supply air.

D. Heating element assemblies shall consist of two or three corrosion resistant steel sheathed elements, mechanically bonded to common corrosion resistant steel fins. Elements shall be helically coiled nickel chromium alloy resistance wire completely embedded in and surrounded by magnesium oxide, enclosed and swaged into corrosion resistant steel sheaths. Elements shall have no more than 60 watts per inch.

E. Heaters shall be equipped with a zero voltage reset thermal overload, which disconnects the motor and elements should normal operating temperatures be exceeded. Provide with manual reset.

F. Provide wall mounted, heavy duty, tamper proof, low voltage thermostat.

G. Units shall be U.L. listed with integral disconnect switch.

2.3 ELECTRIC WALL HEATERS

A. Provide heavy duty, wall mounted, forced air heater of the voltage as specified under the electrical division of work. Units shall be installed and wired in accordance with the manufacturer's recommendations and applicable national and local codes.

B. Heater shall be wall mounted in the vertical. Unit shall contain vertical down discharge designed to supply heated air at the floor.

C. Fan motor shall be permanently lubricated, totally enclosed, shaded pole type with impedance protection. A protective shield shall surround the motor to separate return air from the supply air.

D. Heating element assemblies shall consist of two or three corrosion resistant steel sheathed elements, mechanically bonded to common corrosion resistant steel fins. Elements shall be helically coiled nickel chromium alloy resistance wire completely embedded in and surrounded

by magnesium oxide, enclosed and swaged into corrosion resistant steel sheaths. Elements shall have no more than 60 watts per inch.

E. Heaters shall be equipped with a zero voltage reset thermal overload, which disconnects the motor and elements should normal operating temperatures be exceeded. Provide with manual reset.

F. Provide with integral, tamper proof, low voltage thermostat.

G. Units shall be U.L. listed with integral disconnect switch, and be manufactured by Markel, Raywall, or Berko.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling 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 wall and ceiling heater installation.

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

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly.

B. Install wall and ceiling heaters to comply with NFPA 90A.

C. Suspend wall and ceiling heaters from structure with threaded rod.

3.3 CONNECTIONS

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

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 ADJUSTING

A. Adjust initial temperature set points.

END OF SECTION 23 5543

SECTION 237200

PACKAGED ENERGY RECOVERY VENTILATION UNITS

PART 1 - GENERAL

1.1 DOCUMENT INTENT

A. This specification is intended to provide product and performance requirements for all energy recovery units supplied on Cherokee County Schools projects. All outside air and exhaust air shall be routed to/from an ERU in compliance with this specification unless prior approval for an alternative has been provided by Forsyth County Schools.

1.2 SUMMARY

A. Section Includes:
   1. Packaged energy recovery ventilation units, including required controls interface.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For packaged energy recovery ventilation units. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which equipment or suspension systems will be attached.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged energy recovery ventilation units to include in 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. Filters: One set of each type of filter specified.
   2. Fan Belts: One set of belts for each belt-driven fan in energy recovery units.
   3. Wheel Belts: One set of belts for each heat wheel.

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. ARI Compliance:
   1. Capacity ratings for packaged energy recovery ventilation units shall comply with ARI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."
   2. Capacity ratings for air coils shall comply with ARI 410, "Forced-Circulation Air- Cooling and Air-Heating Coils."

C. ASHRAE Compliance:
   1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
   2. Capacity ratings for packaged energy recovery ventilation units shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

E. UL Compliance:
   1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators."
   2. Electric coils shall comply with requirements in UL 1995, "Heating and Cooling Equipment."

1.8 COORDINATION

A. Coordinate layout and installation of packaged energy recovery ventilation units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

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

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY, STARTUP AND TRAINING

A. A full Parts & Labor warranty shall be provided by the manufacturer for a period of 12 months from start-up. The manufacturer shall agree to replace/repair, within warranty period, components with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required provided manufacturer's instructions for handling, installation, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to defects and failures and does not include filters, belts or fuses. Warranty includes all parts, labor & travel during the warranty period.

B. Units shall be started-up by Manufacturer factory personnel – not an authorized representative of the factory. Complete start-up documentation shall be sent to the County after the job is completed. A minimum of two days training will be required for County personnel after the job is complete. Manufacturer to provide factory direct (direct employee of the manufacturer) service personnel within 100 miles of the site.

C. Compressor warranty shall include parts for a period of 5 years

PART 2 - PRODUCTS

2.1 PACKAGED ENERGY RECOVERY VENTILATION UNITS

A. Manufacturers: Subject to compliance with requirements, Trane Horizon, and AnnexAire.

B. Quality
1. Sizes, arrangements, capacities and performance shall be as indicated on plans and schedules. Unit manufacturer shall be registered under ISO 9001. Coil performance shall be rated in accordance with ARI standards. Unit shall be ETL listed. Units shall be factory pre-assembled, tested and shipped complete with all components necessary to maintain humidity control levels independent of load variations within design limits. Unit(s) shall be designed for year-round 24 hr/day service.

C. Desiccant Wheel:
1. The desiccant wheel media shall be a monolithic, extended-surface contact medium, fabricated entirely of inert, inorganic binders and glass fibers formed into narrow passages in the

direction of airflow. The wheel shall be non-toxic. The process and reactivation air streams shall be separated by air seals and internal partitions so that the humid reactivation air does not mix with the dry process air. Suppliers who do not manufacture their own desiccant wheel, shall provide a five year parts and labor warranty for the wheel and carry stock sufficient to ship replacements within 24 hours. The proposed equipment shall meet the following minimum requirements:

a. Wheel Face Seals: The dehumidifier shall have full-face seals on both the process air entering and the process air leaving sides of the wheel. These shall seal the entire perimeter of both air streams as they enter and leave the wheel. Partial seals shall not be acceptable. The seals shall be the silicone rubber bulb-type, with a protective strip of low-friction, abrasive-resistant surface to extend seal life and reduce the force needed to turn the desiccant wheel. Neither wiper-type seals nor brush-type nor any non-contact-type seal shall be acceptable for the desiccant wheel. The seals shall be documented to have a minimum working life of 25,000 hours of normal operation.

b. Materials: The glass fibers which form the support matrix shall be made from uniform continuous strands larger than five microns in diameter which are non-respirable and are not considered a possible health risk by the International Agency for Research on Cancer (IARC).

c. Flame spread and smoke generation: The wheel shall be tested according to ASTM E84-90 (Standard Test Method for Surface Burning of Building Materials) and shall achieve the following results:
   1) Flame spread index = 0
   2) Smoke developed index = 10

d. Desiccant impregnation: The desiccant shall be evenly impregnated throughout the structure for predictable, consistent performance and for maximum wheel life. Coatings applied on top of the contact medium shall not be acceptable unless the manufacturer can provide independent life tests demonstrating less than a 5% decline in desiccant capacity over a five year period of normal operation.

e. Desiccant type: The desiccant material used in wheels of DryCool ERV units shall be Type III Brunauer isotherm desiccant. The desiccant impregnated into the contact medium shall be a titanium-reinforced silica gel. The HoneyCombe® desiccant wheel shall be a fabricated extended surface contact media with a multitude of small passages parallel to the airflow. The rotary structure shall be a monolithic composite consisting of inert silicates with microscopic pores designed to remove water in a vapor phase. The desiccant shall be hydro thermally -stabilized silica gel reinforced with titanium for maximum strength and stability over time. The fabricated structure shall be smooth and continuous having a depth of between 125 and 200 millimeters in the direction of airflow without interruptions or sandwich layers which restrict air flow or create a leakage

path at joining surfaces. Nominal face velocity shall not exceed 1000 fpm. The HoneyCombe® wheel shall be manufactured in the United States. The manufacturer shall provide documentation to establish that:

1) The desiccant retains more than 90% of its original capacity after ten years of continuous operation in clean air, with inlet air conditions up to an including 100% relative humidity.
2) The wheel as impregnated with silica gel is capable of withstanding five complete water immersion cleaning cycles while retaining more than 95% of its original adsorption capacity.

D. Desiccant Wheel Support and Drive Assembly
   1. Desiccant wheels 60" in diameter and smaller shall be a single piece for fast removal and simple handling. Larger wheels shall be segmented and allow for each segment to be removed individually. In addition, the wheel drive assembly shall provide:
      a. Rotational speed: To avoid excessive heat carryover from reactivation to the process air, the wheel rotation speed shall not exceed 10 rph while achieving the required moisture removal rate at the specified conditions.
      b. Drive Belt: ERVc-8026 and smaller units shall use a polymer composite V-belt with link closure such that the belt can be changed without removing the wheel. ERVc-1026 units and larger shall use direct-drive wheels.
      c. Drive motor: The drive motor shall be fractional horsepower and rated for continuous duty for a period of 20,000 hours under the load conditions imposed by the drive assembly.
      d. Rotation detection: The drive assembly shall be equipped with a rotation detection circuit which shuts down the dehumidifier and signals the operator through an alarm if the wheel is not rotating.

E. Direct Expansion (DX) Cooling Coils
   1. Coils shall be sized to provide the full capacity scheduled. Coils shall be arranged to condition the full volume of process air. Refrigerant pressure drop to be between 1.5 psi and 5 psi, and air face velocities shall be 450 fpm or less. Coil circuiting provides for optimum performance with minimum pressure loss. Coil shall be designed for 600 PSI working pressure and factory tested under water at 600 PSI air pressure.
   2. Direct expansion cooling coils are round-tube, plate-fin type constructed of seamless, smooth-walled copper tubes and .006 inch thickness aluminum fins mechanically bonded to tubes. Casing and tube support sheets are 16 gauge galvanized steel formed to provide mounting flanges and structural support for the fin-tube assembly. Supply headers consist of an expansion valve and distributor to feed liquid refrigerant through copper tubing to all circuits in the coil equally. Tubes are circuited to insure minimum refrigerant pressure drop and maximum heat transfer. Fin spacing of up to 12 FPI provides adequate transfer area to minimum air pressure drop. Direct expansion coils are rated in

accordance with ARI Standard 410 and are compatible with all other components of the same refrigeration circuit.

F. Drain Pans
1. The drain pan is to be constructed of welded 304 SS and bolted in place. The cooling coil drain pan shall extend the entire length of the coil and extend a minimum of 4 inches beyond the air leaving side of the coil. The drain pan shall be double-sloped to ensure zero standing water. Drain connection shall extend through unit base.
2. Each unit shall be provided with a secondary drain pan installed below the unit.
The drain pan shall be installed tight to bottom of duct directly below the footprint of the unit. Drain pan shall be provided with overflow switch. Overflow switch shall tie into unit controls and disable unit if water level in drain pan activates overflow switch. Drain pan shall be constructed of welded 304 SS.

G. Condensing Section
1. Refrigeration system is complete with compressors, condenser heat exchangers, and all controls and accessories required to regulate refrigerant pressure, flow rates and temperatures. The condensing unit is piped together with the evaporator coil and is sized and controlled to operate at all conditions required. The refrigeration equipment shall be capable of operation down to an ambient temperature of 50°F.
2. Compressors are scroll type. Service Access shall be provided around the entire compressor for maintenance. Each compressor shall have its own refrigeration circuit and expansion valve. Tandem compressors sets are not acceptable.
3. Condenser heat exchanger shall be sized to reject the heat absorbed by the evaporator coil and the work of compression at a low delta T relative to ambient to enhance efficiency. Coil circuiting provides for optimum performance with minimum pressure loss. Coil shall be round tube, plate-fin, or microchannel design. Coil shall be designed for 600 PSI working pressure and factory tested under water at 600 PSI air pressure.

H. Weather Protection (Outdoor Units)
1. The dehumidification system shall be capable of continuous outdoor operation. The air inlets shall be protected from water entry by hoods, louvers, mist eliminators or connected duct work. Consequently, all access panels shall be weather tight, as shall all joints between casing and electrical conduits and between the unit casing and any components mounted in separate enclosures. The roof shall be fabricated using a capped standing seam or single piece style construction.
2. The unit cabinet shall be constructed so as not to allow water intrusion up to negative 4” W.C.

I. Fans

1. Fans provide the specified air volume(s) through the system with adequate static pressure to overcome duct and distribution losses specified.
    a. Fan Blowers: Supply blowers shall be belt-driven DWDI BIA or SWSI BIA. Exhaust blowers shall be SWSI BIA. React fan shall be belt-driven DWDI Forward curve. Access shall be provided to all blowers for inspection and servicing. All fans shall be rated in accordance with AMCA Standard 210.
    b. Fan Isolation: DWDI fans shall use rubber-in-shear isolation. SWSI fans shall use 1" spring isolation.
    c. Fan Balancing: Fans shall be balanced such that the maximum displacement in any plane does not exceed 1.5 mils for fans operating at or below 2000 rpm or 1.0 mils for fans operating above 2000 rpm.
    d. Premium Efficiency Fan Motors: Supply, exhaust, and reactivation fan motors shall be the totally-enclosed fan-cooled (TEFC), NEMA premium efficiency type with a minimum of Class F insulation on units with three-phase power.

J. Filters
1. The unit shall include disposable filters with 25% to 30% minimum efficiency with 90% to 92% arrestance minimum as rated by ASHRAE Test Standard 52-76. The filters shall be removable at the inlet of both supply and reactivation air streams. These filters shall be mounted on sliding or lift racks and accessible through access or doors. The entire supply and reactivation air stream shall be filtered.

K. Electrical Control Cabinet
1. The electrical control cabinet shall be weather tight to NEMA 3R standards and shall include:
    a. Wiring to comply with the current National Electrical Code with further fuse and wiring sizing to meet or exceed UL 508A Industrial Control Panel.
    b. Wires shall be color-coded or numbered at both ends and all terminal block connection points shall be numbered. These markings shall correspond with the electrical diagram provided in the operating and maintenance manual.
    c. Components shall be UL, ETL or CSA approved where possible.
    d. Operating and maintenance manual: The control cabinet shall include a copy of the O & M manual, mounted in a separate compartment or pocket to allow access to critical information by maintenance personnel after installation.
    e. All units shall come with a non-fused means of disconnecting the unit power.

L. Controls
1. The unit shall have microprocessor control. Units with a microprocessor shall be capable of communicating with a building management system (BMS) through Native BACnet protocol. Control options include the ability to determine stages of heating

and dehumidification required to maintain space conditions when an "enable" command is given via the BMS or remote panel.

M. Indirect Fired Post Heaters
1. Heater shall conform to ANSI Z83.8. Unit shall be suitable for operation on natural gas or propane as specified. Unit shall be of down blast or horizontal configuration. Unit shall have an input rating of 100, 150, 200, 250, 300, or 400 MBH at full fire and shall be 4:1 turndown modulating output. Where input is greater than 400 MBH multiple heaters shall be used. It shall contain tube type heated exchangers, flue gas collector with vent fan, in shot burners, and controls for high and low fire. Unit shall be un-housed and fit within the unit housing envelope dimensions.
2. Burners shall be die formed in shot type. Burners must be individually removable for cleaning or service. Entire burner assembly must be easily removable as an assembly.
3. Unit shall have a powered venting system consisting of a collection box, direct drive vent fan and an air proving switch. The collection box shall be made of the same material as the heat exchanger bulkhead plate and shall be removable. The venting fan bearings shall have a minimum L10 bearing life of 24000 hrs. The vent fan shall exhaust the flue gas horizontally out the side of the unit. The unit fan shall operate on 120/1/60 and not exceed 2 FLA.
4. Tubes shall be permanently attached to a bulkhead plate to form an airtight seal between combustion byproducts and heated air system. Heat exchanger shall be constructed completely stainless steel. Heat exchanger shall be rated for a minimum lifespan of 100,000 cycles.
5. Gas train shall utilize components certified by AGA. Gas train shall consist of a 24 VAC two stage combination valve (manual on-off, automatic safety shutoff, regulation to handle 0.5 psig input pressure and adjustable pilot valve). The combination valve shall be rated at a flow of 400 MBH. The valve shall feed in shot burners through a manifold with screw in brass orifices sized for either natural gas or propane, as required by unit schedule. The flame controllers shall be solid state module that operates on 24 VAC. It shall have a built in spark igniter and flame sensor with 100% gas shutoff. The pilot shall be ignited during each cycle of operation. After the pilot is proven, the main burner valve shall open. Pilot and main burners shall be extinguished during the off cycle. The thermal disc type high temperature limit switch shall shut off the main and pilot valves if an overheat occurs.

N. Unit Base
1. Unit base shall be bolted steel construction with formed heavy gauge galvanized steel channels around the outside perimeter and reinforced with galvanized steel cross members bolted on centers not exceeding 31 inches. Base shall have a minimum of four lifting brackets.

O. Unit Structure

1. The unit casing shall be constructed using a double wall panel and frame system for torsional rigidity. This includes walls, floors and ceilings. This system shall not contain any through metal. The unit casing shall also meet the following criteria based on ASTM E84-90 (Standard Test Method for Surface Burning of Building Materials), flame spread = 25, smoke index = 50.
2. The frame system components shall be constructed of fiberglass reinforced plastic (FRP) pultruded members. Horizontal frame members shall be supported along their length by intermediate supports and internal partitions. Through metal systems shall not be allowed. To avoid condensation, heat loss or loss of cooling capacity, each panel shall be 2 inches thick and constructed such that there are no through metal connections between the exterior surface and the interior surface. The interior casing shall be 22-gauge galvanized steel. The exterior casing shall be 22-gauge corrosion resistant galvalume. Manufacturers not providing exterior galvalume construction must provide painted galvanized exterior panels. Painted coating must be corrosion resistant exceeding ANSI 2000 hour salt spray standards. Panels shall be foam injected into individual panels with a density of 2-1/2 lb/ft^3. The heat transfer rate through casing walls shall be less than 0.0625 Btu/sq. ft./°F equivalent to an R-value of 14. This construction shall be suitable for a 50°F difference as tested between process air dry bulb temperature and the dew point of the air surrounding the plenum. The unit casing shall be manufactured as an air and vapor tight system. There shall be a gasket system which seals the panels to the structure. Fixed panels shall be provided with flat closed cell neoprene and be sealed in place with FDA approved silicon. Doors and plug panels shall be provided with polyvinyl chloride seals.

P. Access Doors and Panels
1. Access doors or plug panel doors shall be provided. Doors shall be hinge access (tool less). Doors shall be rigid double wall construction and shall use heavy-duty hinges with lockable latches on each door. Doors shall be a minimum of 15” in width. Doors shall be of the same construction as panels. Door latches shall be capable of being fully tightened against gasket surfaces. All major components such as coils, filters, blowers, etc., within the air handling structure shall be easily removable through access panels without dismantling plenums or distributing ductwork. Equipment that requires disassembly of components rather than access through removable or hinged panels shall not be acceptable. The unit casing shall include access panels for inspection and for any maintenance required by the operating and maintenance manual. Panels without gaskets shall not be acceptable.

Q. Recirculation/Bypass Damper
1. Provide recirculation damper for operation in unoccupied mode.

R. Characteristics
1. Outside Air:

a. Summer (High Sensible)
   1) Entering-Air Temperature, Dry Bulb: 95 deg F.
   2) Entering-Air Temperature, Wet Bulb: 75 deg F.
b. Summer (High Latent)
   1) Entering-Air Temperature, Dry Bulb: 82 deg F.
   2) Entering-Air Temperature, Wet Bulb: 77 deg F.
c. Winter
   1) Entering-Air Temperature, Dry Bulb: 10 deg F.

2. Exhaust Air:
   a. Summer:
      1) Entering-Air Temperature, Dry Bulb: 75 deg F.
      2) Entering-Air Temperature, Wet Bulb: 63 deg F.
   b. Winter:
      1) Entering-Air Temperature, Dry Bulb: 68 deg F.
      2) Entering-Air Temperature, Wet Bulb: 52 deg F.
3. Supply Air:
   a. Summer:
      1) Leaving-Air Temperature shall be between, Dry Bulb: 78-70 deg F.
      2) Leaving-Air Humidity Ratio: 45 grains/lbs.
   b. Winter:
      1) Leaving-Air Temperature, Dry Bulb: 75 deg F.
4. Space Design Condition:
   a. Occupied:
      1) Space-Air Temperature, Dry Bulb: 75 deg F.
      2) Space-Air Relative Humidity: 50 %

2.2 CONTROLS

A. Manufacturer provided controls
   1. Provide Native BACnet via MS/TP or IP Protocol to allow for the Building Automation System (BMS) to monitor, enable and disable unit operation.
   2. Provide all required sensors and components required for independent control of the unit to meet all control parameters without control input from BMS.
   3. Unit shall be provided with a digital display for diagnostic and service use.
   4. Unit manufacturer shall work with the ALC Controls to coordinate interface and control of these units.

B. Building Automation System (BMS)
   1. Unless noted otherwise, and except as indicated for packaged equipment to be controlled by equipment manufacturer, all controls shall be provided and installed under this contract by ALC Controls.

PART 3 - EXECUTION

3.1 UNIT CONTROL SEQUENCE

A. Unit Control Overview
1. The ERU is intended to provide an economical way to control the space dew point while delivering room neutral supply air.
2. The ERU shall include a digital compressor with variable capacity to allow for supply air control.
   a. The unit will operate to dehumidify the supply air to maintain the *space* dew-point and limit supply dry bulb temperature. Space feedback can be onboard space sensor or BMS space data. Space dew-point setpoint is defined by the end user and can be changed through BMS. Supply dew-point is a calculated value from the unit microprocessor. Unit *shall* be constant airflow. Duct mounted sensors shall be provided by the manufacturer for control.
3. The enthalpy wheel will rotate if the system is operating in the occupied mode and the outside air is warmer than 75°F (adjustable) or the dew point is greater than 51°F (adjustable) or in the heating mode (if the outside air is below 55°F, adjustable). Units with optional freeze protection will modulate the enthalpy wheel motor to maintain at least a 33°F exhaust leaving air temperature to prevent frosting.
4. In the dehumidification mode, the process air leaving the enthalpy wheel is first pre-cooled and dehumidified using a single stage of direct expansion refrigeration. This cooler and dryer air is then passed through a regenerative desiccant wheel to further reduce the moisture content and reheat the air to a neutral level. The desiccant wheel's ability to absorb moisture is regenerated with a separate air stream that is heated with the waste heat from the refrigeration reactivation condenser of the same direct expansion system. If the supply air temperature or humidity is higher than setpoint, then additional stages of direct expansion refrigeration will be turned on to assist in removing moisture from the air stream. The additional stages include a compressor which has variable capacity and will be modulated to maintain the supply air dew-point and temperature at or below setpoint, within its capacity.
5. In cooling only mode, the desiccant wheel is turned off.
6. Heating the supply air is accomplished with a modulating gas fired burner, hot water, or electric heat to maintain the supply air temperature set point.
7. A VFD shall be provided on the supply, reactivation and exhaust fans. A VFD can be added to the supply fan for variable airflow. Where not actively controlled, the VFD shall be used for airflow balancing.

B. BMS Control
1. The BMS shall be able to enable the unit, change status from occupied to unoccupied, and modify the adjustable set points

listed in the sequence to customize the control and behavior of the unit. If no space sensor is ordered or installed, the BMS can write the space temperature and humidity information to the corresponding BMS points.

C. Unit Operation
1. Once an operating mode is selected by the building automation system or the unit keypad/display, the Supply Fan will start. After air flow is proven, the unit will operate autonomously as described below:
   a. Dehumidification**:** If the dew-point of the air entering the DX coil is higher than the supply air dew-point setpoint, then the unit will enter dehumidification mode. Unit microprocessor will stage internal components to deliver air at or below setpoints. During dehumidification, if supply air dry-bulb temperature gets too warm, even if the supply dew-point is being met, the variable compressor capacity will be increased to lower the supply air temperature. However, this will consume additional energy and the leaving air dry-bulb limit cannot be set below 72°F.
   b. Cooling**:** If the dew-point of the air entering the DX coil is lower than the supply air dew-point setpoint and the temperature is greater than the leaving air dry-bulb setpoint, then the unit will enter cooling mode. Unit microprocessor will stage internal components to deliver air at the supply air dry-bulb setpoint. For units without space feedback, this air will be at the same setpoint as during DH, with a minimum of 72° F. Units with space feedback may deliver cooler air if the space temperature is above setpoint.
   c. Heating**:** If the ambient temperature is below 55°F (adjustable), then heating will be enabled. For units without space feedback, the heater will be modulated to maintain 85°F (adjustable). Units with space feedback may deliver warmer or cooler air as dictated by space conditions.

D. Alarms
1. Critical Alarms(require reset, unit shutoff)
   a. Supply air flow
   b. Exhaust air flow
   c. Reactivation air flow
   d. Supply fan motor overload fault
   e. Exhaust fan motor overload fault
   f. Reactivation fan motor overload fault
   g. Smoke
   h. Heat fail & Supply Air Temp < 55°F
2. Non-Critical Alarms(require reset)
   a. DH Wheel motor overload
   b. DH Wheel rotation
   c. Low suction pressure: Comp. A
   d. High discharge pressure: Comp. A
   e. Low differential pressure: Comp. A
   f. Enthalpy Wheel rotation
   g. Enthalpy Wheel motor fault

h. Low suction pressure: Compressor B
i. High discharge pressure: Compressor B
j. Low differential pressure: Compressor B
k. Sensors

3. Alarm Notes
   a. All resettable alarms can be reset through the BACview display or BMS.
   b. If the alarm persists after resetting it, the root cause remains.
   c. The sensor alarms cannot be reset, as the sensor is reading out of the expected range. The sensor must be put into range to clear the alarm.
4. Control ALC controls shall be capable of through BACnet interface:
   a. Enable/disable the unit
   b. Read and adjust evaporator discharge temperature
   c. Read and adjust unit discharge temperature (Heating, Cooling and Dehumidification)
   d. Read the temperature and humidity of the air at the following locations:
   e. Supply side: Below energy wheel, after energy wheel, before evaporator, after evaporator and leveling unit after the heating section.
   f. Return side: Entering unit from building, before energy wheel and after energy wheel.
   g. Compressor status
   h. Fans status
   i. Enable/disable recirculation mode
   j. Filter status
   k. Heating status

3.2 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before packaged energy recovery ventilation unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

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

3.3 INSTALLATION

A. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.

1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.

B. Install gas-fired furnaces according to NFPA 54, "National Fuel Gas Code."

C. Install ground and floor mounted units on 6-inch-high concrete base.

D. Equipment Mounting:
1. Install packaged energy recovery ventilation units on cast-in-place concrete equipment bases designed by a Registered Structural Professional Engineer for the specific application.

E. Roof Curb: Install packaged energy recovery ventilation units on curbs and coordinate roof penetrations and flashing with roof construction. Secure packaged energy recovery ventilation units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

F. Unit Support: Install unit level on structural support. Coordinate wall penetrations and flashing with wall construction. Secure packaged energy recovery ventilation units to structural support with anchor bolts.

G. Install units with access and clearances for service and maintenance.

H. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

I. Pipe drains from drain pans to nearest floor drain; use ASTM B 88, Type L, drawn-temper copper water tubing with soldered joints, same size as condensate drain connection. Where units are outside, pipe condensate to designed French drain.

J. All exterior ductwork shall be double wall, internally lined, and shall be sealed with weatherproof elastomeric coating. Install such that no “ponding” of water can occur on the ductwork.

3.4 CONNECTIONS

A. Install duct and piping adjacent to unit to allow service and maintenance.

B. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

C. Gas piping serving the unit shall be designed by a Registered Professional Engineer. Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service.

D. Install electrical devices furnished with units but not factory mounted. Electrical service to unit shall be designed by a Registered Electrical Professional Engineer.

3.5 FIELD QUALITY CONTROL

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

C. Tests and Inspections:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Adjust seals and purge.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   4. Set initial temperature and humidity set points.
   5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Packaged energy recovery ventilation units will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Engage Manufacturer factory personnel to train County's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

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SECTION 237313

MODULAR INDOOR AIR-HANDLING UNITS

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 air handing units rated for 800 CFM or greater, and accessories.

1.3 DEFINITIONS

A. BAS: Building automation system.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
   1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

D. Warranty: Special warranty specified in this Section.

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.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Motor, Fan and Drive Failure
      b. Coil Leaks
      c. Casing air leaks
   2. Warranty Period: One year from date of Substantial Completion.

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. Fan-Coil-Unit Filters: Furnish three spare filters for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of design: Trane.

B. Approved Manufacturers: Carrier Model 39 Series

2.2 GENERAL

A. Factory assembled, single-piece central station air-handler with frame and panel construction. Unit shall consist of a fan and coil section with factory-installed chilled water coil and hot water coil, and filter section. Unit base rail shall be minimum 14 gage galvanized steel.

B. Unit layout and configuration shall be as defined in project plans and schedule.

C. Provide unit mounting 12” equipment rails to support all sections of unit and raise unit for proper trapping. Contractor shall be responsible for providing a housekeeping pad when unit mounting device is not of sufficient height to properly trap unit. Unit mounting devices not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel.

D. All internal wiring shall be encased, the entire length, in liquid-tight flexible conduit or “SO” rated cable. See division 16000 for flexible

conduit requirements. Conductors shall not be exposed at starter or motor connections. Wiring penetrations of unit and internal component casing panels shall be sealed air tight with rubber grommets.

E. Unit Mockup: Completely install four (4) air handling units including piping, electrical, and ductwork for approval by owner before installing other units. Two of the units shall be next to each other and the other two shall be directly across mechanical platform. All unit clearances shall be maintained as well as the walk path on the mechanical platform.

2.3 UNIT CASING

A. Unit panels shall be constructed wall galvanized steel and shall be capable of withstanding 375-hour salt spray test per ASTM Standard 117. The unit panels shall not exceed 0.005 inch deflection per inch of panel span at 6 inches w.g. positive or negative static pressure

B. Casing panels shall be removable for easy access to the unit. All access panels shall be double-wall with neoprene gasket to ensure a tight seal.

C. Doors shall be double wall with insulation between galvanized steel panels. Access doors for motor, fan, drive and filter sections shall be hinged. Access panels shall be on both sides of the unit. Provide quarter handles that do not require special tool for each door.

D. Insulation for casing panels on unit shall be 2-in. minimum thickness, min. R-13 injected foam.

E. Condensate drain pans shall be sloped to prevent standing water and constructed of stainless steel; they shall have double wall construction with threaded drain connection.

2.4 FAN SECTION

A. Fan sections shall be constructed of galvanized steel and shall have a formed channel base for integral mounting of fan, motor, and casing panels. Fan scroll, wheel, shaft, and bearings are to be rigidly secured to the base unit.

B. The fan assembly shall be a nine-blade, single width, single inlet, direct-drive plenum fan with high efficiency welded-aluminum impeller that is dynamically balanced as an assembly. Fan shall be maintenance free throughout its operating life. Fans shall be balanced to G6.3 per AMCA 204. No vibration isolation is necessary. Access to motor and fan assembly through hinged access door. Access door shall be sized for removal of entire motor and fan assembly. Motor contains integrated PID controller and accepts 0-10VDC input for variable speed control.

C. Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected to operate at least 25% below the first critical speed, and shall be statically and dynamically balanced as an assembly.

D. Maximum discharge air velocity out of the fan shall not exceed 1800 feet per minute.

E. All fans, shall be internally isolated to inhibit noise and vibration through the ductwork and building structure. A flexible connection shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements.

2.5 MOTORS AND DRIVES

A. Fan Motors shall be heavy duty, open drip-proof design.

B. Manufacturer shall provide for each fan a nameplate with the following information to assist air balance contractor in start up and service personnel in maintenance:
   1. Fan part number
   2. Fan and motor bushing part number
   3. Fan design RPM and motor HP
   4. Center distance between shafts

2.6 COILS

A. All coils shall have mill galvanized casings. Coils shall be factory leak tested at 450 psig air pressure.

B. Chilled water coils shall have aluminum plate fins with belled collars bonded to 1/2 -in. minimum OD copper tubes by mechanical expansion. Coils shall have galvanized steel casings and copper headers with threaded steel pipe connections. Working pressure shall be 300 psig at 200 F. Coils shall be drainable and have non-trapping circuits. No turbulence-promoting devices will be permitted inside the tubes. Headers shall have drain and vent connections.

C. Hot water coils shall have aluminum plate fins with belled collars bonded to copper tubes by mechanical expansion. Coils shall have galvanized steel casings and copper headers with threaded steel pipe connections. Working pressure shall be 175 psig at 400 F. Headers shall have drain and vent connections. Each unit shall be provided with factory installed motor current overload protection, fused line voltage to 24 volt transformer three pole fan contactor and customer terminal strip.

2.7 BASE-LEVEL DRAIN PANS

A. Insulation shall be encased between exterior and interior walls. Units with cooling coils shall have drain pans under complete cooling coil section that extend beyond the air-leaving side of the coil to ensure capture of all condensate in section. Cooling coil drain pans shall be sloped in 2 planes, pitched toward drain connections to ensure complete condensate drainage when unit is installed level and trapped per manufacturer's requirements. All drain pans shall be constructed of stainless steel.

B. Units with heating coils shall have a drain pan under complete heating coil section sloped in 2 planes and pitched toward drain connections to ensure proper drainage during cleaning and to capture water in the event of a coil failure.

C. All drain pan connections supplied by unit manufacturer including, piping, and piping connections extending from stainless steel drain pans shall be constructed of stainless steel. The contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.

D. Flat drain pans shall be acceptable in sections that may have incidental, but not continuous contact with moisture. Flat drain pans shall be accessible for cleaning.

2.8 FILTERS

A. Each filter section shall be designed and constructed to house the specific type of filter specified on the equipment schedule.

B. Flat filter sections shall accept filters of standard sizes. Sections shall include side access slide rails and hinged door access. Flat filter section shall be arranged with minimum depth in direction of airflow.

C. Angle filter section shall accept 2-in. filters arranged in horizontal V formation. Double-walled hinged doors shall be provided.

D. Manufacturer shall provide one set of startup filters.

2.9 FAN STARTER / CONTACTOR

A. A starter shall be provided for each fan motor. Each starter shall be properly sized, factory mounted, and wired to the fan motor to facilitate temporary heating, cooling, ventilation, and/or timely completion of the project. Cover mounted controls shall include a Hand-Off-Auto switch and a reset button. Also include fused control

transformers, one N.O. auxiliary contact, and manual reset overloads. All wiring internal to unit shall be "S0" rated cable or equal.

B. Unit provided disconnects shall be located on the side of the unit and that can be accessed by personnel standing on the floor.

2.10 CONTROLS

A. Each unit shall be provided with an ALC controller provided by ALC Controls. Control module shall be provided by the controls contractor. The controller shall be factory or field installed and wired to the air handling unit. The controller shall be wired to all internal components which are to be controlled by ALC Controls. The unit's transformer shall be sized to handle the ALC controller or a separate transformer shall be provided for the ALC controller by the air handling unit manufacturer. The air handling unit manufacturer shall coordinate exact capabilities for their unit with ALC Controls.

B. The supply air temperature sensor shall be located 24" after the first elbow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive air-handling units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

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

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.

D. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Install piping adjacent to machine to allow service and maintenance.
   2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.

B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 15 Section "Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Division 16 Section "Grounding and Bonding."

D. Connect wiring according to Division 16 Section "Conductors and Cables."

E. Electrical System Connections: Comply with applicable requirements in Division 16 Sections for power wiring, switches, and motor controls.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer’s field service: Engage a factory-employed service representative to inspect components, assemblies, and equipment installations, including connections and to assist in testing. 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. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
   3. Remove and replace malfunctioning units and retest as specified above.

B. During construction unit filters shall be periodically changed while the unit is in operation. This shall include unit filter as well as a filter media to be placed over the return grilles. The unit filter and filter media shall be dated at each replacement. If the ductwork or evaporator coil becomes dirty, the contractor shall clean the ductwork and coil. The contractor shall provide the owner a letter stating that all coils have been inspected and are clean at Substantial Completion.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 1 Section "Demonstration and Training."

3.6 SYSTEM ACCEPTANCE

A. Reference section 01770 for general requirements.

3.7 CLOSEOUT DOCUMENTATION

A. Properly completed start-up forms, including equipment marks and serial numbers, documenting proper field quality control and demonstration shall be received by the Owner prior to granting of substantial completion.

END OF SECTION 237313

SECTION 237314

FAN COIL UNITS

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 fan-coil units for horizontal installation above ceilings, and accessories.

1.3 DEFINITIONS

A. BAS: Building automation system.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
   1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

D. Warranty: Special warranty specified in this Section.

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.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Motor, Fan and Drive Failure
      b. Coil Leaks
      c. Casing air leaks
   2. Warranty Period: One year from date of Final Completion.

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. Fan-Coil-Unit Filter: Furnish three spare filters for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In the Fan-Coil-Unit Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
   1. Basis-of-Design Product: The design for each fan-coil unit is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 DUCTED FAN-COIL UNITS

A. Basis-of-Design Manufacturer: Trane, or a comparable product by one of the following:
   1. Carrier Corporation.

B. Fan coil units shall consist of chilled and hot water coils, condensate pan with float switch, direct drive fan, and filter enclosed in an insulated steel cabinet. Cabinet shall enclose entire assembly and include filter frame, supply, and discharge duct connection collars.

C. Coils shall be 0.006" aluminum fin type mechanically bonded to ½" O.D. copper tubes. Each coil shall have a manual air vent. Coils shall be leak tested at 350 PSIG and shall be suitable for 250 PSIG working pressure. Coils shall have copper sweat connections. Coils sections shall be provided up to 8 rows of cooling, and 2 rows of heating. Heating coil shall in the reheat position.

D. All internal wiring shall be encased, the entire length, in liquid-tight flexible conduit or "SO" rated cable. See Div. 26 for flexible conduit requirements. Conductors shall

not be exposed at starter or motor connections. Wiring penetrations of unit and internal component casing panels shall be sealed airtight with rubber grommets.

E. The fan assembly shall be a nine-blade, single width, single inlet, direct-drive plenum fan with high efficiency welded-aluminum impeller that is dynamically balanced as an assembly. Fan shall be maintenance free throughout its operating life. Fans shall be balanced to G6.3 per AMCA 204. No vibration isolation is necessary. Access to motor and fan assembly through hinged access door. Access door shall be sized for removal of entire motor and fan assembly. Motor contains integrated PID controller and accepts 0-10VDC input for variable speed control. Fan wheels shall be keyed to the shaft and shall be designed for continuous operation at the maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected to operate at least 25% below the first critical speed, and shall be statically and dynamically balanced as an assembly. Maximum discharge air velocity out of the fan shall not exceed 1800 feet per minute. All fans, shall be internally isolated to inhibit noise and vibration through the ductwork and building structure. A flexible connection shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements.

F. Cabinets shall be constructed of single wall galvanized steel. Internal liner shall be minimum 1/2" thick fiberglass insulation with cleanable facing. Cabinet panels shall be removable without affecting the structural integrity of the unit. Service access panels shall have quarter-turn fasteners.

G. Condensate drain pans shall be galvanized, insulated and internally coated with closed cell, fire-retardant foam insulation and equipped with an extension to collect condensate under valves and controls. Drain connection shall be a minimum of 7/8" OD, and shall be extended through the casing.

H. Filters section shall be a flat design for use with standard prefabricated 30% efficient throw-away type media units.

I. A fan starter relay shall be factory mounted and wired.

J. Unit provided disconnects shall be located on the side of the unit and that can be accessed by personnel standing on a 8 foot step ladder.

K. Fan coil units shall be of the size, capacity, and arrangement indicated on the drawings.

L. Unit Mockup: Completely install two (2) fan coil units including piping, electrical, and ductwork for approval by owner before installing other units.

M. Electrical Connection: Factory wire motors and controls for a single electrical connection.

N. Units shall be installed above the ceiling and supported with threaded rods. All sections of unit and raise unit for proper trapping. Unit shall be located high enough above the ceiling to all proper slope of the condensate pipe to the drain termination location. Unit shall be accessible from a step ladder. Unit mounting devices not

constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel.

O. All internal wiring shall be encased, the entire length, in liquid-tight flexible conduit or "SO" rated cable. See Div. 26 for flexible conduit requirements. Conductors shall not be exposed at starter or motor connections. Wiring penetrations of unit and internal component casing panels shall be sealed air tight with rubber grommets.

P. Each unit shall be provided with an ALC controller provided by ALC Controls. Control module shall be provided by the controls contractor. The controller shall be factory or field installed and wired to the air handling unit. The controller shall be wired to all internal components which are to be controlled by ALC Controls. The unit's transformer shall be sized to handle the ALC controller or a separate transformer shall be provided for the ALC controller by the air handling unit manufacturer. The air handling unit manufacturer shall coordinate exact capabilities for their unit with ALC Controls.

Q. The supply air temperature sensor shall be located 24" after the first elbow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

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

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Install unit with auxiliary condensate pan below unit with shutoff sensor that closes the units two or three way chilled water valve.

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.

E. Install new filters in each fan-coil unit within two weeks after Final Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Install piping adjacent to machine to allow service and maintenance.
   2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.

B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

E. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-employed service representative to inspect components, assemblies, and equipment installations, including connections and to assist in testing. 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. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

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

C. During construction unit filters shall be periodically changed while the unit is in operation. This shall include unit filter as well as a filter media to be placed over the return grilles. The unit filter and filter media shall be dated at each replacement. If the ductwork or evaporator coil becomes dirty, the contractor shall clean the ductwork and coil. The contractor shall provide the owner a letter stating that all coils have been inspected and are clean at Substantial Completion.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 1 Section "Demonstration and Training."

3.6 SYSTEM ACCEPTANCE

A. Reference section 01770 for general requirements.

3.7 CLOSEOUT DOCUMENTATION

A. Properly completed start-up forms, including equipment marks and serial numbers, documenting proper field quality control and demonstration shall be received by the Owner prior to granting of substantial completion.

END OF SECTION 237314

SECTION 238126

DUCTLESS SPLIT-SYSTEM HEAT PUMP 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. This Section includes split-system heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Diagram power, signal, and control wiring.
   1. Remaining paragraphs are defined in Division 01 Section "Submittal Procedures" as "Informational Submittals."

C. Operation and Maintenance Data: For split-system heat pump units to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units 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.
   1. LEED-NC Prerequisite EQ 1 requires compliance with requirements in ASHRAE 62.1-2004, including requirements for controls,

surfaces in contact with the airstream, particulate and gaseous filtration, humidification and dehumidification, drain pan construction and connection, finned-tube coil selection and cleaning, and equipment access. Verify, with manufacturers, availability of units with components and features that comply with these requirements.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
   1. LEED-NC Prerequisite EA 2 requires minimum efficiency equal to requirements in ASHRAE/IESNA 90.1-2004.

D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Heat pump."

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system heat pump units that fail in materials or workmanship within specified warranty period.
   1. Compressors shall be warranted for five years.
   2. Warranty Period: Remainder of unit one year from date of Substantial Completion and additional four years for compressor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Air Conditioning; Div. of Carrier Corporation.
   2. Mitsubishi Electronics America, Inc.; HVAC Division.
   3. Daikin.
   4. Trane

2.2 EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

1. Retain subparagraphs below to comply with LEED-NC Prerequisite EQ 1.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
3. Drain Pan and Drain Connection: Comply with ASHRAE 62.1-2004.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Fan: Direct drive, centrifugal fan.

D. Unit shall be wall or ceiling mounted ductless type fan-coil as scheduled with integral discharge deflection grilles, wall mounted controls, and easy to remove filters. Units shall be U.L. listed.

E. Interior of cabinet shall be insulated with 1/4 inch thickness fiberglass insulation. Cabinet shall include a condensate drain pan with anti-corrosion coating; die formed intake grille, permanent filter, and bi-directional discharge grille with auto-sweep feature.
1. Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add paragraphs below to suit Project.

F. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Special Motor Features: Multi-tapped, multi-speed with internal thermal protection and permanent lubrication.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
1. Compressor Type: Reciprocating.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
1. Retain first paragraph below for heat pump units.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Low Ambient Kit: Permits operation down to 45 deg F.

H. Mounting Base: Polyethylene.

I. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1-2004, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. 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.

D. Manufacturer’s recommended condensate pump kit

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounting, compressor-condenser components on 4-inch- thick, reinforced concrete base; 6 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 23 0548 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

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

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 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.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238126

SECTION 238127

SPLIT SYSTEM AIR CONDITIONER

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 split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2010, 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."

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

1.6 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: Compressor - Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Carrier Air Conditioning; Div. of Carrier Corporation.
   2. Trane
   3. Daikin

2.2 FAN-COIL UNITS

A. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
   1. Insulation: Faced, glass-fiber duct liner.
   2. Drain Pans: Galvanized steel, with connection for drain; insulated and complying with ASHRAE 62.1-2010.
   3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2010.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Heating Coil: Electric resistance coil having a U.L. listed certification, and complete with all operating and safety controls.

D. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

E. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

F. Disposable Filters: 1 inch thick, in fiberboard frames with ASHRAE 52.2 MERV rating of 6 or higher.

G. Wiring Terminations: Connect motor to chassis wiring with plug connection.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   1. Compressor Type: Reciprocating or Scroll.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Low Ambient Kit: Permits operation down to 45 deg F.

H. Mounting Base: Polyethylene.

I. Refrigerant:R-134a

J. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1-2004, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. 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.

2.5 GAS FURNACES

A. Provide a natural gas-fired, two-stage, condensing furnace complete with stainless steel heat exchanger, burner assembly, gas valve, induced combustion blower, variable speed evaporator blower with motor and matching cooling coil. Evaporator blower motor shall be ECM type. Unit shall be a minimum of 92% efficient and AGA Design Certified.

B. Heat exchangers shall be stainless steel construction with a minimum 10 year warranty.

C. Unit cabinet shall be galvanized steel with a baked enamel finish. Cabinet shall be 1-piece seamless, wrap around construction with no welds on exterior with foil faced insulation in heat exchanger section.

D. Furnace controls shall include intermittent ignition, redundant gas valve, solid state blower controls to activate blower after burner ignite, pressure switch.

2.6 FURNACE EVAPORATOR COILS

A. Cooling coils shall be seamless copper tubes mechanically boned to aluminum fins. Cools shall be sized to match condensing unit output and equipped with condensate drain pan. Coils shall be provided with thermostatic expansion valves and any additional accessories needed for proper operation and to meet the minimum efficiency requirements.

2.7 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounting, compressor-condenser components on 4-inch-thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

F. Unit shall be provided with electromechanical controls (24-volt terminal strip) for field installation of ALC controller.

3.2 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 unit to allow service and maintenance.

C. Duct Connections: Duct installation requirements are specified in Division 23 Section "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 Division 23 Section "Air Duct Accessories."

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

E. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

3.3 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.

3.4 DEMONSTRATION

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

END OF SECTION 23 8127

SECTION 238130

ROOFTOP UNITS

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. Division 23 Section "HVAC Instrumentation and Controls" for control wiring and control devices connected to energy recovery units.

1.2 SUMMARY

A. This Section includes the following rooftop air conditioners:
1. Cooling and heating units 6 tons and smaller.
2. Cooling and heating units 7-1/2 to 25 tons.
3. Cooling and heating units 30 – 40 tons.

1.3 DEFINITIONS

A. BAS: Building automation system

1.4 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

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. Prepare the following by or under the supervision of a qualified professional engineer:
1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For rooftop air conditioners to include in emergency, operation, and maintenance manuals.

D. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop air conditioners and are based on the specific system indicated. Refer to Division 1 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. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

D. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

F. Comply with NFPA 54 for gas-fired furnace section.

G. ARI Certification: Units shall be ARI certified and listed.

H. ARI Compliance for Units with Capacities Less Than 135,000 Btuh : Rate rooftop air-conditioner capacity according to ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment."
   1. Sound Power Level Ratings: Comply with ARI 270, "Sound Rating of Outdoor Unitary Equipment."

I. ARI Compliance for Units with Capacities 135,000 Btuh and More: Rate rooftop air-conditioner capacity according to ARI 340/360, "Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment."
   1. Sound Power Level Ratings: Comply with ARI 270, "Sound Rating of Outdoor Unitary Equipment."

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

C. Coordinate size, location, and installation of rooftop air-conditioner manufacturer's roof curbs and equipment supports with roof installer.

D. Coordinate installation of restrained vibration isolation roof-curb rails.

E. Duct mounted smoked shall be installed to be accessible from a 8 foot ladder except for in the Gymnasium and Cafeteria.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of rooftop air conditioners that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Final Completion.
   2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than five years from date of Final Completion.
   3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Final Completion.
   4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Final Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 ROOFTOP AIR CONDITIONERS

A. Manufacturers:
   1. Trane Company (The); North American Commercial Group.
   2. Carrier

B. Furnish and install factory assembled, piped and wired single package air conditioners of the type, size operational characteristics and capacity as shown and scheduled on the plans and as specified herein. Unit shall have gas heating section. **All units shall be equipped with a 100% modulating outside air economizer cycle.**

C. Casings:
   1. Unit shall be designed specifically for outdoor installation. All components including accessories shall be contained within the unit.
   2. 2. Unit shall be insulated with a minimum of one inch, one-pound density glass fiber insulation.

3. Access doors or plug panel doors will be provided as indicated on the drawings. Doors shall be hinge access (tool less) Doors shall be rigid double wall construction and shall use heavy-duty hinges with lockable latches on each door. Doors shall be of the same construction as panels. Door latches shall be capable of being fully tightened against gasket surfaces. All major components such as coils, filters, blowers, etc., within the air handling structure shall be easily removable through access panels without dismantling plenums or distributing ductwork. Equipment that requires disassembly of components rather than access through removable or hinged panels shall not be acceptable. The unit casing shall include access panels for inspection and for any maintenance required by the operating and maintenance manual. Panels without gaskets shall not be acceptable.

D. Compressor:
   1. Hermetic or semi-hermetic reciprocating or scroll compressors shall be provided with capacity reduction of a minimum of two steps.
   2. A crankcase heater shall be provided and wired to be active continuously.
   3. The compressors shall be provided with vibration isolators.
   4. Self-reversing oil pump shall provide positive lubrication regardless of rotation.
   5. Compressor shall receive a run-in test at the factory prior to installation into the rooftop units.
   6. Each compressor shall have a warranty covering parts failure for a period of five years.

E. Refrigerant circuit:
   1. Coils shall be constructed of copper tubes mechanically bonded to aluminum fins. It shall be tested for leaks at 300 psig pressure prior to installation within the unit. Expansion valve and filter drier shall be factory installed.
   2. The evaporator coil shall consist of separate refrigerant circuits with individual thermal expansion valves. Provide liquid line sight glasses and filter dryers. Each circuit shall have separate refrigerant controls.
   3. Refrigeration controls shall include a minimum high- and low-pressure control, compressor winding thermostat and overload, lockout circuit resetable at the unit thermostat, contactors for condenser/evaporator fans and compressor, and control power transformer.
   4. Condenser fans shall be direct driven propeller type using three phase motors.

F. Heating Section: This section shall include a tubular natural gas fired heat exchanger made of stainless steel. The design shall be AGA certified specifically for outdoor applications downstream from refrigerant cooling coils. The heat exchanger shall include AGA certified burner and gas train controls using direct spark ignition.

G. Evaporator Fan: Evaporator fan shall be belt driven forward curved type with an adjustable sheave and motor sized to meet the air flow and static pressure as scheduled on the drawings. Motor shall have thermal overload protection and motor and fan bearings shall be permanently lubricated.

H. Filters: Two sets of 2", 35% efficient, pleated throwaway filters shall be provided with the units.

I. Refrigerant shall be R-410a.

J. Accessories to be provided:
1. Factory furnished and wired firestats. Return air firestats shall be set at 135 degrees and supply air firestats at 245 degrees wired so as to shut down the supply air fan if a fire exists. Firestats shall be of the manual reset type.
2. Low ambient operation kit (25 degrees F).
3. Fully automatic economizer cycle for units 3 tons and larger including factory installed controls with moisture eliminators and minimum position rheostat including dampers with modulating controllers and spring return operators. Provide barometric relief including exhaust dampers and exhaust hood.
4. All rooftop units shall be furnished with an internal factory mounted 120 Volt convenience outlet, internally wired through the roof curb assembly. Outlet shall be powered separately from the rooftop unit to allow continued operation when the unit disconnect is off.
5. Unit power shall be routed through separate pipe portal (Alta or Vault assembly). Power shall enter the unit through the manufacturer approved location.
6. Provide hail guards on all units.
7. Provide stainless steel drain pans.
8. You shall be provided with terminal strip for field installed ALC controller

2.3 ROOF MOUNTING CURBS

A. Provide a pre-fabricated, insulated, 12-gauge galvanized steel roof mounting curb for all roof mounted equipment. Duct support members shall be provided to allow for pre-hanging of ductwork prior to unit installation. Provide gasketing to form a positive, weather tight seal between the curb and unit base. Design shall comply with all requirements of the National Roofing Contractors Association. Base of curb shall conform to roof slope and provide a level base on which to mount equipment. Curb overall height (from roof structure to top of curb) shall provide a min. 12" clearance between the top of the curb and the finished roof surface or the minimum height required to meet the roofing bond specifications, whichever is greater.

B. Insulation shall be 1-1/2-inch-thick, 3-lb. density rigid type. Nailer shall be constructed of pressure treated wood.

C. All roof mounting curbs shall comply with requirements of architectural Division 07 the specifications. All roof curbs shall be approved by the Architect prior to placing order for construction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, maintaining manufacturer's recommended clearances.

B. Curb Support: 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.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Controls shall be interfaced and connected per 23 0900 HVAC Instrumentation and Controls. Unit shall interface with "Reliable Controls" provided controls.

C. Install piping adjacent to machine to allow service and maintenance.
   1. Gas Piping: Comply with applicable requirements in Division 23 Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

D. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
   1. Install ducts to termination in roof curb.
   2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
   3. Connect supply ducts to rooftop unit with flexible duct connectors specified in Division 23 Section "Duct Accessories."
   4. Terminate return-air duct through roof structure and insulate space between roof and bottom of unit with 2-inch- thick, acoustic duct liner.

E. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

F. Ground equipment according to Division 26 Section "Grounding and Bonding."

G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 STARTUP SERVICE

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

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean outside coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Adjust vibration isolators.
13. Inspect operation of barometric dampers.
14. Lubricate bearings on fan.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
18. Start refrigeration system in summer only.
19. Complete startup sheets and attach copy with Contractor's startup report.
20. Inspect and record performance of interlocks and protective devices; verify sequences.
21. Operate unit for an initial period as recommended or required by manufacturer.
22. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following:
24. Coil leaving-air, dry- and wet-bulb temperatures.
25. Coil entering-air, dry- and wet-bulb temperatures.
26. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
27. After startup and performance testing, change filters, vacuum heat exchanger and cooling and outside coils, lubricate bearings, adjust belt tension, and inspect operation of power vents.

3.4 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 Final Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.5 FIELD QUALITY CONTROL

A. During construction unit filters shall be periodically changed while the unit is in operation. This shall include unit filter as well as a filter media to be placed over the return grilles. The unit filter and filter media shall be dated at each replacement. If the ductwork or evaporator coil becomes dirty, the contractor shall clean the ductwork and coil. The contractor shall provide the owner a letter stating that all coils have been inspected and are clean at Substantial Completion.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop air conditioners. Refer to Division 1 Section "Demonstration and Training".

3.7 CLOSEOUT DOCUMENTATION

A. Properly completed start-up forms, including equipment marks and serial numbers, documenting proper start-up service, adjusting, and demonstration shall be received by the Owner prior to granting of substantial completion.

END OF SECTION 23 8103

SECTION 260500

COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Common electrical installation requirements.

1.3 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

1.6 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.

2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

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 SLEEVES FOR RACEWAYS AND CABLES

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.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.3 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers:

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

2. Sealing Elements: EPDM, NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 MOUNTING HEIGHTS

Unless otherwise noted on the drawings or required by the architect, the following mounting heights shall apply:

Toggle switches	4'0"
Receptacles	1'6"
Data Outlets	1'6"
Panelboards	6'6" to top
Motor control equipment	5'0"

Upon approval of architect, mounting heights may be adjusted to simplify cutting of blocks, masonry or bricks.

2.5 SHOP DRAWING SUBMITTAL

As soon as practical after the contract is let submit seven sets (shop drawings) to the Architect of complete descriptive and dimensional data on:

1. lighting fixtures
2. 0-10volt LED Diming Switches and lighting controls wiring drawings on the 1/8” scaled floor plans.
3. panelboards
4. dry type transformers
5. other systems
6. dimensioned equipment room rough-in drawings
7. coordination drawings (if applicable)
8. Fire alarm system with point to point wiring drawings on the 1/8” scaled floor plans.
9. Intercom system with point to point wiring drawings on the 1/8” scaled floor plans.
10. Aux. gym sound system with point to point wiring drawings on the 1/8” scaled floor plans.
11. Emergency Responder Radio Antenna Repeater System
12. Short-Circuit Studies
13. Arc-Flash Hazard Analysis

All shop drawings shall be prepared and submitted as a single package.

The contractor shall review the information prepared by his suppliers and note any changes required prior to submitting the information to the engineer and shall include the form, Exhibit 1, entitled "Certification of Compliance - Shop Drawings" with each submittal. Failure to complete and execute this form will result in rejection of the submittal without review.

The contractor shall prepare dimensioned rough-in drawings (1/2"=1'0" scale) for each equipment room. These drawings shall show all equipment to scale (based on actual equipment purchased) and shall be fully dimensioned.

Mockups: Provide interior lighting fixtures, system devices, power, and all associated conduits for typical classroom mockups complete with power and control connections.

Obtain Architect's approval of fixtures for mockups before starting installations.
Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
Label and color code all boxes and coverplates.

All electrical power, equipment, and systems (Generator, Fire Alarm, Intercom, All System, etc.,). Electrical equipment and distribution shall be completely installed and operational 45 days prior to Substantial Completion. Electrical power and system completion shall also include completion of all certifications, tests and closeout documentation.

The electrical contractor shall submit scaled floor plans indicating the proposed route of all feeders and circuit home runs. On separate drawings the contractor should submit the proposed route of all main systems (Fire Alarm, Intercom, and Security Conduits). Include on the systems drawings the proposed route of the building cable tray.

Contractor shall submit scaled floor plan for the equipment yard showing generator, main disconnect switches, ground locations, proposed route of underground feeders. Indicate dimensions on all electrical feeder and equipment locations.

PART 3 -

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Penetration Firestopping."

C. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

D. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

E. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches , thickness shall be 0.052 inch .
2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches , thickness shall be 0.138 inch .

F. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

G. Cut sleeves to length for mounting flush with both surfaces of walls.

H. Extend sleeves installed in floors 2 inches above finished floor level.

I. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

J. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

K. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

L. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with Division 7 Section "Penetration Firestopping."

M. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

N. Aboveground, Exterior-Wall 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.

O. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Penetration Firestopping."

3.5 ELECTRICAL WORK CLOSEOUT

During electrical closeout phase, meet with owner's operating representative frequently and agree upon status of operational responsibility for electrical systems, including security provisions to prevent unauthorized operation, including protective measures to ensure that systems are not neglected or misused.

Except where otherwise indicated, electrical contract drawings are diagrammatic in nature and may not show locations accurately for various components of electrical systems. Shop drawings prepared by the contractor show certain portions more accurately to scale and location, and in greater detail. It is recognized that actual layout of installed work may vary substantially from both contract drawings and shop drawings.

In addition to the requirement of the Division 1 specifications, the contractor shall furnish the following electrical closeout documents:

Maintain blue-line or black-line set of electrical drawings and shop drawings in clean undamaged condition, for mark-up of actual installations which vary substantially from work as shown. Select and mark-up drawings which are most capable of showing installed conditions accurately. Mark with erasable pencil, and use multiple colors to aid in distinguishing between systems. In general, record every substantive installation of electrical work which is not shown or has been shown inaccurate, but in any case record the following:

underground conduits both interior and exterior, drawn to scale and fully dimensioned.

Work concealed behind or within other work, in a non-accessible arrangement.

Mains and branches of wiring systems, with switchboards, panelboards and control equipment and devices located and numbered.

Scope of each change order, denoting change order number.

Grounding system

sensor and signal locations of alarms and control systems.

The engineer will furnish the contractor through the Architect electronic files in AutoCAD format of the Contract Electrical Drawings for the Contractor use in preparing final electronic As-Built drawings. The contractor shall update these drawings indicating all project addenda, change order and As-Built conditions as listed above. Submittal of the Electronic Drawings shall be made on compact disk in AutoCAD format and accompany one full size set of bond plots to the Engineer in color on white background. Plots shall be generated from the CD As-Built Electronic files. Electronic file names and plot sheet numbering shall match the Contract Document format.

Work shall be recorded when performed. Failure to record work in a timely manner shall be considered sufficient reason to reject such work. At each site visit of Architect/Engineer, have the "in-progress" record drawings available to the engineer for his review.

Prior to transmittal of record drawings; obtain a set of prints for each contract drawing that has been used to record installed conditions. Erase incorrect information and transfer correct information onto the prints. Transmit corrected drawings to the architect for the owners' use.

SECTION 260500 - Exhibit No. 1
CERTIFICATION OF COMPLIANCE - SHOP DRAWINGS

To:
Project:

I have reviewed the contract documents, including but not limited to specifications, drawings, addenda, and change orders. To the best of my knowledge the materials described by the enclosed shop drawings are consistent with and meet the requirements of the aforementioned documents. I further recognize that; 1) the engineers review is to assist me in complying with the documents by checking for errors in my interpretation of the requirements set forth in the contract documents, 2) review of shop drawings, by the engineer, shall not relieve me of my responsibility for confirming and correlating all quantities, dimensions and work with that of other trades, and for performing the work in a safe and satisfactory manner, and 3) review of shop drawings, by the engineer, shall not permit any deviations from plans and specifications.

I understand that I will be required to remove and replace at no additional cost to the owner any item found to be inconsistent with or not meet the requirements of the contract documents.

The undersigned states that the above is true to the best of his knowledge and that he has the authority to legally bind his firm to the above terms. Failure to provide a legally binding signature shall void submittal.

Electrical Contractor:
By:_____ Date:
Title:
Company:

General Contractor:
By:_____ Date:
Title:
Company:

END OF SECTION 260500

SECTION 260519

LOW-VOLTAGE POWER CONDUCTORS AND CABLES

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. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.
4. ALL CONDUCTORS SHALL BE COPPER.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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

C. Comply with NFPA 70.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, and XHHW.

2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.

4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

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.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

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. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel or Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 LIGHTING FIXTURE WIRING – Factory whips may be used to connect lighting fixtures. Whips shall be installed from a junction box to each fixture, and shall not be run from fixture to fixture. Maximum length shall not exceed 6'-0".

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

I. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway, Armored cable, Type AC, or Metal-clad cable, Type MC.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

K. Class 1 Control Circuits: Type THHN-THWN, in raceway.

L. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 8 inches of slack.

Provide an 8” long pigtail connection for phase, neutral, and ground connections. Do not “through wire” devices. Connections to devices shall be made on SCREW TERMINALS – not in push-in slots.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both wall surfaces.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve

seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with the following requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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

END OF SECTION 260519

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1.3 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Ground rods.
2. Grounding arrangements and connections for separately derived systems.
3. Grounding for sensitive electronic equipment.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at ground rings grounding and connections for separately derived systems based on NETA MTS and NFPA 70B.

    a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
    b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

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

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch diameter by10 feet.

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.

1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.
2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Underground Grounding Conductors: Install bare copper conductor, No. 3/0 AWG minimum.

1. Bury at least 24 inches below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connections, except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connections.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits. Conductors shall be sized per NFPA 70.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.

4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: In addition to the equipment grounding conductor, install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

H. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each above ground portion of gas piping system downstream from equipment shutoff valve.

E. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 3/0 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Seismic restraints for electrical equipment and systems.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IBC: International Building Code.

C. IMC: Intermediate metal conduit.

D. NBC: National Building Code.

E. RMC: Rigid metal conduit.

F. SBC: Standard Building Code.

G. Seismic Restraint: A structural support element such as a metal framing member, a cable, an anchor bolt or stud, a fastening device, or an assembly of these items used to transmit seismic forces from an item of equipment or system to building structure and to limit movement of item during a seismic event.

H. UBC: Uniform Building Code.

1.4 SUBMITTALS

A. Product Data: Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of electrical support and seismic-restraint component used.

1. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
2. Annotate to indicate application of each product submitted and compliance with requirements.

B. Shop Drawings: Indicate materials and dimensions and identify hardware, including attachment and anchorage devices, signed and sealed by a qualified professional engineer. Professional engineer qualification requirements are specified in Division 1 Section "Quality Requirements." Include the following:

1. Seismic Restraints: Detail anchorage and bracing not defined by details or charts on Drawings. Include the following:

a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
b. Details: Detail 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.
c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC, NBC, and SBC unless requirements in this Section are more stringent.

B. Testing of Seismic Anchorage Devices: Comply with testing requirements in Part 3 and in Division 16 Section "Electrical Supports and Seismic Restraints."

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 PROJECT CONDITIONS

A. Site Class as Defined in the IBC: D

B. Assigned Seismic Use Group or Building Category as Defined in the IBC: C**.**

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 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed under this Project, with a minimum structural safety factor of five times the applied force.

B. Steel Slotted Support Systems: Comply with MFMA-3, factory-fabricated components for field assembly.

1. Manufacturers:

a. Cooper B-Line; a division of Cooper Industries.
b. Thomas & Betts Corporation.
c. Unistrut; Tyco International, Ltd.

2. Finishes:

a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-3.
b. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-3.
c. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-3.

3. Channel Dimensions: Selected for structural loading and applicable seismic forces.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch-diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Manufacturers:

    a. Allied Support Systems; Aickinstrut Unit.
    b. Cooper B-Line; a division of Cooper Industries.
    c. Fabco Plastics Wholesale Limited.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles
4. Rated Strength: Selected to suit structural loading and applicable seismic forces.

D. Raceway and Cable Supports: As described in NECA 1.

E. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

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

    a. Manufacturers:

        1) Hilti, Inc.
        2) ITW Construction Products.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co. Inc.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    a. Manufacturers:

        1) Cooper B-Line; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc
        3) Hilti, Inc.
        4) ITW Construction Products.
        5) MKT Fastening, LLC.
        6) Powers Fasteners.

3. Concrete Inserts: Steel or malleable-iron slotted-support-system units similar to MSS Type 18; complying with MFMA-3 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 SEISMIC-RESTRAINT COMPONENTS

A. Rated Strength, Features, and Application Requirements for Restraint Components: As defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Strength in tension, shear, and pullout force of components used shall be at least five times the maximum seismic forces to which they will be subjected.

B. Angle and Channel-Type Brace Assemblies: Steel angles or steel slotted-support-system components; with accessories for attachment to braced component at one end and to building structure at the other end.

C. Cable Restraints: ASTM A 603, zinc-coated, steel wire rope attached to steel or stainless-steel thimbles, brackets, swivels, and bolts designed for restraining cable service.

1. Manufacturers:

a. Amber/Booth Company, Inc.
b. Loos & Co., Inc.
c. Mason Industries, Inc.

2. Seismic Mountings, Anchors, and Attachments: Devices as specified in Part 2 "Support, Anchorage, and Attachment Components" Article, selected to resist seismic forces.
3. Hanger Rod Stiffener: Steel tube or reinforcing steel angle clamped to hanger rod, of design recognized by an agency acceptable to authorities having jurisdiction.
4. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.
5. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 for application of hangers and supports for electrical equipment and systems, except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
2. Secure raceways and cables to these supports with two-bolt conduit clamps *single-bolt conduit clamps using spring friction action for retention in support channel shall not be used**.***

D. Spring-steel clamps shall not be used for supporting conduits.

3.2 SUPPORT AND SEISMIC-RESTRAINT INSTALLATION

A. Comply with NECA 1 for installation requirements, except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Install seismic-restraint components using methods approved by the evaluation service providing required submittals for component.

D. 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. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

E. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To New Concrete: Bolt to concrete inserts.
2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
3. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight

concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

4. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
5. To Light Steel: Sheet metal screws.
6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF SEISMIC-RESTRAINT COMPONENTS

A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

B. 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.

C. Restraint Cables: Provide slack within maximums recommended by manufacturer.

D. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Make flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross expansion and seismic-control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to electrical equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing: Test pullout resistance of seismic anchorage devices.

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Record test results.

END OF SECTION 260529

SECTION 260533

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. <u>All branch circuit and systems conduit shall be run in the walls and above the ceiling unless explicitly noted on the floor plans.</u>

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. LFNC: Liquidtight flexible nonmetallic conduit.

G. NBR: Acrylonitrile-butadiene rubber.

H. RNC: Rigid nonmetallic conduit.

1.4 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. EMT: ANSI C80.3.

E. FMC: Zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket.

G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel, compression type.

H. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

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. AFC Cable Systems, Inc.

2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; a Hubbell Company.
12. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. LFNC: UL 1660.

D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

E. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

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

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS

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. Hoffman.
2. Lamson & Sessions; Carlon Electrical Products.

C. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

D. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

E. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

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

a. Thomas & Betts Corporation.
b. Walker Systems, Inc.; Wiremold Company (The).
c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.

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. Butler Manufacturing Company; Walker Division.
b. Enduro Systems, Inc.; Composite Products Division.
c. Hubbell Incorporated; Wiring Device-Kellems Division.
d. Lamson & Sessions; Carlon Electrical Products.
e. Panduit Corp.
f. Walker Systems, Inc.; Wiremold Company (The).
g. Wiremold Company (The); Electrical Sales Division

2.6 BOXES, ENCLOSURES, AND CABINETS

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

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Spring City Electrical Manufacturing Company.
9. Thomas & Betts Corporation.
10. Walker Systems, Inc.; Wiremold Company (The).

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Non-metallic Outlet and Device Boxes: NEMA OS2.

E. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.

F. Nonmetallic Floor Boxes: Nonadjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast Metal Access, Pull, and Junction Boxes: NEMA FB1, galvanized and gasketed cover.

I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2. Nonmetallic Enclosures: Plastic.

J. Cabinets:

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.

1. Color of Frame and Cover: Gray.
2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, as indicated for each service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. CDR Systems Corporation.
d. NewBasis.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of cast iron.

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

a. Carson Industries LLC.
b. Christy Concrete Products.
c. Nordic Fiberglass, Inc.

2.8 SLEEVES FOR RACEWAYS

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

B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.9 SLEEVE SEALS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit or IMC.
2. Concealed Conduit, Aboveground: Rigid steel conduit or IMC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
6. Application of Handholes and Boxes for Underground Wiring:

a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Fiberglass enclosures with polymer-concrete frame and cover, SCTE 77, Tier 15 structural load rating.
b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Heavy duty fiberglass units with polymer-concrete frame and cover, SCTE 77, Tier 8 structural load rating.
c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC. Includes raceways in the following locations:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: Rigid steel conduit or IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel or nonmetallic in damp or wet locations.

C. Minimum Raceway Size: 1/2-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Maintain a minimum of 4" separation between conduits of different systems.

F. Conduits shall be installed parallel with or perpendicular to the building architectural and structural construction. Maintain conduit runs as straight and direct as possible. Limit each bend to 90 degrees. Limit the bend radius to a minimum of 6 times the conduit diameter for low voltage conductors, 10 times the conduit diameter for telephone and data lines.

G. No conduits shall be run horizontally in a wall.

H. No conduits shall be run between the roof decking and the structure.

I. No conduits shall be supported from adjacent conduits. Furnish and install trapeze type hangers using 1/4" threaded rod and steel channel for horizontal runs. No conduits shall be supported from the ceiling suspension cables.

J. A junction box supported from the structure shall not be used to support the attaching conduits. Additional trapeze type hangers using 1/4" threaded rod and steel channel shall be used to support the conduit.

K. Conduits shall be supported a minimum of every ten feet, at every 90 degree bend and within one foot of every conduit coupling.

L. A conduit penetration through a wall shall not be used to support the conduit. Additional trapeze type hangers using 1/4" threaded rod and steel channel shall be used to support the conduit.

M. No conduit penetration through the HVAC platform.

N. Do not run conduits on the exterior of the building between the brick and the block.

O. Fire Proofing is not allowed to be installed on any conduits or boxes.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Provide cast metal boxes where surface mounted in wet or dry locations.

E. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

F. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

G. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

H. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

M. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

N. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

O. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.

1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.
d. Attics, Platforms, and Mezzanines: 135 deg F temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.

3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

P. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures. Use a maximum of 36 inches of FMC for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

Q. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

R. Set metal floor boxes level and flush with finished floor surface.

S. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

T. All conduits not installed below grade or in the slab shall be installed parallel and perpendicular to the building structure.

U. Branch circuits for lighting and general purpose receptacles may be combined up to a maximum of three phase (must be of different phases) and one neutral conductor. Homeruns shall be run directly into panelboard or equipment cabinet and shall not be collected in junction boxes or wireways. Feeders shall not be combined in common raceways.

V. All data/security system conduits should be fire sealed after the owner furnished cabling is installed. Furnish and install an insulation bushing on the end off all data conduits stubbed out to the cable tray.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Encase underground PVC conduits, where used for service entrance conductors, with 24” concrete jacket (top, sides, and bottom). Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31 Section "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished

grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, 12” below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall 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.

M. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.8 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Identification for raceway.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

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

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

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

PART 2 - PRODUCTS

2.1 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

2.2 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.3 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches .

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and

with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES

2.4 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch .
2. Tensile Strength: 50 lb minimum.
3. Temperature Range: Minus 40 to plus 185 deg F
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded**,** self-adhesive vinyl tape applied in bands.

1. Fire Alarm System: Red.
2. Fire-Suppression Supervisory and Control System: Red and yellow.
3. Combined Fire Alarm and Security System: Red and blue.
4. Security System: Blue and yellow.
5. Mechanical and Electrical Supervisory System: Green and blue.
6. Telecommunication System: Green and yellow.
7. Control Wiring: Green and red.

B. Power-Circuit Conductor Identification: For conductors in pull and junction boxes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape Identify each ungrounded conductor according to source and circuit number.

D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

F. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

   a. Power transfer switches.
   b. Controls with external control power connections.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

G. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

H. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

System Painting of exposed conduits, supports, boxes, etc. shall be performed under other sections of this contract. Painting for system identification shall be performed by this contractor. All outlet boxes exposed or accessible thru removable ceiling panels, shall be painted and marked:

Normal Power	unpainted	mark "#"
Emerg. Power	Paint YELLOW	mark "#"
Fire Alarm	Paint RED	mark "FA-#"
Intercom	Paint Blue	mark "IC-#"
MATV	unpainted	mark "TV-#"

where "#" is the appropriate circuit designation or zone number.

1. Labeling Instructions:

   a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where 2 lines of text are required, use labels 2 inches high.
   b. Outdoor Equipment: Stenciled legend 4 inches high.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

   a. Panelboards, electrical cabinets, and enclosures.
   b. Access doors and panels for concealed electrical items.
   c. Electrical switchgear and switchboards.
   d. Distribution Breakers in switchboards and distribution panels.
   e. Transformers.
   f. Emergency system boxes and enclosures.
   g. Disconnect switches.

h. Enclosed circuit breakers.
i. Motor starters.
j. Push-button stations.
k. Power transfer equipment.
l. Contactors.
m. Remote-controlled switches, dimmer modules, and control devices.
n. Voice and data cable terminal equipment.
o. Master clock and program equipment.
p. Intercommunication and call system master and staff stations.
q. Television/audio components, racks, and controls.
r. Fire-alarm control panel and annunciators.
s. Monitoring and control equipment.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. Color-Coding for Phase Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.

2. Identify neutrals in branch circuits with stripped coloring.

3. Colors for 208/120-V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.

4. Colors for 480/277-V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.

5. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

I. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

END OF SECTION 260553

SECTION 260573.13

SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-based, fault-current study to determine minimum interrupting capacity of circuit protective devices.

B. Related Requirements:
1. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

1.2 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items must remain functional throughout construction period.

B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

D. SCCR: Short-circuit current rating.

E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

F. Single-Line Diagram: See "One-Line Diagram."

1.3 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Short-Circuit Study Report:

1. Submit the following after approval of system protective devices submittals. Submittals **must** be in digital form.

a. Short-circuit study input data, including completed computer program input data sheets.
b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
c. Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms must comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

A. Comply with IEEE 399 and IEEE 551.

B. Analytical features of power systems analysis software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output.

D. Computer program must be designed to perform short-circuit studies or have function, component, or add-on module designed to perform short-circuit studies.

E. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kVA and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
6. Derating factors and environmental conditions.
7. Any revisions to electrical equipment required by study.

D. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Calculated asymmetrical fault currents:

        1) Based on fault-point X/R ratio.
        2) Based on calculated symmetrical value multiplied by 1.6.
        3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. No AC Decrement (NACD) ratio.
    e. Equivalent impedance.
    f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

A. Obtain data necessary for conduct of study.

1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For **equipment that** is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers in accordance with NFPA 70E.

B. Gather and tabulate required input data to support short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
11. Derating factors.

3.2 SHORT-CIRCUIT STUDY

A. Perform study following general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 5 kA or less.
2. Exclude equipment supplied by single transformer smaller than 75 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

H. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

I. Include in report identification of protective device applied outside its capacity.

END OF SECTION 260573.13

SECTION 260573.19

ARC-FLASH HAZARD ANALYSIS

PART 1 - GENERAL

A. Section Includes:

1. Computer-based, arc-flash study to determine arc-flash hazard distance and incident energy to which personnel could be exposed during work on or near electrical equipment.

B. Related Requirements:
1. Section 260573.13 "Short-Circuit Studies" for fault-current studies.

1.2 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

D. p.u.: Per unit. The reference unit, established as a calculating convenience, for expressing all power system electrical parameters on a common reference base.

E. SCCR: Short-circuit current rating.

F. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

G. Single-Line Diagram: See "One-Line Diagram."

1.3 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Study Submittals:

1. Submit the following after approval of system protective devices submittals. Submittals **must** be in digital form:

    a. Arc-flash study input data, including completed computer program input data sheets.
    b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

    c. Revised one-line diagram, reflecting field investigation results and results of arc-flash study.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.5 QUALITY ASSURANCE

A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms must comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1.6 REGULATORY AGENCY APPROVALS

A. Submittals for arc-flash hazard analysis requiring approval by authorities having jurisdiction must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

A. Comply with IEEE 1584 and NFPA 70E.

B. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer program must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.

D. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kVA and voltage ratings, including derating factors and environmental conditions.
4. Motor, Elevator and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

F. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

G. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.

3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

H. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce 3.5 by 5 inch (76 by 127 mm) self-adhesive equipment label for each work location included in analysis.

B. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Protection boundaries.

    a. Arc-flash boundary.
    b. Restricted approach boundary.
    c. Limited approach boundary.

4. Arc flash PPE category.
5. Required minimum arc rating of PPE in Cal/cm squared.
6. Available incident energy.
7. Working distance.
8. Engineering report number, revision number, and issue date.

C. Labels must be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies: Perform **Short-Circuit study** prior to starting Arc-Flash Hazard Analysis.

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.
2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.
3. Calculate arc-flash energy at 38 percent of maximum short-circuit current in accordance with NFPA 70E recommendations.
4. Calculate arc-flash energy with utility contribution at minimum and assume no motor contribution.

D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment fed from transformers smaller than 75 kVA.

F. Calculate limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must take into account changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:

1. Fault contribution from induction motors must not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).

H. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:

1. When circuit breaker is in separate enclosure.
2. When line terminals of circuit breaker are separate from work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain data necessary for conduct of arc-flash hazard analysis.

1. Verify completeness of data supplied on riser diagram and Panel Schedules on Drawings.
2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and contractors.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to amount of detail that is required to be acquired in field. Field data gathering must be under direct supervision and control of engineer in charge of performing study, and must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance or available short circuit current at service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

3.4 LABELING

A. Apply arc-flash label on front cover **of each section of equipment and on side or rear covers with accessible live parts and hinged doors or removable plates** for each equipment included in study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below **not fed by single transformer smaller than 75 kVA** must have arc-flash label applied to it:
   1. Low-voltage switchgear.
   2. Switchboards.
   3. Panelboards.
   4. Motor-control centers.
   5. Low voltage transformers.
   6. Safety switches.
   7. Control panels.
   8. Elevator.

C. Note on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.

   1. Indicate arc-flash energy.
   2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

END OF SECTION 260573.19

SECTION 260923

LIGHTING CONTROL DEVICES

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 lighting control devices:

1. Time switches.
2. Photoelectric switches.
3. Lighting contactors.

B. Related Sections include the following:
1. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 QUALITY ASSURANCE

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

1.4 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

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. Intermatic, Inc.
2. Leviton Mfg. Company Inc.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Paragon Electric Co.; Invensys Climate Controls.
5. Square D; Schneider Electric.
6. TORK.
7. Watt Stopper (The).

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

1. Contact Rating: 20-A ballast load, 120/240-V ac.
2. Program: 7-day, 4-circuit with an annual holiday schedule that overrides the weekly operation on holidays.
3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
4. Astronomic Time: All channels.
5. Battery Backup: For schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

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. Intermatic, Inc.
2. Lithonia Lighting; Acuity Lighting Group, Inc.
3. Paragon Electric Co.; Invensys Climate Controls.
4. Square D; Schneider Electric.
5. TORK.
6. Watt Stopper (The).

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

C. Description: Solid state, with SPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
2. Time Delay: 30-second minimum, to prevent false operation.
3. Lightning Arrester: Air-gap type.
4. Mounting: Twist lock complying with IEEE C136.10, with base.

2.3 LIGHTING CONTACTORS

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. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. GE Industrial Systems; Total Lighting Control.
5. Hubbell Lighting.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Square D; Schneider Electric.
8. TORK.
9. Watt Stopper (The).

B. Description: Electrically operated and mechanically held, and electrically operated and electrically held combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
5. All contactors shall have relays that would fail in the closed position so that the lights remain “on”.
6. Each contactor shall have an integral H-O-A switch.

2.4 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

2.5 MOTION DETECTORS:

Basis of Design Product – Occupancy sensors for lighting control shall be ceiling mounted, dual technology ultrasonic/infrared as manufactured by Acuity or approved equal by Wattstopper. Sensors shall have a manual bypass mode that will allow lights to operate normally in the event of a component failure. In the event of sensor failure, the occupancy sensors shall fail in the "on" position to allow control of the lights in the space with the switch. Unit should be provided with auxiliary relay contacts for Owners future controls.

The Dual Technology sensor shall be capable of detecting presence in the control area by detecting doppler shifts in transmitted ultrasound and passive infrared heat changes. Sensors shall use patent pending ultrasonic diffusion technology that spreads coverage to a wider area. Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic and PIR technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either shall hold lighting on. Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off. Sensors shall be ceiling mounted with a flat, unobtrusive appearance and provide 360° coverage.

Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 KHz. It shall utilize Advanced Signal Processing that automatically adjusts the detection threshold dynamically to compensate for changing levels of activity and airflow throughout controlled space. To avoid false ON activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion. The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.

Sensors shall operate at 24 VDC/VAC and halfwave rectified and utilize a Watt Stopper power pack. Sensors shall utilize SmartSet™ technology to optimize time delay and sensitivity settings to fit occupant usage patterns. The use of SmartSet shall be selectable with a DIP switch. Sensors shall have a time delay that is adjusted automatically (with the SmartSet setting) or shall have a fixed time delay of 5 to 30 minutes, set by DIP switch. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.

Sensors shall have a built-in light level sensor that works from 10 to 300 footcandles. Sensors shall have a manual on function that is facilitated by installing a momentary switch. Sensors shall have eight occupancy logic options that give the ability to customize control to meet application needs. The sensors shall feature terminal style wiring, which makes installation easier.

Sensor shall have an additional single-pole, double throw isolated relay with normally open, normally closed and common outputs. The isolated relay is for use with HVAC control, data logging, and other control options.

Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.

To ensure quality and reliability, sensor shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%. Sensors shall have standard 5 year warranty and shall be UL listed.

Submit wiring diagram for Occupancy Sensor, 0-10V diming switch and Daylight Harvesting Photocell. All three devices shall be by the same manufacturer.

2.6 LED 0-10v Dimmer:

Lutron Diva single pole, 120v – 277v, 8a load DVSTV series, Switch and plate color as selected by Architect or equal by Leviton. Submit wiring diagram for Occupancy Sensor, 0-10V diming switch and Daylight Harvesting Photocell. All three devices shall be by the same manufacturer.

2.7 Daylight Harvesting Photocell:

1. Industry-exclusive fail-safe circuitry: in the event of product failure, return-to-closed feature causes the relay to default to ON which eliminates life safety concerns
2. Fade rate time setting 3-30 minutes
3. Controls 1-10V sinking ballast
4. Dim to OFF — over DDL for 30 seconds then lights OFF
5. Test Mode — 30 second fade rate for 15 minutes then auto exit
6. Measures light from any source in the visible spectrum within a 60º cone at 8-12’ mounting height
7. Provides continual measurements to control the lighting
8. Mounts on ceiling — surface mount orlow-profile flush mount
9. LED status indicators for ease of installation.

Contractor to furnish and install all power packs, control wiring, etc. Control wiring shall be the same insulation rating as the power conductors and run in the same conduit. Contractor may upsize conduit to allow for control cables.

Manufacturer – Leviton ODCOP-DOW series. Submit wiring diagram for Occupancy Sensor, 0-10V diming switch and Daylight Harvesting Photocell. All three devices shall be by the same manufacturer.

0-10V dimmer switches shall control the light fixtures and override the daylight harvesting control to dim lights. While at full brightness the daylight harvesting unit shall control fixture brightness.

Field Quality Control:

Functional testing for automatic lighting controls is required and covered specifically in the IECC C408.3. This contractor shall hire a third-party commissioning agent from those listed below to perform this service. All associated cost for the commissioning shall be included in the base bid.

Linked2 Systems
3939 LaVista Rd
E-114
Tucker, GA 30084
(855)558-8400x601
info@linked2software.com
www.linked2software.com
Richard Blackwell
855-558-8400
Richard.Blackwell@Linked2Software.com

NGN Consulting Inc
2483 Heritage Village
Suite 16-130
Snellville, GA 30078
http://www.ngnconsulting.com
Tokey Arojojoye
404-975-8800
tokey@ngnconsulting.com

M2 Technology Group, LLC
2201 Marietta Ave
Muscle Shoals, AL 35661
256-412-4599
https://www.m2techgroup.com/index.html
Caleb Baggett
caleb.baggett@gmail.com

PART 3 - EXECUTION

3.1 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.4 ADJUSTING

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

3.5 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 260923

SECTION 262200

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

1. Shop Drawings: Wiring and connection diagrams.

B. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 16 Section "Electrical Supports and Seismic Restraints." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control test reports.

D. Output Settings Reports: Record of tap adjustments specified in Part 3.

E. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

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

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Products.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature for 15KVA and below. Maximum of 150 deg C rise above 40 deg C ambient temperature for transformers over 15KVA. Transformers are to be completely enclosed except for ventilation opening to meet the NEC 450.21B exception#2.

G. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.

H. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Concrete bases shall be a minimum of 4 inches larger than the transformer footprint in both directions.

B. Provide Korfund series “MM” vibration isolators. Size for the weight of the transformer. Manufacturers – Square D, Cutler Hammer, GE, or approved equal.

3.3 CONNECTIONS

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

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

C. Transformer primary and secondary feeders shall be run in IMC or Rigid Steel Conduit with the last three feet of the feeder connection to the transformer run in liquid-tight flexible metal conduit.

D. Tighten electrical connectors and terminals according to the manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.5 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262416

PANELBOARDS

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Electronic-grade panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

The contractor shall prepare dimensioned rough-in drawings (1/2"=1'0" scale) for each equipment room. These drawings shall show all equipment to scale (based on actual equipment purchased) and shall be fully dimensioned.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include wiring diagrams for power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section " Hangers And Supports For Electrical Systems." Include the following:

1. Basis of 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.

D. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
    b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect and Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. 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.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

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

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. Keys: Six spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section " Hangers And Supports For Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets as scheduled.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1, unless otherwise listed in the panel schedule.
b. Outdoor Locations: NEMA 250, Type 3R.
c. Wet or Damp Indoor Locations: NEMA 250, Type 4.
d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

3. Hinged Front Cover: **Entire front trim continuous piano hinged** to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

    a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: Galvanized steel same finish as panels and trim.
    c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover. Directory card shall be typewritten with spares and spaces indicated neatly in pencil.

C. Incoming Mains Location: Top or Bottom.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Compression type.
4. Feed-Through Lugs: Compression or Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker or Lugs only as scheduled.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

G. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only as scheduled.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 LOAD CENTERS

A. Load centers shall not be used.

2.5 ELECTRONIC-GRADE PANELBOARDS

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

1. Current Technology; a subsidiary of Danahar Corporation.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
4. Liebert Corporation.
5. Siemens Energy & Automation, Inc.
6. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1; with factory-installed, integral TVSS; labeled by an NRTL for compliance with UL 67 after installing TVSS.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

F. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

G. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the panelboard

short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

1. Accessories:

    a. Fuses rated at 200-kA interrupting capacity.
    b. Fabrication using bolted compression lugs for internal wiring.
    c. Integral disconnect switch.
    d. Redundant suppression circuits.
    e. Redundant replaceable modules.
    f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
    g. LED indicator lights for power and protection status.
    h. Audible alarm, with silencing switch, to indicate when protection has failed.
    i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
    j. Six-digit, transient-event counter set to totalize transient surges.

2. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.
3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.

    a. Line to Neutral: 100,000 A.
    b. Line to Ground: 100,000 A.
    c. Neutral to Ground: 50,000 A.

4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
5. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120-V, three-phase, four-wire circuits shall be as follows:

    a. Line to Neutral: 400 V for 208Y/120.
    b. Line to Ground: 400 V for 208Y/120.
    c. Neutral to Ground: 400 V for 208Y/120.

6. Protection modes and UL 1449 SVR for 240/120-V, single-phase, three-wire circuits shall be as follows:

    a. Line to Neutral: 400 V.
    b. Line to Ground: 400 V.
    c. Neutral to Ground: 400 V.

7. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:

a. Line to Neutral: 400 V, 800 V from high leg.
b. Line to Ground: 400 V.
c. Neutral to Ground: 400 V.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits; Type HACR for feeding heating, air-conditioning, and refrigeration equipment.

d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
e. Shunt Trip: 24 V trip coil energized from separate circuit, set to trip at percent of rated voltage as recommended by the manufacturer.
f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
g. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
3. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

2.7 PANELBOARD SUPPRESSORS

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

1. Current Technology; a subsidiary of Danahar Corporation.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
4. Liebert Corporation.
5. Siemens Energy & Automation, Inc.
6. Square D; a brand of Schneider Electric.

B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:

a. LED indicator lights for power and protection status.
b. Audible alarm, with silencing switch, to indicate when protection has failed.
c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.

C. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition,

short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:

    a. Fuses rated at 200-kA interrupting capacity.
    b. Fabrication using bolted compression lugs for internal wiring.
    c. Integral disconnect switch.
    d. Redundant suppression circuits.
    e. Redundant replaceable modules.
    f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
    g. LED indicator lights for power and protection status.
    h. Audible alarm, with silencing switch, to indicate when protection has failed.
    i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
    j. Six-digit, transient-event counter set to totalize transient surges.

2. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.
3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.

    a. Line to Neutral: 100,000 A.
    b. Line to Ground: 100,000 A.
    c. Neutral to Ground: 50,000 A.

4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
5. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120-V, three-phase, four-wire circuits shall be as follows:

    a. Line to Neutral: 400 V for 208Y/120.
    b. Line to Ground: 400 V for 208Y/120.
    c. Neutral to Ground: 400 V for 208Y/120.

6. Protection modes and UL 1449 SVR for 240/120-V, single-phase, three-wire circuits shall be as follows:

    a. Line to Neutral: 400 V.
    b. Line to Ground: 400 V.
    c. Neutral to Ground: 400 V.

7. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:

a. Line to Neutral: 400 V, 800 V from high leg.
b. Line to Ground: 400 V.
c. Neutral to Ground: 400 V.

2.8 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Mount panelboard so that top of trim is at 74”AFF, unless otherwise indicated.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

F. Install filler plates in unused spaces.

G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Spares and spaces shall be neatly handwritten in pencil.

C. Panelboard Nameplates: Label each panelboard with an engraved nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with an engraved nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Panelboards will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies panelboards included. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

A. Upon completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use

compressed air to clean the equipment. Touch up and repair exposed surfaces to match original finishes.

END OF SECTION 262416

SECTION 262726

WIRING DEVICES

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. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-Lock receptacles.
3. Isolated-ground receptacles.
4. Snap switches and wall-box dimmers.
5. Solid-state fan speed controls.
6. Communications outlets.
7. Pendant cord-connector devices.
8. Cord and plug sets.
9. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. UTP: Unshielded twisted pair.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available,

obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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

C. Comply with NFPA 70.

1.5 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

a. Cooper; 5351 (single), 5352 (duplex).
b. Hubbell; HBL5351 (single), CR5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5381 (single), 5352 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

    a. Hubbell; CR 5253IG.
    b. Leviton; 5362-IG.
    c. Pass & Seymour; IG6300.

2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

    a. Cooper; TR8300.
    b. Hubbell; HBL8300SG.
    c. Leviton; 8300-SGG.
    d. Pass & Seymour; 63H.

2. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

D. USB Tamper-Resistant Charger Receptacle, 125V, 3 wire grounding, Four USB ports 5 amp, 5V DC, type A, class 2.0. Switch activated port door, when open enables power, when closed all power is switched off for a zero no-load draw. Green LED indictor to show USB power available. Compatible with USB1.1/2.0/3.0 devices including Apple products. Hubbell USB4W series.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

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

    a. Cooper; GF20.
    b. Pass & Seymour; 2084.

C. Isolated-Ground, Duplex Convenience Receptacles:

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

   a. Cooper; IG5362BLS.
   b. Hubbell; IG5362SA.
   c. Leviton; 5380-IG.

3. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.4 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

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

   a. Cooper; L520R.
   b. Hubbell; HBL2310.
   c. Leviton; 2310.
   d. Pass & Seymour; L520-R.

2.5 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.6 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

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

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

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

a. Cooper; 2221PL for 120 V and 277 V.
b. Hubbell; HPL1221PL for 120 V and 277 V.
c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
d. Pass & Seymour; PS20AC1-PLR for 120 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:

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

a. Cooper; 2221L.

b. Hubbell; HBL1221L.
c. Leviton; 1221-2L.
d. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

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

a. Cooper; 1995L.
b. Hubbell; HBL1557L.
c. Leviton; 1257L.
d. Pass & Seymour; 1251L.

2.8 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 1000 W; dimmers shall require no derating when ganged with other devices.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.9 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.

1. Continuously adjustable slider or rotary knob, 5 A.
2. Three-speed adjustable slider or rotary knob, 1.5 A.

2.10 COMMUNICATIONS OUTLETS

1. Provide empty device box with blank stainless steel cover plate.

2.11 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Jumbo stainless steel cover plates.
3. Material for Unfinished Spaces: Jumbo stainless steel cover plates.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.12 FLOOR SERVICE FITTINGS

A. Type: Modular, flap-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Blank cover with bushed cable opening.

2.13 POKE-THROUGH ASSEMBLIES

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. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
3. Square D/ Schneider Electric.
4. Thomas & Betts Corporation.
5. Wiremold Company (The).

B. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.

1. Service Outlet Assembly: Flush type with receptacles and telephone/data outlet provisions as indicated.

2. Size: As indicated on drawings.
3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

2.14 MULTIOUTLET ASSEMBLIES

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. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold Company (The).

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Wire: No. 12 AWG.

2.15 SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.

1. Poles: Nominal 2.5-inch- square cross section, with height adequate to extend from floor to at least 6 inches above ceiling, and with separate channels for power wiring and voice and data communication cabling.
2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
3. Finishes: Satin-anodized aluminum.
4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
5. Power Receptacles: As indicated on the plans.
6. Voice and Data Communication Outlets: As indicated on the plans.

2.16 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. Isolated-Ground Receptacles: Orange.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted. ALL NEW RECEPTACLES SHALL BE TAMPER RESISTANT/CHILD PROOF to meet the requirements of NEC 406.12.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Device plates shall be jumbo type, and shall fully cover the wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 16 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on the back face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Tests for Convenience Receptacles:
1. Ground Impedance: Values of up to 2 ohms are acceptable.
2. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

3. Using the test plug, verify that the device and its outlet box are securely mounted.
4. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

SECTION 262813

FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.
2. Spare-fuse cabinets.

1.3 SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit on translucent log-log graph paper.
4. Coordination charts and tables and related data.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

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

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.
5. Insert manufacturer's name.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, dual element, time delay, current limiting.
2. Feeders: Class RK1, dual element, time delay, current limiting.
3. Other Branch Circuits: Class RK1, dual element, time delay, current limiting.
4. Control Circuits: Class CC, [**fast acting**] [**time delay**].

B. Fuse all HVAC and plumbing equipment according to the maximum overcurrent or maximum fuse size listed in the nameplate or other manufacturer’s data. Include all fuse adaptors to install smaller size fuses in larger disconnect switches as required by the manufacturer (ie – 25A fuses in a 60A disconnect switch).

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 262813

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).

4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

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

C. Seismic Qualification Certificates: For enclosed switches and circuit breakers, 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.

D. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect and Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.

2.2 NONFUSIBLE SWITCHES

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

B.

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

2.3 MOLDED-CASE CIRCUIT BREAKERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical style with Compression type lug kits, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits; Type HACR for heating, air-conditioning, and refrigeration equipment.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.4 MOLDED-CASE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Mechanical type with Compression lug kits, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Kitchen and other Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1, NEMA PB 1.1, and NEMA PB 2.1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

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

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION 262816

SECTION 265100

INTERIOR LIGHTING

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. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LER: Luminaire efficacy rating.

E. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast.
4. Energy-efficiency data.
5. Life, output, and energy-efficiency data for lamps.
6. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
    a. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

C. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

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

C. Comply with NFPA 70.

D. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.

C. Special Warranty for T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: One year from date of Substantial Completion.

D. Special Warranty for LED Light Fixtures: Manufacturer's standard form, made out to Owner and signed by manufacturer agreeing to replace fixtures that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Ten year from date of Substantial Completion.

1.8 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. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
3. Battery and Charger Data: One for each emergency lighting unit.
4. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified. All manufacturers not listed in the lighting fixture schedule who wish to be considered for the project shall submit prior approval packages at least 10 days prior to the bid date. Prior approval packages shall include cut sheets and full descriptions of each fixtures submitted for approval.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598.

C. Fluorescent Fixtures: Comply with UL 1598.

D. HID Fixtures: Comply with UL 1598.

E. Metal Parts: Free of burrs and sharp corners and edges.

F. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

G. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

H. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

I. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

   a. Lens Thickness: A19 (minimum) lens unless different thickness is indicated.
   b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.
4. Operating Frequency: 20 kHz or higher.
5. Lamp Current Crest Factor: 1.7 or less.
6. BF: 0.85 or higher.
7. Power Factor: 0.95 or higher.

2.4 BALLASTS FOR HID LAMPS

A. Electromagnetic Ballast for Metal-Halide Lamps: Comply with ANSI C82.4 and UL 1029. Include the following features, unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
3. Normal Ambient Operating Temperature: 104 deg F.
4. Open-circuit operation that will not reduce average life.
5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

B. Auxiliary Instant-On Quartz System: Factory-installed feature automatically switches quartz lamp on when fixture is initially energized and when power outages occur. System automatically turns quartz lamp off when HID lamp reaches approximately 60 percent light output.

2.5 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.

2.6 FLUORESCENT LAMPS

A. T8 rapid-startlamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.

2.7 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.

2.8 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

F. LED Fixtures shall be rated for 4000k color temperature, 90 CRI and have 0-10v dimming controls.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.

1. Install a minimum of two ceiling support system wires for each fixture. Connect to opposite diagonal corners of each lighting fixture. Wires shall have a breaking strength of three times the weight of the fixture.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.

3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Adjust aimable lighting fixtures to provide required light intensities.

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

F. Each fixture shall be designed to mount in the type of ceiling in which it is being installed (i.e. plaster, grid, concealed spline, sloped, etc.). Each lighting fixture shall be UL labeled for proper operation in the type of ceiling construction and for the mounting arrangement on/in which it is installed. Where similar fixtures or a family of similar fixtures are specified obtain form one manufacturer.

Field verify ceiling slope for fixtures installed in sloped ceilings and dimensions for any custom fabricated fixture.

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

SECTION 265319
EMERGENCY RESPONDER RADIO ANTENNA REPEATER SYSTEM

PART 1 - GENERAL

1.1 APPROVED VENDORS

A. Cherokee County School District (CCSD) restricts the work performed in this specification section to one of the following approved vendors:

1. Mobile Communications America
2. Diversified Electronics, Inc

1.2 DESCRIPTIVE NARRATIVE

A. 700/800 MHZ Communication Enhancement System shall support Public Safety & Emergency Responders Radio Communications. System shall provide capabilities
for existing emergency responder's radio/ communication equipment to function at a transmission success rate per current adopted NFPA 1 to include Annex ''O".

1.3 SUMMARY

Furnish, install, and test a complete and operating 700/800 MHZ Communication Enhancement System that only amplifies Cherokee County's public safety radio system.

This Section includes the requirements for an 800 MHZ Communication Enhancement System for the purposes of amplifying Emergency Responder radio signals to achieve minimum signal strengths.

1. Critical areas, such as the emergency command center(s), the fire pump room(s), exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by the AHJ, shall be provided with 99 percent floor area radio coverage.
2. General Building Areas. General building areas shall be provided with 95 percent floor area radio coverage.

Coordination shall be performed with local AHJ's.

The Owners ' private security and/or maintenance personnel radio systems, etc. shall not transmit **over** Public Safety & Emergency Responders Radio Communications without approval of AHJ's. Final acceptance and approval is required from the AHJ(s) in writing prior to contract closeout.

Section Includes

1. Bi-directional amplifiers (BDA's)
2. Distributed Antenna System
3. Coaxial cables
4. Splitters and direction couplers
5. UPS - Customer provided
6. All other equipment and components necessary for a complete and functioning Emergency Responder Radio Antenna/Repeater System.

1.4 REGULATIONS

A. Comply with most recent adopted codes, regulations and standards referenced herein:

1. NFPA 1 - The National Fire Code (including Annex O)
2. NFPA 70 - The National Electrical Code
3. Georgia Life Safety Code
4. NFPA 101, Life Safety Code
5. NFPA 72-10 National Fire Alarm Code
6. FCC 47 CFR Private Land Mobile Radio
7. 90.219-2007 Services-Use of Signal Boosters
8. ICC 2009 International Fire Code, Code and Commentary
9. S ADA "Americans with Disabilities Act"
10. FCC's OET 65 Standards "Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields".
11. FCC Rules Part 22, Part 90 and Part 101

1.5 DEFINITIONS

A. Definitions:

1. Bi-Directional Amplifier BOA: Device used to amplify band - selective or multi- band RF signals in the uplink, to the base

station for enhanced signals and improved coverage.

2. 800 MHZ Communication Enhancement System: A two-way radio communication system installed to assure the effective operation of radio communications systems for fire, emergency medical services or law enforcement agencies within a build i ng or structure. A system used by firefighters, police, and other emergency services personnel.
3. Delivered Audio Quality Definitions (DAQ): This is a universal standard often cited in system designs and specifications.

   a. DAQ 1: Unusable, speech present but unreadable.
   b. DAQ 2: Understandable with considerable effort. Frequent repetition due to noise/distortion.
   c. DAQ 3: Speech understandable with slight effort. Occasional repetition required due to noise/distortion.
   d. DAQ 3.5: Speech understandable with repetition only rarely required. Some noise/distortion
   e. DAQ 4: Speech easily understood. Occasional noise/distortion.
   f. DAQ 4.5: Speech easily understood. Infrequent noise/distortion.
   g. DAQ 5: Speech easily understood. Coupled Bonding Conductor (CBC) - The term "Coupled Bonding Conductor" shall mean a bonding conductor placed, e.g. strapped, on the outside of any technology cable, used to suppress transient noise.
   h. FCC: Federal Communications Commission
   i. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
   j. Public Safety/First Responder: Public Safety or First Responder agencies which are charged with the responsibility of responding to emergency situations. These include, but are not limited to: law enforcement departments, fire departments, and emergency medical companies.

1.6 SUBMITTALS

A. Submit product data for each type of proposed system component specified, including dimensioned drawings showing minimum clearances and installed features. All shop drawing shall be digitally transmitted to the Architect in “PDF” format.

B. Layout Drawings

   1. Component specification sheets shall be 8 inch x 11 inch or greater, scaled or dimensioned, with dimensions or scale clearly noted.

2. Floor plan drawings shall be 30 inch x 42 inch minimum with drawings scaled to legible size.
3. Floor plan drawings shall include elevation detail names for each elevation view. Sheet title shall include site name, address, sheet number, floor plan number and north arrow. Include site plan view of the subject buildings and surrounding property to clearly indicate the location and orientation of roof mounted outdoor antennas associated with the proposed system.
4. Include a minimum of (1) building elevation depicting the location of any outdoor antennas associated with the proposed system. Include height of antenna centerline above building, orientation, and location of all external grounding connections.
5. Include a detail plan view of all Telecommunications Spaces housing head-end and/or other consolidated equipment, showing the location of the rack(s) and/or enclosure(s) of the Emergency Responder Radio Antenna/Repeater System equipment.

6. Include a separate plan view of each interior floor where indoor antenna systems are proposed. Include antenna numbers, coaxial cable routes, and the locations of any other system components including splitters, couplers, filters, amplifiers, etc. All components shall be named or labeled for reference in power budget calculations tables. Overlay approximated coverage radii indicating -95 dBm downlink (base to mobile) signal strength around each proposed indoor coverage antenna. Include results of any previous coverage testing per grid, if available.
7. Include a minimum of one (1) detail elevation view(s) of all rack(s) and/or enclosure(s) housing the Emergency Responder Radio Amplifier System (Signal Booster) equipment. Identify each piece of equipment by brand, model number and equipment type (e.g. Acme BA123 RF amplifier).
8. Specify antenna grounding and surge protection in accordance with NEC Article 810.
9. Specify the backup power source (Life Safety) and include calculations to ensure the backup power requirements as specified in this standard are met.

C. Equipment Specification Sheets

1. Provide copies of manufacturer specification sheets of all system components, including:

   a. Amplifiers - Signal Boosters
   b. Antennas
   c. Coaxial cable, couplers, splitters, combiners, or other passive components

2. Operation and maintenance data
3. Pass band curves in for the uplink and downlink portions of the NPSPAC band for any amplifiers, if not included in #1. Amplifiers may NOT amplify portions of other licensed services, including Nextel and Specialized Mobile Radio Licensee band, or Cellular A or **B** bands.
4. Backup battery and charging system.

D. Submit wiring diagrams from manufacturer differentiating clearly between factory and field-installed wiring. Include diagrams for each component of the system with all terminals and interconnections identified. Make all diagrams specific to this Project.

E. Submit product certificates signed by the manufacturer of radio system components certifying that their products comply with specified requirements.

F. Submit agenda for training class and copies of all handouts for the class.

G. Maintenance data for radio system shall be included in the operation and maintenance manual. Include data for each type of product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.

H. Record of field tests of the radio system shall be included in the operation and maintenance manuals.

I. Design Approval: Plans shall be submitted and approved prior to installation. The following information shall be provided to the local AHJ(s) representative by the system designer/Contractor:

1. A minimum of Two (2) copies of detailed drawings showing the location of the amplification equipment and associated antenna systems which includes a view showing building access to the equipment; and
2. A minimum of two (2) copies of schematic drawings of the electrical system, backup power, antenna system and any other associated equipment relative to the amplification equipment including panel locations and labeling.
3. A minimum of (1) copy of the Manufacturer's data sheets on all equipment to be installed.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Submit applicable licenses and certification.
2. Engage an experienced factory - authorized installer to perform work of this Section.
3. System design and lead installer shall have a valid FCC General Radio Operators License.

B. Single-Source Responsibility: Obtain radio system components from a single source who assumes responsibility for compatibility of system components.

C. All equipment shall be UL listed and labeled, and in accordance with applicable NEMA and ANSI Standards. Where copper cabling is routed to an area, either in another building, or with a separate electrical service, the Technology Contractor shall provide primary protective equipment.

D. MANUFACTURERS

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

1. CommScope/Andrew
2. Corning
3. Times Microwave
4. Tessco
5. CCI (Communication Components Inc.)
6. Solid Technologies
7. Bird Technologies

PART 2 - PRODUCTS

2.1 GENERAL PERFORMANCE REQUIREMENTS

A. Compatibility: The equipment, including but not limited to repeaters, transmitters, receivers, signal boosters, cabling, fiber distributed antenna system, etc., shall not interfere with the existing communication systems utilized by the Public Safety and First Responder agencies.

B. Power Supplies: At least two (2) independent and reliable power supplies shall be provided, one primary and one secondary. The primary power source shall be supplied from a dedicated 20 ampere branch circuit and comply with 4.4.1.4 of NFPA 72. The secondary power source shall be a dedicated battery, capable of operating the in-

building radio system for at least 12 hours of 100% system operation. The battery system shall automatically charge in the presence of external power input. The battery system shall be contained in one NEMA 1. Monitoring the integrity of power supplies shall be in accordance with 10.17.2 and
10.17.3 of NFPA 72. Where the contractor requires power to the system components, he shall run ½"C & #10 conductors and ground to the nearest 120-volt emergency panel and connect to a spare 20a/1p breaker.

C. Survivability

1. Physical Protection: All wiring and fiber optics shall be installed in conduit. Refer to Section 26 05 33, "Raceways and Boxes for Electrical Systems" for type, sizing and install at ion standards. Cabling shall be run in conduit where installed in exposed ceilings. All cabling shall be plenum rated.
2. Fire Performance: **All** main risers or trunks of the antenna system shall be installed with resistance to attack from a fire using one of the following methods:

   a. A 2-hour fire rated cable or cable system.
   b. Routing the cable through a 2-hour fire rated enclosure(s) or shaft(s).
   c. A system configured in a looped design, routed through 1-hour fire rated enclosure(s) or shaft(s). The circuit shall be capable of transmitting and receiving a signal during a single open or non- simultaneous single ground fault on a circuit conductor.
   d. Performance alternative approved by the authority having jurisdiction.

3. Cabinet: The signal booster and all associated RF filters shall be housed in a single NEMA 4 cabinet. Exterior locations require NEMA 4 certified, painted steel weather tight box. The cabinet shall be large enough to dissipate internal heat without venting the inside of the cabinet to the outside atmosphere. Operating temperatures: -22 degrees F to +120 degrees F (-30 degrees C to +50 degrees C) minimum temperature range, including microprocessors. Equipment installed on the roof of structures shall be rated for the expected extreme temperatures associated with rooftop installations.
4. Passive Equipment: Passband shall be 700/800 MHz, IP rating of 2 GHz.
5. Cable: Passband shall be 700-900 MHz Cable shall be rated for fire plenum and riser rating.

2.2 SYSTEM COMPONENTS

A. Signal Strength

1. Downlink: A minimum signal strength of -95 dBm shall be provided throughout the coverage area.
2. Uplink: Minimum signal strength of -95 dBm received at the local Fire Department Radio System from the coverage area.
3. A donor antenna must maintain isolation from the distributed antenna system. The donor antenna signal level shall be a minimum of 15 dB above the distributed antenna system under all operating conditions.

B. Permissible Systems

1. Buildings and structures shall be equipped with an FCC Certificated Class A (Channelized) Bi- Directional **UHF** Amplifier(s) as needed.
2. The distributed antenna system may utilize a radiating cable, fixed antennas or a combination *of* both.

C. Supported Frequencies: The radio system shall support frequencies in the 700 and 800 MHz public safety bands as utilized by the local AHJ(s).

D. Reject Filters: Notch filter sections shall be incorporated to minimize adjacent channel cellular and Specialized Mobil Radio {SMR) degradation of the signal booster performance. The minimum downlink band adjacent band rejection shall be 35 dB or greater at 865 MHz and 870 MHz.

E. Band Migration Capability: The signal booster shall include re-tunable or replaceable filters to accommodate rapid and economic passband changes in the event of mandatory FCC changes within the NPSPAC band. The use of non-adjustable and non-replaceable RF input and output filters is prohibited.

F. Output Level Control: An automatic output leveling circuit shall be included for both passbands with a minimum dynamic range of 60 dB, less any gain reduction setting, to maintain FCC out of band and spurious emission compliance.

G. Degraded Performance in Emergencies; The system shall be designed to all ow degraded performance in adverse conditions, such as abnormally high temperatures resulting from nearby fires, extreme voltage fluctuations or other abnormal conditions that may occur during an emergency. Circuits that intentionally disable the signal booster in such situations (i.e. under/over voltage, over/under current, over/under temperature, etc.) will not be implemented as the standard mode for public safety applications.

H. Mode of Operation: The system shall be normally powered on. Unless design criteria prohibits continuous passing of frequencies, passing of

frequencies shall be continuous during normally powered conditions within the Public Safety and First Responder bands.

I. All in-building radio systems shall be compatible with both analog and digital communications simultaneously at the time of installation.

2.3 SYSTEM MONITORING

A. The distributed antenna system shall include a connection to the fire alarm system to monitor the integrity of the circuit of the signal booster(s) and power supplies and annunciate this malfunction on the fire alarm system shall comply with 10.17.2 & 3 of NFPA 72**.**

B. A sign shall be located at the fire alarm panel with the name and telephone number of the local Fire Department indicating that they shall be notified of any failures that extend past the 2 hour time limit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Distribution System Signal Wires and Cables

1. Wires and cables shall enter each equipment enclosure, console, cabinet in such a manner that all doors or access panels can be opened and closed without removal or disruption of the cables.
2. Routing and Interconnection

   a. Wires or cables routed between consoles, cabinets, and other equipment shall be installed in an approved conduit or cable tray that is secured to building structure.
   b. Completely test all of the cables after installation and replace any that are found to be defective.

3. Install cables without damaging conductors, shield, or jacket.
4. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.
5. Pull cables without exceeding cable manufacturer's recommended pulling tensions.

B. Product Delivery, Storage, and Handling

1. Delivery: Deliver materials to the job site in OEM's original

unopened containers, clearly labeled with the OEM's name and equipment model and serial identification numbers.

2. Store and protect equipment in a conditioned space until installation.

C. System Installation

1. Coaxial antenna cabling shall not be installed in the same conduit, raceway, or cable trays used for other systems.
2. All equipment shall be connected according to the OEM's specifications to insure correct installation and system performance.
3. Coordinate all roof penetrations with Owner and/or roofing contractor.

3.2 LICENSING

A. All fees associated with the licensing shall be paid by the Owner.

B. All testing must be done on frequencies authorized by the FCC.

3.3 GROUNDING

A. Ground cable shields and equipment per Manufacturer's requirements.

B. Antenna mast shall be grounded per NFPA 70 NEC requirements and antenna manufacturer's requirements. Provide grounding blocks and surge protection for outside coaxial cabling.

3.4 APPROVAL TESTING

A. The local AHJ's will review plans and specifications. Upon acceptance, plans will be stamped to indicate approval. Stamped plans are required to be present at the acceptance test. Any field changes that occur during construction shall be incorporated into new Record Drawings, including any manufacturer's data sheets for any equipment changes not submitted in the original submittal. Record Drawings, if required due to system changes, shall be submitted to the local AHJ for record and approval.

B. Tests shall be made using frequencies close to the frequencies used by Public Safety/Emergency Responders. If testing is done on the actual frequencies, then this testing must be coordinated with the local AHJ and Public Safety Offices. All testing must be done on frequencies authorized by the FCC. A valid FCC license will be required if testing is done on frequencies different from the police, fire or emergency medical frequencies.

C. Testing Procedures

1. Minimum Signal Strength: For testing system signal strength and quality, the testing shall be based on the delivered audio quality (DAQ) system. A DAQ level below 3.0 shall be considered a failed test for a given grid cell.
2. Measurements shall be made with the antenna held in a vertical position at 3 to 4 feet above the floor to simulate a typical portable radio worn on the belt or turnout coat pocket.

D. Final Acceptance Testing

1. All acceptance testing shall be done in the presence of a local AHJ representative or Public Safety Official at no expense to the City.

2. Small scale drawings (11-inch x 17 inch maximum) of the structure shall be provided by the Contractor to the Owner. The plans shall show each floor divided into the grids as described above, and the results of the pre-testing. Each grid shall be labeled to indicate the DAQ result from the final acceptance testing.

3. The Contractor shall provide the latest approved plans for the system, including any manufacture's data sheets for any equipment changes not submitted in the original submittal to the Owner. Include testing results of the repeater (output wattage, gain level, etc.) and connection to the fire alarm.

4. AHJ is requesting the following testing procedure: A grid is overlaid onto a floor area to provide 20 grid cells. Grid cells are provided with definite minimum and maximum dimensions. For most buildings, using a minimum grid dimension of 20 ft (6.1 m) and a maximum grid dimension of 80 ft (24.4 m) will suffice to encompass the entire floor area. Where a floor exceeds 128,000 ft2 (11,900 m2), which is the floor area that can be covered by the maximum grid dimension of 80 ft (24.4 m), it is recommended that the floor be subdivided into sectors each having an area of less than or equal to 128,000 ft2 (11,900 m2), and each sector be tested individually with 20 grid cells in each sector. Signal strength measurements shall be taken at the center of each grid and shall be performed using standardized parameters as specified in CO6930 .001. 00 Part 1.4. A.3 Signal strength typically is recorded on the Delivered Audio Quality (DAQ) scale.

3.5 MAINTENANCE AND ANNUAL TESTING

A. Annual tests will be conducted by the local AHJ or authorized representative,

1. The re-testing will be done at no expense to the City or the appropriate emergency services departments as required in the original testing procedures.

B. Maintenance Contract

1. Maintenance contract with a Radio Service Provider in place with name of authorized company, who will provide a 24 hour by 7-day emergency response within two (2) hours after notification. The system shall be maintained in accordance with FCC requirements. The contract shall be for 5 years.
2. All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radio telephone Operator License, or a technician certification issued by the Association of Public-Safety Communications Officials International (APCO) or equivalent as determined by the local Fire Department.
3. Maintain a list of contact personnel with phone numbers at the radio repeater system cabinet. The contact personnel shall have knowledge of the building and the repeater system and be available to respond to the building in the case of an emergency.

4. Radio Service Provider maintenance contract shall include but not limited to:

a. Annual Test

1) All active components of the distributed antenna system, including but not limited to amplifier, power supplies, and back-up batteries, shall be tested a minimum of once every 12 months.
2) Amplifiers shall be tested to ensure that the gain is the same as it was upon initial installation and acceptance. The original gain shall be noted and any change in gain shall be documented.
3) Back-up batteries and power supplies shall be tested under load for a period of 1 hour to verify that they will operate during an actual power outage.
4) Active components shall be checked to determine that they are operating within the manufacturer's specifications for their intended purpose.
5) Documentation of the test shall be maintained on site

and copies delivered to the Cherokee County Fire Marshal's Office.

5. Fire Department Radio personnel, after providing reasonable notice to the Owner or their representative, shall have the right to enter onto the property to conduct field testing to be certain that the required level of radio coverage is present

END OF SECTION 26 53 19

SECTION 27 32 25
SUPERVISED NETWORK INTERCOM AND PAGING SYSTEM

INTRODUCTION

1.1 GENERAL

A. Where applicable visit the site, verify all existing items shown on plans or specified, and be familiar with the working conditions, hazards, and local requirements involved. Submission of bids shall be deemed evidence of such visit. All proposals shall take these existing conditions into consideration before bidding.

Contractor shall expand the existing system to add the new devices as indicated on the drawings and these specifications. Maintain existing system at all times. The additional equipment shall be compatible with the existing equipment. The contractor shall check the existing system (and the existing system in the other buildings on campus) and shall verify the complete operation of the system prior to making any modifications or relocating of equipment. The contractor shall provide written correspondence to the county indicating any problems that exist. The Owner shall have the option of contracting with a third party to repair any inoperative equipment, once the system has been verified to be completely operational, the contractor shall have complete responsibility for the system and shall repair any and all equipment that becomes damaged or inoperative prior to final acceptance by the county. Contractor shall maintain all devices and circuiting outside of the areas of renovations and that pass through and feed downstream devices.

B. All materials, unless otherwise specified, shall be new, free from any defects, and of the best quality of their respective kinds. All like materials used shall be of the same manufacture, model, and quality, unless otherwise specified.

C. Manufacturer's names are listed herein to establish a standard. The products of other manufacturers will only be acceptable if approved by the specifying architect 10 days prior to bid. These products must: be of equal or better quality than the features specified herein, will serve with equal efficiency and dependability, and satisfy the purpose for which the items specified were intended.

D. Contractor shall do all necessary cutting and drilling of present walls, floors, ceilings, etc., for the installation of new work; but no structural work shall be cut, unless specifically shown on drawings and/or approved by the Owner. All exposed building surfaces damaged by installation or removal of electrical work shall be patched and finished in the same materials and manner as adjacent areas by this Contractor.

E. Contractor shall co-ordinate their work with the Owner for times which changeover, removal of existing equipment, and new connections of existing systems can be completed.

F. All cabling shall be run in conduit. Minimum size of raceway shall be 3/4”c. The systems manufacturer shall furnish and install the systems cabling and this low voltage system contractor shall furnish and install the raceway system. The low voltage system contractor should install the raceway for this system wiring according to the point to point wiring diagrams submitted from the manufacturer.

1.02 QUALITY ASSURANCE

A. The Low Voltage System Contractor shall be normally engaged, for a period of five years or more, in the design, installation and maintenance of this type of system and shall be the authorized distributor the equipment supplied under this contract. The contractor shall maintain his own service organization under his direct control capable of furnishing service under the warranty as specified. The contractor shall provide a letter from the manufacturing indicating that he is the authorized distributor of the equipment provided. The contractor shall also provide a letter in the submittals stating that he is in compliance with the above requirements. The architect reserves the right to request a resume.

B. The Low Voltage System Contractor shall make available to the Owner, the service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts.

C. The Low Voltage System Contractor must be licensed in the State of Georgia within the electrical trade and show proof of low voltage certification.

D. The Low Voltage System Contractor must show proof of being in the low voltage Data Communication trade for a minimum of three years.

E. The Low Voltage System Contractor shall show proof of having at least one Registered Communications Distribution Designer (RCDD) on staff.

F. All the above information must be provided at the time of the contract award, prior to signing the contract.

1.2 RACEWAYS AND CABLES

A. Electrical work will conform to the National Electric Code and applicable local ordinances.

B. All 125-volt electrical conductors shall be installed in minimum 1/2" size conduit.

C. All low-voltage wires and cables concealed in walls shall be run in conduits from flush outlet boxes to above accessible ceilings. Provide conduits where cables penetrate firewalls above ceilings.

D. All conduits entering boxes shall be served with insulating throat connectors and locknuts.

E. No raceway shall be located in proximity of hot water lines or excessive heat.

F. Use Cast "C" clamps, "U" straps, or ring hangers attached to rods, and/or brackets fastened to structure.

G. No perforated straps or tie wires permitted for supporting raceways.

H. Use wire ties for supporting low voltage cables run concealed above ceilings. Do not run cables loose on ceiling tiles. Support from structure above. Group cables

in bundles.

I. Tie mounts, plates, and anchors shall be used.

J. Ground all electrical apparatus in accordance with the National Electric Code.

1.3 QUALITY ASSURANCE

1 Manufactures: Firms regularly engaged in manufacture of integrated communication systems, time keeping systems, and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for no less than five years.

A. Installer's Qualifications: Firms with at least five years of successful installation experience with projects utilizing integrated communications systems and equipment similar to that required for this project.

B. All items of equipment including wire and cable shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all interconnections.

C. The Contractor shall be an established communications and electronics Contractor that has had and currently maintains a locally run and operated business for at least five years. The Contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty privileges.

D. The Contractor shall show satisfactory evidence, upon request, that they maintain a fully equipped service organization capable of furnishing adequate inspection and service to the system. The Contractor shall maintain at their facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

E. Except where specifically noted otherwise, all equipment supplied shall be the standard product of a single manufacturer of known reputation and experience in the industry. The Contractor shall have attended the manufacturer’s installation and service school and upon request must show proof of attending such a school.

1.4 SCOPE OF WORK

A. Furnish and install all materials, labor, equipment, permits, etc., to provide communications system as described herein and illustrated on the drawings for a complete operating system.

B. All manufactured articles, material, and equipment shall be applied, installed connected, erected, used, cleaned, adjusted, and conditioned as recommended by the manufacturers, or as indicated in their published literature, unless specifically herein specified to the contrary.

C. All work shall be performed by competent professionals and executed in a neat and professional manner providing a thorough and complete installation. Work shall be properly protected during construction, including the shielding of soft or fragile materials. At completion, the installation shall be thoroughly cleaned and all tools, equipment, obstructions, or debris present as a result of this portion of work shall be removed from the premises.

D. Program the operational characteristics matching the operation described herein, adjusting for call routing, transfers, priorities, and volume levels.

E. Remove all existing conduit, wire device, etc., being abandoned due to relocation.

F. The Contractor shall provide a minimum of eight hours of in-service training with this system. These sessions shall be broken into segments, which will facilitate the training of individuals in the operation of this system. Operator Manuals and User Guides shall be provided at the time of this training.

1.5 SUMMARY

A. Work Included. The scope of work of this section consists of the design, installation, and programming of all materials to be furnished under this SECTION, and without limiting the generality thereof, consists of providing all labor, materials, equipment, plant, transportation, appurtenances, and services necessary and/or incidental to properly complete all work as shown on the drawings, as described in the specifications, or as reasonable inferred from either or, in the opinion of the Architect and Owner, as being required and in general, is as follows:

1. Supervised Network Intercom and Paging System, including but not limited to:

    a. Supervised network amplifiers, back boxes, and all equipment, cabling and support required to interface the public address system to the Owner’s telephone system via SIP Trunk Interface.

    b. Supervised network system speakers, and ceiling mounted speakers, wall mounted horn, both interior and exterior.

    c. Cabling to support the Public Address System (NOTE: category 5/6 cable must conform to Owner guidelines. Coordinate with Owner prior to submission for approval).

d. Master and secondary clock system, clocks and cabling. Elapsed time indicator control panels where shown on the drawings.

e. Supervised network PA override signal to local sound systems.

f. Supervised network emergency messaging display/clock capable of receiving and scrolling up to 64 character long custom messages without affecting or replacing display of time segments, and coded messages simultaneous with plain text message (displacement to time segments permissible for coded messages).

g. Interactive Graphical User Interface (IGUI) supporting a pictorial view of architectural room locations on a map, and controlling intercom functions including zone or all page, dynamic zone assignments, answering intercom call-ins, selecting and distributing program sources to any and all zones. IGUI will also annunciate, locate and indicate loss of communication to all supervised network devices including speakers, amplifiers, emergency messaging display/clocks, and notification switches.

h. Emergency communication shall be initiated by the local console or from a centrally located district office via a District Wide Emergency Communication platform (included/not included in this contract). Emergency communication shall include but not be limited to, pre-recorded audio, live audio, emergency textual message display activation, computer pop-up notification, SMS Text message, and email.

1.6 SUBMITTALS

A. Submit the shop drawings, product data, and quality control submittals specified below at the same time as a package.

B. Shop Drawings: Composite wiring and/or schematic diagrams of the complete system as proposed to be installed. Drawing shall include relative position of all major components, typical connections, field components, accessories, and cable types.

C. Product Data: Include catalogue data sheets, manufacturer’s default specifications, user operation guides, and bill of materials.

D. Quality control shall include the following:

1. Name, address, and telephone number of the nearest fully equipped service organization.

2. Submit a certificate of completion of installation and service training from the system manufacturer.

3. Submit a list of comparable completed projects. Furnish the name, address, telephone number, and contact name of end user.

2. **PRODUCTS**

2.1 GENERAL DESCRIPTION OF NETWORK INTERNAL COMMUNICATION SYSTEM

A. Supply and install a complete supervised network based intercom system. Field wiring shall be CAT 5E or CAT 6 cable, control wiring for power distributions and very long runs, and utilize an optional fiber backbone (when distances exceed normal Ethernet limitations). All station equipment shall utilize standard RJ-45 modular connections. All remote devices utilizing standard structured cabling shall be capable of PoE (Power over Ethernet) or power supplied within the CAT 5E or CAT 6 cable jacket. Wiring shall be capable of either being installed in conduit or cable trays, where shown on the plans

B. The system shall be capable of interconnecting with the building LAN (Local Area Network). This connection shall be minimal and utilize only one Ethernet 100 Mbps (or optionally 1 Gb) connection per station to accomplish all intercom operations. Ethernet ports and associated network switches that are required to connect any intercom devices will be provided by the OWNER.

C. Provide a separate circuit for each room and administrative office so each room, speaker, amplifier, and emergency messaging display/clock can be individually addressed.

D. Overall intercom communications network shall utilize Ethernet or VoIP communications between all major components: administrative consoles, intercom stations, amplifiers and individual paging speakers, and network switches. Systems not utilizing Ethernet or VoIP communications protocol to each end-point device will not be acceptable. Systems not capable of supervising all networked devices including network amplifiers, network speakers, notification switches, and emergency messaging display/clocks will not be acceptable.

E. The network shall support a VLAN configuration to separate activity in the intercom system from other in building LAN traffic. In locations where the supervised network communications system will be considered as part of the facility's life safety systems, a dedicated and isolated network shall be required.

F. The system shall interface to the facility's PBX via SIP trunk connectivity.

G. The Communications System shall include master clock support and synchronization of digital secondary clocks, event scheduling, and messaging software allowing the facility to configure multiple schedules per school, multi zone time tone signaling for class changes, and message notification.

H. The system shall support fault monitoring and trouble notification features. When a fault monitoring device detects a fault, devices will notify of trouble should they be capable and configured to do so. Faults shall include but not be limited to devices:

   a. Disconnecting from the network

   b. Having invalid configuration

   c. Having mismatched firmware

2.2 DESCRIPTION OF NETWORK INTERCOM / PA / MESSAGING FEATURES

A. The system specified is based on the Telecor eSeries Supervised Network based Communications System providing at least the features and functions outlined below. It shall be installed and programmed by a local authorized and certified Telecor dealer.

B. The system shall utilize a decentralized network structure not requiring any head-end equipment, central server, or any other control hardware to maintain system operation. Systems utilizing centralized electronics and subject to a single-point-of-failure (power supply, CPU, server, power, etc.) shall not be accepted unless the system has 100% duplication of all centralized operating equipment running concurrently and can automatically take over, including up to the minute programming configuration in the event of a failure of the main system head-end electronics or any required, centralized electronics required to make the system fully operational. Systems that are not based on decentralized structure or systems that do not provide 100% duplication of head-end or systems that operate in a "down-graded" operational mode as the result of a centralized failure are not acceptable.

C. All station devices shall receive power and data through a Power-Over-Ethernet switch. Once plugged into the LAN through a Power-over-Ethernet network switch, all networked devices shall be immediately operational and as applicable shall be able to place or receive calls and pages from Stations as well as page all devices in the network. Consoles, intercom stations, clocks, emergency displays, or speakers connected to the network shall not require any network configuration or administration to function.

D. Each Intercom Station, Loudspeaker, clock/message display, shall be assignable to all or any combination of Unlimited Paging, Program Distribution or Time Zones in the system.

E. Each Classroom shall be provided with two Call Stations located in separate locations in order to comply with NEMA Standard SB40 for Emergency Communications in K-12 Schools. On Call switch shall provide the ability to generate normal calls to a designated location while the other shall generate Emergency level calls.

F. Speech shall be transmitted in the frequency range from 50 Hz to 7 kHz and shall use a maximum of 128 kbps of bandwidth during a call. In order to assure maximum intelligibility, all system audio shall be HD Audio as defined in Intel(™) High Definition Audio Specifications, June 17, 2010.

G. Intercom communications between consoles and system devices shall be non-blocking with no channel restrictions or limitations (other than network capacity) to the number of simultaneous conversations at any time between pairs of intercom stations, intercom station to console, console to console, console to speaker or zone of speakers, program source to a speaker or zone of speakers, or bell tones to a speaker or zone of speakers regardless of number of stations or consoles.

H. Any and all device shall have the ability to have its programming downloaded, individually or simultaneously via the network. Programming shall be downloadable in a series of human readable, industry standard comma-separated values (CSV) files that can be saved and edited using common spreadsheet applications. Consoles, intercom stations, clocks, displays, and speakers residing on a network shall have the ability to update their programming, simultaneously from a CSV file. Furthermore, all devices shall also have the capability to be configured directly,

such that device numbers, names, zones, and call-in destinations can be altered in real time without the uploading or downloading of their programming. System shall be capable of uploading firmware updates to all device classes simultaneously, via the network, without the requirement of tools, by authorized technician or qualified facility technician or representatives.

I. Audio communications between all devices shall be accomplished with latency values of a maximum of 0.1 seconds and connection times of 0.01s for 1 to 500 speakers.

J. The system shall support a minimum of 50 channels of simultaneous duplex communication paths on the intercom system LAN, plus a minimum of 10 simultaneous duplex channels for PBX integration.

K. The system shall be capable of routing calls from the Public Switched Telephone Network (PSTN) into any classroom, zone or the entire school via the District's SIP enabled Telephone System. This shall allow for remote monitoring and two-way voice communications from outside the facility to classrooms as well as paging into areas of the school. Additional features shall include:

   a. The ability to place call-ins from classroom call stations to SIP Telephones

   b. The ability to initiate calls from SIP Telephones to eSeries Classroom Speakers.

   c. The ability to initiate zone and all call paging announcements from SIP Telephones to eSeries Speakers throughout the facility.

   d. The ability to make outside calls from Administrative Consoles to the PSTN via the Districts Phone System.

L. The System shall allow users to configure multiple schedules per school, with an unlimited number of programmable events in each schedule. Each Event shall sound a user selectable tone and play a user provided audio file or an external audio source. In addition a textual message shall be able to be programmed to be displayed at associated message displays throughout the school. All scheduling assignments shall be performed via a simple to use Graphical User Interface (GUI) from a non-dedicated PC residing in the School. Programming shall also be accomplished from a non-dedicated PC at the District Office. The following features and functions shall be provided. Systems that cannot provide these, shall not be acceptable.

   a. The system schedules shall facilitate the requirements of combined facilities (e.g. elementary and middle schools in a common building) where multiple schedules running concurrently would be required.

   b. Each event shall play any of the available tones, audio files or audio sources provided. Events shall be directed to any one or more Time Zones in the systems.

   c. Events shall include textual messages to clock/message displays. These shall be formatted as fixed, flashing or scrolling displays that can include up to 200 characters in length.

   d. Time Tones may be manually activated from Administrative Consoles or selected SIP phones residing on the school IP-PBX.

   e. An integral Master Clock shall provide time synchronization to all secondary

digital clock / Message Displays throughout the school. The communications shall be capable of obtaining it's time synch signal from any NTP time server.

M. The System shall be capable of automatically distribute SMS and email notifications to relevant staff members when an emergency event is occurring at the facility. Notifications shall be distributed to user alert devices such as mobile phones and smart devices. Mobile phones shall receive the notifications as SMS messages while smart devices shall receive email messages. Emergency events include:

   a. The activation of emergency-themed element icons on a PC GUI (e.g., Lockdown, Evacuate, etc.) i

   b. Emergency Calls placed from Call Stations located in room locations.

N. The system shall automatically distribute SMS and email notifications to appropriate technical support staff in the event that the system is experiencing a fault.

2.3 SUPERVISED NETWORK ADMINISTRATIVE CONTROL CONSOLE

A. The Supervised Network Administrative Control Console (subsequently referred to as Console) shall be a Telecor model e300 or approved equal. The Console shall be supervised and allow the operator to establish two-way communications with an intercom station, talkback speaker, or another Console using the handset or speakerphone. VOX functioning shall be automatically enabled when the handset is used. The Push-to-Talk button shall toggle the Console between talk and listen mode when the speakerphone is used. The Console shall provide a 2-line by 20-character LCD display. The display shall be able to be tilted at different angles for optimum viewing. When there are no active calls, the display shall show the Console name and dial number. If a time server is connected to the network, the display shall also show the time and date.

B. Incoming calls to a Console shall show the originating station dial number and name on the Console display. Calls shall be displayed in the order they are received. The operator shall be able to scroll through the list of calls and answer them out of sequence. Emergency call-ins shall be distinctly annunciated both visually and audibly.

C. The Console shall allow call-ins to be forwarded to another Console, or for calls to be put on hold or transferred to another Console location. Additionally, call-ins or calls shall be forward/transfer-able to PBX telephone extensions via a SIP trunk interface.

D. The Console shall be able to select remote audio sources connected at any location on the local area network, and distribute the audio broadcast from the source to all speakers in a facility or to selected areas such as a speaker zone or a selection of speakers. The Console shall be capable of audio source verification by attendant prior to page zone activation. In this manner attendants shall be able to listen to the audio source locally, including listening to pre-recorded announcements, prior to system broadcast.

E. The Console shall be able select a tone or a pre-recorded announcement and

broadcast the tone or announcement to all facility speakers or to select areas, such as a speaker zone or a selection of speakers.

F. The Console shall be equipped with digital volume control that shall allow for the separate adjustment of the speaker listen and handset listen volumes. The levels for intercom listen, tones, and program distributions shall be independently adjusted and stored in memory.

G. The system shall allow user programming of alphanumeric architectural room names and numbers. The Console shall be capable of using 1 to 7 digit sequences for dial out and call-in identification, and shall display station numbering, station name, and call-in priority.

H. The end-user shall be allowed to choose and determine the number and location of Consoles. The end-user shall not be limited by pre-set manufacturer limitations of the number of Consoles required by this project; allowing for unrestricted future expansion. Consoles may be added at any time. Consoles added by the end-user that exceed the engineered design for this project shall be at owner's expense. Communication between consoles or consoles and intercom stations or rooms shall not be inhibited by channel number restrictions.

I. The Console shall be capable of displaying room statuses such as Privacy and Do Not Disturb and shall have the ability to override any status limiting communication between the Console and a station with Privacy or Do Not Disturb status activated. Temporary override shall not interfere with continued activation of Privacy and Do Not Disturb after communication has been established and electively terminated.

J. The Console shall support an optional desktop microphone that shall be a Telecor model MCC-PM-MA or approved equal. The desktop microphone shall provide additional buttons, indicators and circuitry to control the Console during intercom and paging operations. The desktop microphone shall feature a gooseneck microphone that includes a ring LED around the microphone to indicate when the microphone is live. The desktop microphone shall connect to the Console via CAT5 or higher cable with RJ-45 terminations. The desktop microphone shall feature pushbuttons for listen audio volume control, Push to Talk, Call Cancel, forwarding Console call-ins to another pre-programmed Console, and zone paging. These push buttons shall behalf identically to their Console counterparts. The desktop microphone shall also feature a 2.5mm jack to support a headset. A headset pushbutton shall toggle between directing audio to the desktop microphone speaker and the connected headset. Also featured shall be a ¼" phono jack to support a footswitch that behaves as the Push to Talk button.

2.4 SUPERVISED NETWORK INTERCOM TALK-BACK SPEAKER

A. The Supervised Network Intercom Talk-Back Speaker (subsequently referred to as Network Speaker) shall be a Telecor model eS8-TB. The Network Speaker shall be supervised and capable of up to 10 watts of audio signal and provide a minimum of 92db @ 1 meter SPL for maximum intelligibility. Speaker spacing shall be as defined by manufacturer to provide maximum intelligibility.

B. The Network Speaker shall provide transmission of HD audio as generated from intercom console and/or associated push-to-talk, intelligent microphone, supervised network amplifier, or program sources connected to the network.

C. The Network Speaker shall provide a dry contact output that can be activated remotely from a station or from a console, such as may be required in a door release application.

D. The Network Speaker shall receive power and data over a RJ45 connect CAT5E/6 cable via a Power-Over-Ethernet switch port. Once plugged into the LAN through a Power over Ethernet network switch, the Network Speaker shall be immediately functional and be able to receive calls and pages from consoles on the network. The Network Speaker shall not require any network configuration or administration to function.

E. The Network Speakers shall support talkback; to optimize intelligibility talkback capabilities shall be supported via a microphone conditioned for low noise, HD audio, and with compression and noise gate capability. Stations that use the speaker instead of a separate microphone for talkback capability shall not be accepted.

F. The Network Speaker shall have a call-in roll-over feature where if it places a call-in to a primary call destination which is not answered after a preset amount of time, the call-in shall be automatically escalated to a secondary call-in destination. If both the primary and secondary call-in destinations are unavailable, the call-in shall be redirected to a back-up Station, Console, or telephone device.

G. The Network Speaker shall have the capability to be configured as a member of 1 or more paging zones.

H. The Network Speaker shall support the direct connection with RJ45 connectors of two, supervised room notification stations. The stations shall provide the means for: normal calls, emergency calls, privacy mode, and do not disturb mode. Notification stations shall include a call placed assurance status LED to indicate a call has been placed. Notification stations shall be supervised and immediately indicate disconnection or a wiring fault.

I. In addition to the visual call-in assurance status indicators on the notification stations, call-in assurance status indication must also be provided on the associated speaker. Also, in addition to visual call-in assurance, audible call-in assurance shall also be provided in support of persons with visual disabilities.

J. Under blackout conditions the notification station shall be illuminated such that it can be located in the dark.

K. Normal call stations must support the ability to activate emergency call-in signals via multiple button presses and press and hold operations. Emergency call stations shall be separate and clearly labeled with a red button so as to impart obvious operation in the event of an emergency. Systems that only provide a single call station with dual emergency and normal operation shall not be acceptable.

L. The Network Speaker shall provide local, visual indication of operation or failed-communication and shall immediately annunciate a loss of communication at the main console location.

M. Network Speaker volume must be capable of individual level settings through the network. Settings must not be adjustable without authorization. Volume controls located in rooms must be centrally lockable via the network. Systems that allow a volume adjustment without authorization shall not be acceptable. Systems that utilize a manually operated transformer or resistive volume control design shall not

be acceptable. Volume controls shall be capable of establishing and maintaining levels for intercom, paging, program distribution, and tones, independently for each of the above functions. Emergency announcements shall be sent at a volume/level as required by the AHJ and shall not be affected by the adjustment of other speaker volume/levels for the purposes of paging, intercom, or other lower priority audio events.

2.5 SUPERVISED NETWORK MASTER/SATELLITE TALKBACK SPEAKER

A. The Supervised Network Master/Satellite Talkback Speaker (subsequently referred to as the Master Talkback Speaker) shall be a Telecor model eS8-TB4 or approved equal. The Master Talkback Speaker shall support all functionality of the Telecor model eS8-TB (specified above).

B. The Master Talkback Speaker shall be supervised and shall support the connection of Satellite Speakers, and support up to four watts of additional 25V Satellite Speaker load. Satellite Speakers shall be Telecor model S8T2570 or approved equal.

C. The Satellite speakers shall not support talkback; to optimize intelligibility talkback capabilities shall be supported from a single point via a microphone conditioned for low noise, HD audio, and with compression and noise gate capability. Stations that use the speaker instead of a separate microphone for talkback capability shall not be accepted.

D. The Satellite Speaker shall receive power over a RJ45 connect CAT5E/6 cable via the Supervised Network Master/Satellite Talkback Speaker. Both the Supervised Network Master/Satellite Talkback Speaker and the Satellite Speaker shall receive all power through a single Power-Over-Ethernet switch port. Systems that require auxiliary power or additional external or supplementary audio power amplification are not acceptable.

2.6 SUPERVISED NETWORK EMERGENCY DISPLAY/CLOCK

A. The Supervised Emergency Display/Clock (subsequently referred to as Message Display) shall be a Telecor model e365-TB or approved equal. The Message Display shall be supervised and shall simultaneously display the time and date. The time shall be displayed in hours, minutes, and seconds. Hours and minutes shall be displayed in large 2.25” digits. The seconds shall be slightly smaller for easy distinction. The date shall be displayed in plain text by a 10-character, dot matrix display showing the day of the week, followed by the month and date. Loss of communication to the Message Display shall result in an immediate indication of communication loss with the device and annunciated at the designated locations.

B. The Message Display shall receive power and data over a RJ45 connect CAT5E/6 cable from a single Power-Over-Ethernet switch. Once plugged into the LAN through a Power over Ethernet network switch, the digital calendar Message Display shall be immediately functional. The Message Display shall not require any network configuration or administration.

C. The Message Display shall by default show the time and date which shall be synchronized to all other Message Display. If time signal communication to the

Message Display is lost, it shall maintain the time independently, and remain synchronized to other Message Displays connected on the local area network. Once communication is restored, the Message Display shall resynchronize with the time server and shall be automatically updated to current data communication provided at time of restoral.

D. The Message Display shall provide a dry contact output that can be activated remotely from a station or console, such as may be required in a door release application.

E. The Message Display shall be capable of supporting notification devices and shall have a call-in roll-over feature where if a call-in to the primary call destination is not answered after a pre-set amount of time, the call shall be automatically escalated to a secondary call destination. If both the primary and secondary call destinations are unavailable, the call shall be redirected to a back-up station or console.

F. The Message Display shall have the capability to be configured as a member of 1 or more paging zones.

G. The Message Display shall optionally activate strobe and siren signals in conjunction with emergency call-ins. Siren shall be automatically suspended upon an audio connection. Strobe shall be maintained until call completion.

H. The Message Display shall automatically activate and maintain strobe signals in conjunction with emergency pages, programs, tones, announcements, and/or textual messages.

I. In addition to displaying the time, the Message Display shall also feature elapsed timer and count-down functions. Timer functions shall include the ability to count upwards from zero to 24 hours, as well as counting down to zero from a specified value. The timer shall be controlled using the Telecor model 2481-TBP Timer Button Panel, providing start, stop, and reset functionality. When not operating as a timer, the Message Display shall default back to displaying the current time. Elapsed time and countdown functions shall also be controlled via contact closure and connected directly to the Message Display

J. Mounting options for the Message Display shall include: surface mount and dual mount with the 2423 dual mounting kit, creating a double-faced version. The Dual Mounting Kit shall be supplied with a bracket that shall allow the Emergency Display/Clock to be mounted 4" away from a wall or ceiling surface. An optional 2433 clock guard shall also be available for the surface mount models. The guards shall be constructed from sturdy, heavy gauge steel and include a Plexiglas window that shall provide both protection and optimum visibility of the display.

2.7 SUPERVISED NETWORK EMERGENCY DISPLAY/CLOCK COMPANION TALKBACK SPEAKER

A. The Emergency Display/Clock Companion Talkback Speaker (subsequently referred to as Companion Speaker) shall be a Telecor model e365-TB-SPK or approved equal. The Companion Speaker shall be supervised and shall be ceiling or wall mountable in a location distinct from the supervised network emergency display/clock. Systems that do not provide flexible talkback speaker ceiling mount options are not acceptable.

B. The Companion Speaker shall receive power and data over a RJ45 connect CAT5E/6 cable from the Supervised Emergency Display/Clock which is connected to a single Power-Over-Ethernet switch port. Once plugged into the Emergency Display/Clock, the Companion Talkback Speaker shall be immediately functional. Systems that require more than one Ethernet PoE port to support time and simultaneous textual messaging, paging, program, tone distribution, strobe and siren activation signals, and normal and emergency call-in shall not be acceptable. The Companion Talkback Speaker shall not require any network configuration or administration

C. The Companion Speakers shall support talkback; to optimize intelligibility talkback capabilities shall be supported via a microphone conditioned for low noise, HD audio, and with compression and noise gate capability. Stations that use the speaker instead of a separate microphone for talkback capability shall not be accepted.

D. The Companion Speaker shall be used in conjunction with the Supervised Emergency Display/Clock to support the direct connection of two, supervised room notification stations via RJ45 connectors. The stations shall provide the means for: normal calls, emergency calls, and privacy and do not disturb modes. Notification stations shall include a call placed assurance status LED to indicate a call has been placed. Notification stations shall be supervised and immediately indicate disconnection or a wiring fault.

E. The Companion Speaker shall provide transmission of HD audio as defined by Intel(™) High Definition Audio specifications, June 17th, 2010 as generated from intercom console and/or associated push-to-talk, intelligent microphone, supervised network amplifier, or program sources connected to the network.

F. In addition to the visual call-in assurance status indicators on the notification stations, call-in assurance status indication must also be provided on the associated Companion Speaker. Also, in addition to visual call-in assurance, audible call-in assurance shall also be provided in support of persons with visual disabilities.

G. Under blackout conditions the notification station shall be illuminated such that it can be located in the dark.

H. Normal call stations must support the ability to activate emergency call-in signals via multiple button presses and press and hold operations. Emergency call stations shall be separate and clearly labeled with a red button so as to impart obvious operation in the event of an emergency. Systems that only provide a single call station with dual emergency and normal operation shall not be acceptable.

I. The Companion Speaker shall provide local, visual indication of operation or failed-communication and shall immediately annunciate a loss of communication at the main console location.

J. The Companion Speaker shall enable the Emergency Display/Clock to support the call-in roll-over feature where if it receives a call-in as a primary call destination which is not answered after a pre-set amount of time, the call shall be automatically escalated to a secondary call destination. If both the primary and secondary call destinations are unavailable, the call shall be redirected to a back-up station or console.

K. The Companion Speaker volume must be capable of individual level settings through the network. Settings must not be adjustable without authorization. Volume controls located in rooms must be centrally lockable via the network. Systems that allow a volume adjustment without authorization are not acceptable. Systems that utilize a manually operated transformer or resistive volume control design shall not be acceptable. Volume controls shall be capable of establishing and maintaining levels for intercom, paging, program distribution, and tones, independently for each of the above functions. Emergency announcements shall be sent at a volume/level as required by the AHJ, and shall not be affected by the adjustment of other speaker volume/levels for the purposes of paging, intercom or other lower priority audio events.

2.8 SUPERVISED CALL STATIONS

A. The Supervised Call Stations, as indicated on the drawings, shall be Telecor model eCS-1 eCS-2, eCS-3, eCS-4, eCS-5, eCS-6 or approved equal. The station shall be used to initiated calls from remote locations to eSeries Consoles.

B. Call Stations shall be monitored for call line failure. In the event of an open circuit, short circuit or short to ground, the System shall detect the fault and notify a designated console operator automatically. The type of fault and its identity on the system shall be displayed on a designated console screen.

C. Call Stations shall provide “message waiting” indications to staff members. If no one is present in a room to respond to a call, or the room is in Privacy or Do Not Disturb mode, the console operator shall have the option to leave a Message Waiting (MW) indication at the Station. If the MW option is chosen, the LED indicator on the room call switches shall begin to pulse. When a call-in is initiated from the room, the MW indication shall be automatically deactivated, and the call-in shall be automatically routed to the console that left the MW indication.

D. Call Stations shall utilize a momentary contact touchpoint to initiate a “Normal” priority level call. Stations equipped with an “Emergency” touchpoints shall

initiate "Emergency" priority level calls. All stations shall have a Call Assurance LED. The LED shall flash when a call in initiated, confirming call placement to the user. The LED shall continue to flash until the call is answered by the console operator.

E. Calls Stations that are equipped with "PRIVACY" touchpoints shall place the room into a "Privacy" state, preventing the monitoring of audio activity in that room. When in the state privacy, the touchpoint shall illuminate indicating privacy status. When a call is initiated from the Call Station, the privacy state shall automatically be suspended for the duration of the call and automatically re-enabled when the call is complete. If a Console places a call to a location that has a Call Station that is in "Privacy", the caller shall be given verbal instructions, automatically generated by the console, that the room has been placed in privacy and the callers options are to cancel the call, leave a message waiting indication or connect regardless. If they choose to connect, the audio shall be allowed to be transmitted from the console to the room, but the calling party shall not be able to listen to the room audio unless the party in the room turns off the privacy feature.

F. Call stations that are equipped with "DO NOT DISTURB" (DND) touchpoints shall place the room into DND mode when pressed. When DND mode is enabled, the back lit LED on the station shall illuminate, indicating that the station is in a DND state. Schedule scheduled events, zone pages and normal priority audio programs shall be blocked from being broadcast into a room that is set into the DND state. However, Emergency pages, manual tones and high priority audio programs shall continue to be broadcast into the room. If a call-in is initiated from a room is set to DND, the DND status shall be automatically suspended for the duration of the call, and automatically re-enabled when the call is completed. If a call is placed from a Console to a location that has a Call Station set to DND, ", the caller shall be given verbal instructions, automatically generated by the console, that the room has been placed in DND and the callers options are to cancel the call, leave a message waiting indication or connect regardless. If they choose to connect, the intercom call shall proceed normally allowing the caller to speak to the party in the room.

G. Call stations that are equipped with "CHANNEL SELECT" touchpoints shall toggle through the available public channels that the room shall be tuned to.

H. Call stations that are equipped with "VOLUME" up and down touchpoints shall increase or decrease the volume of the current audio operation type the call station is engaged in. The type of audio operations that can be affected are intercom, normal page, emergency page, and public channel.

2.9 SUPERVISED NETWORK INTERCOM STATIONS

A. The Supervised Network Security Intercom Station (subsequently referred to as Intercom Station) shall be a Telecor model eSTN-0, eSTN-1, eSTN-2, eSTN-3, or approved equal. The Station shall be supervised and used to establish communication between specific areas of a facility, providing for two-way communications as well as call-in capabilities.

B. The Station shall be equipped with zero to three tamperproof push-button switches

as required for the application. The unit shall be inscribed with simple operating instructions on the stainless steel faceplate. Stations shall support placement of a call-in (normal or emergency), the annunciation of a call-in, answering of a call-in for intercom, and placement of an all call, emergency, or zone page as required.

C. The Station shall have a station status LED indicator with "Status" inscribed on the faceplate.

D. The Station shall provide a dry contact output that can be activated remotely from another station or from a console, such as may be required in a door release application.

E. The Station shall receive power and data through a Power-Over-Ethernet switch. Once plugged into the LAN through a Power over Ethernet network switch, the Station shall be immediately functional and be able to receive calls and pages from consoles on the network. The Station shall not require any network configuration or administration to function.

F. The Stations shall have a call-in roll-over feature where if it receives a call-in as a primary call destination which is not answered after a preset amount of time, the call shall be automatically escalated to a secondary call destination. If both the primary and secondary call destinations are unavailable, the call shall be redirected to a back-up station or console.

G. The Station shall have the capability to be configured as a member of 1 or more paging zones.

H. The Station shall be wall-mounted on a 3-gang backbox with a depth of no less than 2.75". Mounting hardware shall be tamper-proof. The face plate shall be fabricated from 11 gauge stainless steel with a brushed, mar-resistant finish. The Station shall be designed to withstand physical damage and everyday wear-and-tear. The buttons shall be tamper-proof and the overall assembly shall be designed to be vandal-proof. A G3 weather-seal gasket shall be available as an additional option to weatherproof the Stations.

2.10 SUPERVISED ETHERNET TERMINATION BOARD UNIT

A. The Termination Unit shall be a Telecor Model eTBU-MI or approved equal. It shall reside on the facility's LAN providing provide two-way intercom communications between Consoles and industry standard 25 Volt speaker stations.

B. The Termination Unit shall distribute program audio to speaker locations and detect call-in annunciation from call switches in room locations. It shall be able to selectively transmit Paging, Audio Programs and Time Tone Signals originating on the eSeries Network Devices, to individual rooms, all rooms, selected rooms, or zones of loudspeakers.

C. The Termination Unit shall be consistent with the ANSI/NEMA SB 40 Standard for Communications Systems for Life Safety in Schools, supporting multiple call-in locations per room. These include the support of call-in devices with LED call assurance and privacy or do-not-disturb indication for each room. Multiple devices at a room location shall be configured to place call-ins with different destinations and priority levels. If the call-in destination of these devices is a Console or an IP-PBX phone extension, the device display shall indicate the calling room location dial number, a textual room name, and the priority level of the call-in. Room locations can be configured with a primary, secondary, and back-up call-in

destinations. Emergency priority call-ins placed from a room location shall be configured with a different call-in destination.

D. The Termination Unit shall support a Message Waiting (MW) feature. This feature shall use the LED on call stations to indicate waiting messages to room occupants. If no one is present in a room location to respond to a call or if the room is in Privacy or DND mode, the caller has the option to activate a MW indication. This causes the LED on the call station to pulse. When a call-in is initiated from the room, it shall be directed to the device that activated the MW indication and the MW indication will be deactivated.

E. The Termination Unit shall support the Privacy function on Call Stations that are equipped with a Privacy button. When pressed, the Privacy button shall place the room location in privacy mode. This shall prevent monitoring of audio in the room. In privacy mode, the LED on the Call Station shall illuminate to indicate privacy mode. When a call-in is placed from the room location, privacy mode shall automatically be suspended for the duration of the call and re-enabled afterwards. If a call is placed to the room location while in privacy mode, the caller shall be alerted to the privacy mode and given the option to connect the call, leave a message waiting indication, or to cancel the call.

F. The Termination Unit shall include support for the Do Not Disturb mode. Call Stations equipped with a Do Not Disturb (DND) button shall be able to place the room in DND mode when pressed. In DND mode, the LED on the Call Station shall flash to indicate that the station is in the DND mode. This shall suspend zone pages and normal priority audio distributions from being broadcast into that room. DND mode shall not prevent emergency priority operations from reaching the location. If a call is initiated from a room location that is in the DND state, the DND shall be automatically suspended for the duration of the call and re-enabled afterwards.

G. The Termination Unit shall also provide synchronization and correction of traditional Digital and Analog Clocks, as well as Electronic Message Displays. The digital signaling that provides support for these devices shall originate in the eSeries Network. Analog Clock correction formats supported by Legacy T2 or XL systems, shall also be supported by the Termination Unit.

H. The Termination Unit shall monitor the wiring of all room location call devices for call line failure. It shall analyze the wiring for an open circuit, short circuit, or short to ground conditions. In the event of a fault, the Termination Unit shall detect the fault and provide trouble notification messages to devices equipped with trouble LED and buzzers which will annunciate the trouble signals.

I. The Termination Unit shall be equipped with an integrated 25 watt, dual-purpose intercom/paging amplifier. It shall be used to provide amplification for two-way intercom communications to room stations, as well as amplification for paging, audio programs, and time tone signals to speaker locations. In the event that the audio load is greater than 25 watts, a line level output shall provide for the connection of an external power amplifier.

J. All speakers, when connected to the Termination Unit shall reside on an "Off Bus." This shall ensure failsafe operation, where even in the event that network connectivity is lost, a redundant audio source can be connected to the "Off Bus" and emergency paging announcements can be transmitted to all speakers connected to the Termination Unit.

K. The Termination Unit shall mount in a standard rack panel measuring 19" W x 1.75" H and shall occupy a single rack unit. It shall be ideally suited for use with the Telecor C5PPL patch panel. Alternatively, two 50-pin, RJ-21 connectors shall provide termination facilities to a pair of TM-2X25 terminal blocks for connecting field devices. The unit shall be powered from an external 24 VDC Power Supply.

2.11 SUPERVISED SPEAKER BREAKOUT MODULE

A. The Speaker Breakout Module shall be a Telecor model eSBM-TB or approved equal. It shall provide the means of integrating traditional analog speakers and call initiating devices to the eSeries System. The Module shall also be a Single Zone Paging Adapter that can drive an amplifier to provide paging coverage in a facility. The Module shall have three relay outputs that can activate automatically during a call processing operation.

B. The Module shall receive power and data through a Power-Over-Ethernet switch. Once plugged into the LAN through a Power over Ethernet network switch, the Module shall be able to place or receive calls and pages from the eSeries network. The Module shall not require any network configuration or administration to function.

C. Speech shall be transmitted through the Module in crystal-clear HD Audio. Audio shall be transmitted in the frequency range from 50 Hz to 7 kHz and shall use a maximum of 128 kbps of bandwidth during a call. Audio between the Module and eConsoles shall be non-blocking.

D. The Module shall support eSTB-12 2x2 Ceiling Inlay Speakers, which shall connect to the eSBM-TB via a standard CAT5 cable or conventional 8Ω/25V/70V speakers to provide paging and talkback operation from eSeries e300 eConsoles or phones via an eSIP and an IP-PBX.

E. The volume of the speakers shall be adjustable individually, by zone, or across the entire eSeries network via the ePort Management Interface or eCI Control Interface. Volume controls incorporated into certain eCS station models shall also allow a user to adjust the speaker volume locally. Volume levels shall be set by specific functions: intercom, paging, emergency paging, and Public Channel operations.

F. Call-in capabilities shall be provided with addition of any of Telecor's eSeries Call Stations. The eCS-6 and eCS-3 shall be used to initiate Normal and Emergency calls respectively. Advanced stations that provide additional features shall also be available: the eCS-1 (Privacy and Normal Call), eCS-2 (Do Not Disturb and Normal Call) , and eCS-4 (Volume Control, Public Channel Select and Normal Call). All eCS Call Stations shall also provide "message waiting" indication.

G. The eSBM-TB shall also support placing normal and emergency priority call-ins from simple pushbutton call switches. Pressing the normal call switch shall initiate a normal call-in, and either pressing it three times quickly or pressing and holding it for three seconds to shall place an emergency call-in. Pressing the emergency switch once shall place an emergency call-in.

H. The Module shall have the ability to direct normal and emergency call-ins to different devices. If the device that is configured to receive the call-in loses network connectivity, the Module shall automatically search for an alternate

destination. If no other suitable call-in destinations exist, the Module shall audibly and visually indicate a fault.

I. The Module shall have a call-in roll-over feature where if a call-in to the primary call destination is not answered after a preset amount of time, the call shall be automatically copied to a secondary call destination. If both the primary and secondary call destinations are unavailable, the call shall be redirected to a back-up eConsole.

J. The Module shall have the capability to be configured as a member of one or more paging zones.

K. The Module shall have a built-in 4-watt audio amplifier that shall drive up to 4 watts of audio to a small zone of 25/70 volt loudspeakers. The module shall provide a line level audio output that can connect to an external power amplifier for applications where the speaker zone load exceeds 4 watts.

L. The Module shall be monitored for network connectivity. If the Module's network connection is lost, targeted e300 eConsoles shall report that station as absent and display its dial number. When the Module is used with eCS Call Stations, the Module shall also provide full supervision and monitoring for Call Station and call-in destination connectivity. If a wiring fault is detected between an eCS Call Station and the Module, the Module shall audibly and visually indicate the error utilizing the status LEDs on the Module. The eCS Call Stations shall pulse to indicate a trouble condition. In case of a fault, the ePort or eLog shall log the location, time, date and type of fault. If so configured, the ePort, eLog, eCI and eAmplifiers shall also generate an alarm tone.

M. The Module's status LED that shall flash in different patterns to indicate normal operation, call-in assurance, message waiting, a call or paging audio in progress, or to indicate an error.

N. The Module shall be equipped with three relays that can be used to operate auxiliary devices such as strobe lights, tone initiating devices and door locks.

O. The eSBM-TB shall be wall-mounted using the attached mounting brackets.

2.12 SUPERVISED NETWORK AMPLIFIERS

A. The Supervised Network Amplifier (subsequently referred to as Network Amplifier) shall provide a minimum of 25 watts for paging and public address and shall be capable of utilizing analog amplifiers to increase the amount of amplified signal from the network amplifier. The Network Amplifier shall be connected directly to the network switch by an RJ45 connector and shall receive signals directly from the network.

B. The Network Amplifier shall be supervised and in the event that network communications is lost, an audible alert shall sound on the Amplifier. The Network Amplifier shall provide a silence feature to mute the audible alert for 24 hours.

C. The Network Amplifier shall also be capable of receiving local input from local devices such as tape decks, iPod docks, CD players, etc. The network amplifier shall be capable of transmitting signals received from the local input to other network locations or locally to directly connected 25/70 volt or 8 ohm analog speakers.

D. Each Network Amplifier shall be capable of providing two audio inputs for local devices and shall be programmable as either a microphone or line-level input.

E. The Network Amplifier shall be controlled remotely such that audio programs, input, tones, textual messages, or announcements may be initiated by other devices connected at different locations on the local area network.

F. The Network Amplifier shall have a minimum of 4 local tone/pre-recorded announcement audio message control lines which when activated will distribute tones/pre-recorded audio messages to intended network amplifiers for re-distribution, network talk-back speakers (or a zone), and/or local 25/70 volt or 8 ohm analog speakers directly connected to amplifier. Each network amplifier shall be capable of storing four (4) pre-recorded announcements in addition to a minimum of 16 tones. Tones and announcements shall be activated locally or from other network devices.

G. The Network Amplifier shall store and transmit companion textual messages for each stored audio announcements. Textual messages shall be automatically broadcasted to the same zones along with the audio messages such that any device programmed for that zone automatically receives both the audio and textual announcement/message and automatically reproduced each or both messages to the extent of the devices' capabilities.

H. The Network Amplifier shall be capable of transmitting HD level audio as defined by Intel(™) High Definition Audio specifications, June 17th, 2010 at a minimum.

I. The Network Amplifier shall shut down to protect itself should an output short circuit fault or overload occur that jeopardizes the integrity of the Network Amplifier.

J. The Network Amplifier shall be able to continuously broadcast public channel audio that other devices shall be able to tune to. The Network Amplifer shall support one public channel audio source. The eSeries network shall support up to 10 simultaneous public channels. Public channel audio being received by any station device shall be of the lowest priority and will be overridden by any other audio broadcast, pages, and intercom calls.

2.13 SUPERVISED INTERACTIVE GRAPHICAL USER INTERFACE

A. The system shall include an Interactive Graphical User Interface (subsequently referred to as IGUI). The software shall reside on Telecor provided PC and should have ability to interface to District Wide Emergency Communication system located in district office.

B. The IGUI shall be supervised and shall utilize an easy-to-use Graphical User Interface for quick and easy graphically aided navigation to access functionality for all intercom stations, paging zones, and program distribution sources. Emergency operations shall be simplified through the IGUI allowing stored audio files and alphanumeric messages for message displays to be activated from the IGUI. The IGUI shall allow common operations such as daily announcements to become simplified into single touch activated icons; removing the need for multi-step console set ups and dial strings.

C. The voice device used to originate voice communication for the IGUI to selected locations shall be a system console, telephone handset, or microphone independent

from the computer hosting the IGUI. The voice device shall remain functional and accessible regardless of the operational state of a computer supporting the IGUI.

D. The IGUI shall allow the creation of a custom operating screen(s) based on the floor plans of the facilities. Icons representing intercom stations, zones used for paging, tone distribution, textual Message distribution, and audio program distribution shall be incorporated onto the floor plans. The IGUI software shall provide:

    a. Simple routine call processing, including: hold, transfer, and forward
    b. Activation of remote station auxiliary relays for applications such as door lock or release
    c. Emergency functions
    d. Paging
    e. Audio program distribution
    f. Customizable page elements
    g. Customizable operating screen
    h. Element library for emergency event icons
    i. Initiation of emergency and non-emergency messaging, textual and audible
    j. Remote station volume adjustment
    k. Remote activation of do not disturb status and/or message waiting status
    l. Remote station trouble indication
    m. Remote station background music channel selection
    n. Dynamic zone management for interactive on-the-fly console specific zones
    o. Single touch emergency response (supporting both actual emergencies and drills) including but not limited to all or any combination of the following:

        - Live voice notification
        - Pre-recorded audio message
        - Digital plain text messaging with simultaneous numerically coded message capability
        - Remote system activation, i.e., access control systems, CCTV systems, door release systems, etc.

E. The IGUI must provide an efficient and reliable method of notifying the occupants within the facility of critical situations. A variety of emergency tone signals that reside within the intercom/paging system shall be activated by clicking on pre-programmed buttons on the IGUI screen, initiating the transmission of tone signals to speakers, and alphanumeric messages to message displays/digital clocks. A "lockdown" icon shall be designed as per Owner direction, with Owner selecting the appropriate tone. Whole building macros for emergency or off-normal response shall be built into the internal communication system as directed by the Owner. Each macro shall be capable of being activated by the console, the IGUI as indicated on plans or as directed by the Owner or AHJ. It shall be possible to activate a WAV file message or Owner selected tone coinciding with multi-language textual messages for distributions to zones as directed by the Owner, all from a single activation icon located on the IGUI. Other single action macros shall be activated in similar fashion via the IGUI and a custom labeled icon. Plain language labeling of all icons on the IGUI shall be user changeable.

2.14 CONTROL INTERFACE

A. The Control Interface shall be a Telecor model eCI or approved equal. It shall provide a Desktop Application for PC interaction with the Intercom and Paging system, a Command Interface Protocol for external system interaction with 3rd party systems, Group Zone functionality, and a Scripting Engine supporting multiple sequential operations.

B. The system shall incorporate a Windows based Desktop application that makes use of a Command Protocol Interface, allowing external systems to interact with the Network Intercom and Paging System. Combined with the Scripting and Group Zones features, the Desktop application shall be able to generate a preprogrammed series of operations from a single action. These features shall be used in conjunction with a graphical user interface and the Microsoft Windows desktop.

C. Default Scripts shall be used to generate customized shortcuts according to the needs of a facility. These shortcuts shall then be placed directly on the Windows desktop and shall be able to activate virtually any Intercom and Paging function by clicking on the shortcut icon. These shall include activating:

   a. Alerts, audio distributions, coded and plain text messages, intercom operations.
   b. Pre-Recorded Evacuate, Lockdown, and All Clear audio files.
   c. Companion text messages for audio alerts.
   d. Coded messages on all secondary digital clocks and displays.

D. The Desktop Application shall also be able to use to activate SMS text messages, computer pop-up notifications, and email distributions in conjunction with any Desktop Script. Desktop Icons such as a Panic Button shall be able to send SMS notifications to a crisis team, advance warning to building occupants through pop-ups to heighten the level of awareness.

E. Any Desktop location running the Application shall have the ability to create and send an instant message using the Desktop's keyboard any display. The textual message can be sent independently or as a companion message to an audible alert.

F. The Desktop Application shall be capable of utilizing Soft Call and Panic buttons. Soft Call buttons shall be able to be created to operate as a call button on the desktop with a normal or emergency call priority. They shall also be able to be combined with other preset or on-the-fly custom text messages. Panic buttons shall allow a user to unobtrusively activate an audio path from the panic button location to another eSeries device at a security location. This shall allow security personnel to listen to an occurring situation and provide the appropriate response.

G. The System shall be capable of streaming multiple audio programs over 10 available channels, simultaneously, to speaker locations in the facility. The ability to turn the broadcast on or off to a specific location shall be controlled from the Desktop Application.

H. A user from the Desktop Application shall be able to enable or disable Do Not Disturb (DND) mode for a group of devices such as speakers or intercom stations.

I. Volume Adjustments to individual devices, devices in a zone, or all devices in the intercom and Paging System shall be able to be made from the Desktop Application

J. The Desktop Application shall be able to be used to create a call directory to provide

the user with the ability to quickly and easily place calls to a large number of prospective recipients and locations. The shortcuts shall be able to be customized with the name of the call recipient or location. The call directory shall also be able to contain shortcuts that activate message waiting indications in addition to the option of placing calls.

K. The system shall interface with other external systems using a Command Interface Protocol. External systems include integrated security management or building management systems via devices such as computers, programmable logic controllers, or software based annunciator panels.

L. The Command Interface Protocol shall be used to send real time commands and receive real time status messages between the 3rd party system and eSeries devices. The Command Interface Protocol shall be an ASCII protocol that includes both outbound messaging, and support for inbound command via a virtual COM port and a physical USB connection.

M. Scripting shall allow operations to be carried out in sequence. Scripts shall be activated in various ways including: automatically based on the day of week and time of day, using an eConsole or a phone, or by using eDesktop, or from other scripts.

N. When scripts from an eConsole or PBX phone (via eSIP), the name of the script shall be displayed on the eConsole or phone. Then the user shall be presented with options to enable or disable the script (depending on the current state of the script). eConsoles and PBX phones that dial the script number shall hear voice prompts for enabling or disabling the script.

O. Scripts shall be used for scheduling time tone programs that include tones, pre-recorded messages, and textual messages displayed on e365-TB Message Display/Clocks reoccurring at specific times and days.

P. Scripts shall be able to perform cascading evacuation operations where evacuation audio messages are automatically first distributed to zones closest to the location of an emergency before spreading outwards to other zones according to a time schedule, thus reducing evacuation route congestion throughout the facility.

Q. Group Zones shall allow groups of page zones or devices to be defined as a group zone with a dial number. Group Zones shall be able to be accessed from eDesktop, eConsoles or PBX phones.

R. Group zones shall be the destination for various functions including textual messages, or audio operations, such as pages or audio program distributions). Group zones shall be assigned customized names which will appear on eConsole or phone displays when they are dialed.

S. Group Zones shall make it possible for a dial number to forwarded to a different destinations based on time and day. For example, common audio operations directed to a Group Zone dial number shall be able to be configured to go to the usual destination during regular hours but to a different destination outside of regular hours.

T. Group Zone shall support designated priorities, such as emergency. Operations that are to a zone with a priority are automatically elevated to override any normal or lower priority operations the devices in that group zone are receiving.

2.15 SUPERVISED SIP TRUNK IP/PBX INTERFACE

A. The system Session Internet Protocol (SIP) Interface shall be a VoIP PBX phone interface of the same manufacturer as the supervised network intercom and paging system. Third party gateway devices shall not be accepted.

B. The SIP Interface shall be supervised and shall connected directly to the facility's network and the PBX's network and shall provide the following:

   i. Establish a barrier gateway between the intercom and paging network and the PBX and/or common computer network.

   ii. Transparent audio operation between VoIP PBX phones and any device on the supervised network intercom and paging system. Paging access from any telephone on the facility system VoIP PBX to any intercom speaker, speaker zone, intercom station, console, all speakers, or paging horns and zones throughout the facility.

   iii. Any call-in from the supervised network intercom and paging system shall be capable of being routed directly to a VoIP PBX phone. Call-in stations can be configured and programmed to automatically dial any number on the publicly switched telephone network, landline, or cellular number through the SIP interface and via the PBX.

   iv. Ability to escalate a call-in directed to a console to be redirected to a VoIP PBX connected phone via the SIP Interface. Escalation can also include the ability to dial any number on the publicly switched telephone network, landline, or cellular number through the SIP interface via the PBX.

   v. Ability to initiate alarm and crisis response protocols from any VoIP PBX connected phone.

   vi. Ability to require security access code to utilize the intercom or paging system emergency communication features.

   vii. Minimum of 10 simultaneous telephone channels of access to/from VoIP PBX phone system. Full caller ID support from any supervised network intercom call-in device to a VoIP PBX connected phone identifying the calling station ID/Location.

   viii. Emergency level call-in to be uniquely identified as emergency on the VoIP PBX phones.

   ix. Activation of all supervised networked intercom and paging system emergency tones and pre-recorded announcements from any phone connected to the building VoIP PBX phone system.

   x. The SIP Interface shall additionally allow for calls to be placed from a console to any phone number on the publicly switched telephone network (landline or cellular). Additionally, intercom calls at a console may be transferred to any number on the publicly switched telephone network to any landline or cellular number through the SIP interface via the PBX.

C. Systems that connect to a building or district phone system and are limited to a SLT or CO connection will not be accepted as a substitute for a fully operational SIP Interface.

D. The SIP Interface shall support integration with InformaCast systems. The InformaCast system shall be able to activate messages activated via dialing on a Console and via the InformaCast web interface. The InformaCast messages shall include text to message displays, pre-recorded audio, and ad-hoc audio to eSeries devices which will be appropriately distributed to targeted and applicable eSeries devices.

2.16 MASTER CLOCK /MESSAGE HOST

A. The Master Clock / Message Host shall be a Telecor model eMH or approved equal. It shall be a time master device for the eSeries network which enables configuration and activation of eSeries operations from a web-based graphical user interface (GUI). An unlimited number of operations shall be managed for activation by schedules or use The application shall be web-based and secured via HTTPS certification. It shall be preconfigured with a variety of default operations, schedules, audio, and icons for quick customization. Users shall log into the application from any desktop computer or mobile smart device using a supported web-browser. Supported web browsers shall include Microsoft Edge, Mozilla Firefox, Google Chrome, and Apple Safari.

B. Master Clock functionality shall include central time keeping and synchronization of all other eSeries devices throughout the eSeries network.

C. The Master Clock shall manage an unlimited number of calendar-based schedules, which are collections of operations intended to be performed frequently, periodically, or on specific dates and times. For example, a schedule may be a series of bell tones that consistently indicate class changes. Users shall set schedules so that the operations they contain will activate accordingly.

D. Schedules shall be viewed, enabled or disabled in a calendar. The calendar shall display schedules on a daily, weekly, monthly or yearly basis. The eMH shall support scheduling operations up to 10 years into the future.

E. An unlimited number of holidays shall be specified and marked on the calendar. This shall indicate days where disabling all schedules may be appropriate.

F. The Master Clock shall obtain time from and synchronizes with Network Time Protocol (NTP) servers directly or via an NTP-enabled eSIP present on the eSeries network.

G. Operations shall include several components, including: pre-announce tones, pre-recorded audio, scrolling textual messages, and coded messages. If desired, specific details of the components shall be customized. Customization shall include: the number of times the pre-announce tone plays, the message scroll speed, and the delay before pre-recorded audio repeats. Depending on the operation type, user-activated operations shall be distributed immediately or queued for later distribution.

H. The Home page shall provide a quick overview of eMH-managed operations. This shall include the next scheduled operation, the schedules that are currently active, and the next scheduled school drill. The eMH shall include user specific short tutorial videos that explain various aspects of the GUI and provides built-in on demand training.

I. The Live page shall show currently active and upcoming operations. A history of recently performed operations shall confirm operations occurred as intended. Also, users shall easily initiate on-the-fly operations on the Live page by configuring and activating them on demand.

J. Routine operations shall include an unlimited number of pre-configured common audio distributions. Examples shall include announcements for special assemblies, bus arrivals, staff meetings, and festive events.

K. Operations shall be associated with eSeries eCI scripts so that they shall be activated by users. The GUI shall indicate if the eCI script is active even if it was activated via other means such as dial access code or Visual Console for eSeries. Other emergency operations (such as Lockdown) shall also be seamlessly integrated with Visual Console for eSeries.

L. Audio files shall be used for tones or announcements while images shall be used as icons throughout the GUI to represent different operations or schedules. Audio file formats shall include (WAV and MP3) and images to support operations.

M. Access shall be user-account controlled. An unlimited number of users shall be supported with a high level of individual customization. Users shall be given access to only the pages and operations relevant to their intended roles. For each page, users shall be granted permissions to activate or configure operations and schedules from a desktop or, for certain users, from mobile devices. An administrator account shall have full access to view and make configuration changes on all pages, while an operator account shall be limited to activating routine or emergency operations and enabling or disabling schedules.

N. Users with administrative privileges shall have the ability to configure the site name, time, time zone, test zone, and import and export databases. To aid installers with initial configuration, a test mode shall be provided as well as a database import/export feature. Test mode shall redirect all activated operations to a test zone (that only the installer occupies) to prevent disrupting other people during configuration and testing. Database import/export shall allow the configuration to be exported for backup purposes or to copy to other installations.

O. The system shall be configured for an unlimited number of dedicated emergency response operations. A corresponding drill operation shall be automatically created for each emergency situation. Users shall be able to activate emergency response operations from facility PCs or remote mobile devices.

2.17 SUPERVISED MESSAGE DISPLAY/CALENDAR CLOCK/SPEAKER/STROBE

A. The Supervised Message Display/Calendar Clock/Speaker/Strobe Assembly (subsequently referred to as MDCSS Assembly), as indicated on the drawings, hall be a Telecor model e2444-LD or approved equal Project Name End-Point Network Intercom and Paging System County or Description Section 17300 – Page 23 City, State End-Point Network Intercom and Paging System 17300-23

B. The MDCSS Assembly shall receive power and data over a RJ45 connect CAT5E/6 cable via a Power-Over-Ethernet switch port. Once plugged into the LAN through a Power over Ethernet network switch, the MDCSS shall be immediately functional and shall not require any network configuration or administration to function

C. The MDCSS Assembly shall be supervised and monitored for connectivity to the

network. Additionally, any Call Stations connected to the MDCSS shall be monitored for call line failure. In the event of an open circuit, short circuit or short to ground, the System shall detect the fault and notify a designated console operator automatically

D. The MDCSS Assembly's Speaker shall have a power rating of 10 watts of audio signal and provide a minimum of 92db @ 1 meter SPL for maximum intelligibility.

E. The MDCSS Speaker shall provide transmission of HD audio as generated from intercom console and/or associated push-to-talk, intelligent microphone, supervised network amplifier, or program sources connected to the network.

F. The MDCSS Speakers shall support talkback; to optimize intelligibility talkback capabilities shall be supported.

G. The MDCSS Assembly shall support the direct connection with RJ45 connectors of two supervised room Call Stations. The stations shall provide the means for: normal calls, emergency calls, privacy mode, and do not disturb mode, as well as for the adjustment of Audio Volume. Call Stations shall include a call placed assurance status LED to indicate a call has been placed. Call Stations shall be supervised and immediately indicate disconnection or a wiring fault.

H. Emergency Call Stations shall be separate and clearly labeled with a red button so as to impart obvious operation in the event of an emergency. Systems that only provide a single call station with dual emergency and normal operation based on a sequence of button presses shall not be acceptable.

I. The volume of the MDCSS Speaker shall be adjusted individually, by zone, or across the entire network. Volume controls incorporated into certain Call Station models shall allow a user to adjust the volume of a local MDCSS speaker. Volume levels can be set for specific functions: intercom, paging, emergency paging, and Public Channel operations.

J. Volume controls shall be capable of establishing and maintaining levels for intercom, paging, program distribution, and tones, independently for each of the above functions. Emergency announcements shall not be affected by the adjustment of other speaker volume/levels such as paging, intercom, or other lower priority audio broadcasts. Systems that utilize a manually operated transformer or resistive volume control design shall not be acceptable.

K. The MDCSS Speaker shall have the capability to be configured as a member of one or more paging zones.

L. The MDCSS Assembly shall include an integral LED Strobe that shall illuminate for the duration of an announcement being broadcast over the MDCSS speaker to alert room occupants of the announcement in progress.

M. The LED Strobe shall be configured to illuminate in up to 4 colors (white, red, green or blue) with various flash patterns. Patterns can be set to activate based on the priority of announcements. For example, using a distinct color and flash pattern for an Emergency Announcement while a routine announcement or intercom call can be assigned another pattern and color. Project Name End-Point Network Intercom and Paging System County or Description Section 17300 – Page 24 City, State End-Point Network Intercom and Paging System 17300-24

N. The MDCSS Assembly shall include a Message Display/Clock that shall simultaneously display plain text emergency or routine messages and

independent numerically-coded messages. When not displaying a message, it shall display the current time and date. Hours and minutes shall be displayed with large 2.25" digits. Seconds shall be slightly smaller for easy distinction. The date shall be displayed in plain text by a 10-character, dot matrix display showing the day of the week, followed by the month and date. The date shall be displayed in the English, Spanish or French language.

O. The Message Display/Clock shall automatically broadcast the audio announcement and a corresponding text message that is initiated on the over the communications system. These shall be enhanced by strobe illumination.

P. The Message Display/Clock shall also display text-only messages independent of any audio messages.

Q. In addition to plain text messages, the Message Display/Clock shall also simultaneously display numerically-coded messages which can be activated independently to provide trained staff with additional context to the plain text messages.

R. The Message Display/Clock shall include elapsed timer and count-down functions. Used in conjunction with a Timer Button Panel, users shall set the Clock to count upwards from zero to 24 hours or count down from a specified value to zero. Additionally, the unit shall have a local input that will accept a relay closure to activate the elapsed or countdown timer operation. Timers embedded into pre-set plain text messages shall display messages for a pre-set period of time.

S. All Message Display/Clocks shall be continuously synchronized to a Time Master connected anywhere on the same network Time corrections shall be performed instantaneously so that all Clocks display the correct time. If communication is lost with the Time Master, Clocks shall maintain the time independently and stay synchronized with each other. Once communication with the Time Master is reestablished, the displays shall automatically resynchronize with the Time Master.

T. The MDCSS Assembly shall integrate with the Classroom Sound Field System and automatically mute the System during an intercom call, paging announcement or class change tone signal. Integration shall include the ability for an Emergency level call to be initiated from the Sound Field pendant microphone to the Administrative Console.

U. The MCDSS Assembly shall be equipped with 3 control relays to support integration with ancillary classroom devices. The relays shall be automatically activated during an emergency call-in or when receiving a broadcast or textual emergency message.

V. The LED strobe shall require Class 4, PoE+ power from the Network Switch.

W. The MCDSS Assembly shall be flush mounted using an e2444-BBF, or approved equal enclosure. In applications where surface mounting is required, an e2444-BBS or approved equal enclosure shall be provided.

3. **EXECUTION**

A. Install the system in accordance with the manufactures printed instructions and

recommended cable types.

B. Provide point to point wiring diagrams showing location of all wire pulls. Mark all cables corresponding to point to point wiring diagrams.

C. System Acceptance Test

1. Have the company field adviser adjust the completed system to desired volume levels of customer.

2. The system shall operate for at least two weeks with no failures or changes required.

3. Test every circuit in the system to ensure proper operation.

4. Test each daily function school will be using making sure staff is knowledgeable in the operation of the system.

D. The Contractor shall provide a one-year warranty of the installed system against defects in material and workmanship. All labor and materials shall be provided at no expense to the Owner during normal hours. The warranty period shall begin on the date of acceptance by the Owner.

E. The Contractor shall, at the Owner's request, make available a service contract offering continuing factory authorized service of this system after the initial warranty period.

F. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.

SECTION 275202
Cafeteria Sound System

PART 1 - GENERAL

RELATED DOCUMENTS

Drawings and general provisions of contract, including general and supplementary conditions and division-1 specification sections, apply to work of this section.

DESCRIPTION OF WORK

Furnish all labor, materials, tools and equipment necessary for complete installation and checkout of the system as outlined in these specifications. The intercom system company shall manufacture the new cafeteria sound systems.

All cabling shall be run in conduit. Minimum size of raceway shall be 3/4”c. The systems manufacturer shall furnish and install the systems cabling and this low voltage system contractor shall furnish and install the raceway system. The low voltage system contractor should install the raceway for this system wiring according to the point to point wiring diagrams submitted from the manufacturer.

CONTRACTOR QUALIFICATIONS

The Low Voltage System Contractor shall be normally engaged, for a period of five years or more, in the design, installation and maintenance of this type of system and shall be the authorized distributor the equipment supplied under this contract. The contractor shall maintain his own service organization under his direct control capable of furnishing service under the warranty as specified. The contractor shall provide a letter from the manufacturing indicating that he is the authorized distributor of the equipment provided. The contractor shall also provide a letter in the submittals stating that he is in compliance with the above requirements. The architect reserves the right to request a resume.

The Low Voltage System Contractor shall make available to the Owner, the service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts.

The Low Voltage System Contractor must be licensed in the State of Georgia within the electrical trade and show proof of low voltage certification.

The Low Voltage System Contractor must show proof of being in the low voltage Data Communication trade for a minimum of three years.

The Low Voltage System Contractor must provide three (3) references with contact names and telephone numbers regarding successful completion of Data Communication projects.

The Low Voltage System Contractor shall show proof of having at least one Registered Communications Distribution Designer (RCDD) on staff.

All the above information must be provided at the time of the contract award, prior to signing the contract.

SHOP DRAWINGS

Submit drawings on the system and all its components including wiring diagrams, schematics and interconnections.

Where equipment is specified herein or on drawings, by manufacturers' names or numbers, this shall denote minimum requirements as to quality, type, capacity, function, and performance. All equipment must have the Engineer's approval before ordering. Submit not less than six (6) copies of submittal data on all equipment and materials.

Submittals shall be bound in a binder with index tabs and shall include a cover sheet for each piece of equipment itemizing equipment features to show compliance with or deviation from the requirements contained in the specifications and drawings.

Submittals may be submitted in electronic *.pdf format. File name shall include the job name, specification section and date of the submittal. Submittals containing multiple items must include a table of contents with hyperlinks to the cover page for each item. The cover page for each piece of equipment shall itemize equipment features to show compliance with or deviation from the requirements contained in the specifications and drawings. If the supporting product data is more than ten (10) pages long, include hyperlinks on the item’s cover page to the supporting information.

OPERATION AND MAINTENANCE INSTRUCTIONS

The Contractor shall furnish not less than three (3) copies of operating and maintenance instructions for all equipment he has furnished and installed. Manuals shall be in durable 3 ring binders with the job name, General Contractors and sub-contractors names, addresses, contact information, and general description of the contents on the front cover and side spline. C. Product data shall be grouped into logical groups and divided with tab type dividers. An index shall be provided. The index and dividers shall be numbered for quick reference.

TESTING

At the completion of the work, a thorough test shall be made in the presence of the Engineer or his representative, with all equipment, machinery, and appliances in operation and free from defects. The Contractor shall uncover all concealed areas and remove all panelboard covers during the inspection if requested.

The intent of this specification is to provide a sound reinforcement system and all necessary low voltage wiring.

The major system components include, but are not limited to:

- Amplifiers
- Audio Mixers
- Speakers
- Processor
- Wall Plates
- Cables and wiring

SCOPE

Provide all labor and material for the complete installation of the equipment as hereafter specified and shown. The necessary conduit, cable trays, raceways and recessed back boxes to be provided by the Contractor.

The audio System Contractor shall furnish all low voltage wiring required for a fully operational system. The equipment shall be installed by factory authorized installers, having not less than (10) ten years experience in installing such systems and shall provide a list of (5) five projects of similar type and scope completed by him the last (24) twenty-four months with contact name and phone number. The Audio Equipment Contractor shall be an authorized dealer for all equipment provided under this section in order to assure availability of parts and service. All system components shall be completely prewired with all field connections clearly labeled. All equipment shall be UL listed and shall comply with the National Electrical Code and all applicable regulations of serving utilities and governmental bodies having jurisdiction.

The equipment shall not be stored at the job site. Equipment shall be moved to the job site from a conditioned space only when scheduled for installation. The entire system shall be fully factory tested prior to shipment and shall be guaranteed against defects in material and workmanship for one year from date of acceptance by the Owner or (18) eighteen months from the date of shipment, whichever occurs first.

No equipment having a shorter warranty shall be considered and equipment purchased shall be covered by this warranty. Unspecified length of warranties shall not be acceptable. Contractor shall provide for replacement of defective materials and repair of faulty

workmanship within (24) twenty-four hours of notification by owner guaranteed at no cost to the owner during the warranty period.

Three sets of as-built drawings shall be supplied with these manuals. All items of video equipment and all installation procedures for the equipment shall meet all applicable requirements of the NEC and local codes.

After installation of the equipment, the Audio System Contractor shall provide a qualified factory trained service technician to check the system and make any adjustments of modifications necessary for proper operation. Installed equipment to be operated for the approval of the Owner's representative(s).

CONTRACTORS QUALIFICATIONS

Contractors making proposals under this specification must meet the following qualifications:

- Be regularly engaged in the design, fabrication, installation and service of professional Audio systems.
- Have been in business for 10 years.
- Have completed, within the last two years, at least five projects similar scope described above. List of references including names, addresses and phone numbers for these five projects must be furnished with the bid.
- Be able to provide service within 48 hours of notification by Owner.
- Have suitable service facilities and test equipment for providing competent service for all professional video/data projection, and sound reinforcement equipment listed in this specification.
- Contractor is to maintain necessary insurance to the full value of the equipment and material on site. The insurance shall cover loss from fire, vandalism and theft, and all be carried until formal acceptance of the completed work. Also, maintain additional insurance to protect the Owner against damage claims for personal injury, including death, which may arise during performance of work covered by this specification.

Contractors submitting bids under this specification are to carefully examine the contract documents and the construction site to obtain first hand knowledge of existing conditions. Contractors will not be given extra payments for conditions which can be determined by examining documents or site and will not be relieved of any obligation with respect of bid.

PART 2 – PRODUCTS

GENERAL

Contractor shall provide and install all distribution amplifiers, mounts, cables, wiring, low voltage cable runs, connections, and electrical multi-plugs to make below stated systems operational.

MIXER/AMPLIFIER

- The amplifier shall be compatible with both high- (70/25V) and low- (4/8- ohm) impedance speakers, with the capability of 100 watts. The amplifier shall provide 8 module bays for plug-in input modules with two of the bays also capable of handling plug-in signal-processing output modules. There shall be 4 levels of priority available between all modules. Each of the 8 module bays shall have an associated independent volume control. Each independent volume control shall have a signal/clip LED to indicate signal condition. Each amplifier shall also include bass and treble controls, as well as a motorized master volume control, which can be remotely operated using the RVCP accessory (sold separately). For larger applications, the amplifier shall be able to bridge to another Power Vector amplifier or mixer using a built-in bridging jack and mute terminals. This connection shall effectively increase the number of inputs. An 11-segment LED output level meter will register either the average or peak level of the amplifier's output level, as selected by an Average/Peak switch. Each Power Vector amplifier shall have a Tone Control Bypass switch and a Low-Cut Filter switch, both located on the rear of the amplifier in module bay 6. A lockable switch will permit the selection of transformercoupled output or direct output for speaker connections. Signal-processing Insert jacks (RCA connectors) will allow external equipment to be inserted between the preamp output and the power amp input. Each model will have a Pre-EQ, unbalanced (RCA jack), buffered output whose signal is post all volume controls, tone controls, and output module signal-processing, but before (pre-EQ) any external signal-processing equipment connected to the Insert jacks. Each amplifier will have bridging in/out capability and individual access to internal module priority buses for easy connection of multiple amplifiers or mixers in a system. Each amplifier will include a 500W maximum, unswitched AC power receptacle
- **Bogen V100 or Approved Equal**
    - Quantity: One (1) each

SPEAKER

- The loudspeakers consist of one 6-1/2" (nominal) low frequency transducer, and one 20mm (3/4") (nominal) high frequency transducer with a filter network for dividing frequencies between the transducers. The input connector shall be a 4-screw snap-lock removable connector, providing "loop-through" for additional speakers. Power input selection shall be via a front-mounted rotary switch, located under the removable

grille. 70V (highimpedance) tap selections shall be 1, 2, 4, 8, 16, and 32 watts; 100V (high-impedance) tap selections shall be 2, 4, 8, 16, and 32 watts. A low-impedance 16-ohm selection shall also be provided. Dispersion area shall be 140°.

- **Acceptable: Bogen OPS1W**
    - Quantity: As shown on the prints.

MICROPHONE INPUT JACK PLATE

- **Acceptable: Lowell WP11 or Approved Equal**
    - Quantity: As shown on the prints.

WALL MOUNT RACK

- **Acceptable: Middle Atlantic EWR-10-22SD or Approved Equal**

MICROPHONES

- **Acceptable: Atlas MW100-HH**
    - **Wireless Microphone Kit**
    - Quantity: One (1) each

PART 3 - EXECUTION

Provide all equipment wiring, conduit and outlet boxes required for the erection of a complete and operating system in accordance with the manufacturer's recommendations, these plans and specifications. All wiring shall be in a completely separate conduit system. Color coding shall be used throughout.

Manufacturer shall test entire system including each device for system signal initiation.

The Contractor shall conduct an operating test and the system shall be demonstrated to operate in accordance with the requirements of the specifications. The test shall be performed in the presence of an authorized representative of the school system whose name shall be included in the report of the test.

A letter from the Contractor shall certify the system is operating within the specified requirements, and the system has been accepted by the school systems representative.

Check each speaker line for correct impedance and short circuits. The load shall not be greater than the amplifier output.

It shall be the sole responsibility of the Contractor to verify all dimensions, take his own field measurements, and install all work to suit conditions encountered on the job site.

The drawings are generally diagrammatic and except where dimensions are indicated are not intended to show exact locations of outlets, conduits, etc. All work shall be installed as nearly

as possible in the locations indicated, with minor adjustments as required to avoid interferences with structure or the work of other trades.

Prior to beginning work, the Contractor shall carefully examine all construction drawings and the job site and report to the Owner any discrepancies or interferences are noted, the Contractor shall promptly report them to the Owner. Failure to report such discrepancies or interferences shall result in the correction of the same at the Contractor's expense. All work under this specification, which either interferes with the architectural or any other work or deviates from the drawings and specifications without prior approval of the Owner, shall be altered by the Contractor at his expense. These alterations shall clear such interferences or shall comply with the drawings and specifications as directed by the Owner.

All equipment must be installed in a neat and orderly fashion by competent workmen according to the manufacturer's instructions at the location shown on the drawing.

MECHANICAL

Except for portable equipment, all other equipment must be permanently installed. Fastenings and supports must provide a safety factor of at least three times that required for safe support. Precautions must be taken to prevent electrostatic and electromagnetic hum and radio frequency interference. All electronic must be easily accessible and have adequate ventilation.

CONNECTIONS
All wiring connections must be made with rosin core solder or mechanical connectors as specified. Terminations on all cable must be dressed properly with shrink tubing. All low voltage control level connections to terminal blocks are to be made with crimp on spade lugs. All crimp on connectors must be fastened with the proper tool as specified by the manufacturer. Improper crimping will be cause for rejection. All "drain" wires on microphone and line level termination's are to be properly dressed using transparent shrink tubing to avoid the possibility of shorting "whiskers".

LABELS
All wiring is to be numbered on both ends with "EZ Code" type markers. Wire numbers are to be secured with transparent shrink tubing. Wire numbers are to follow a logical sequence and are to be listed on the proper document.

DOCUMENTATION
Upon final completion of the system a documentation package is to be turned over to the Owner and include the following items.

System signal flow diagram showing all components, interconnections, connector types and wire numbers of the following systems:

Audio System one line and detail interconnect. Interconnect and wiring designation list. Wire

numbers are to appear on the drawings. Pictorial drawings with dimensions showing equipment placement within the facility, and any special panels or mounting hardware as necessary. Instruction manuals as supplied by the manufacturer for all electronics.

WARRANTY
All equipment is to be new and warranted free of faulty workmanship and damage.

All electronics are to be warranted free of defects for a period of one year from day of final acceptance.

Replacement of defective materials and repair of faulty workmanship is to take place within 24 hours of notification by Owner- guaranteed at no cost to the Owner during the warranty period.

Paint and exterior finishes, fuses, lamps and owner supplied equipment are excluded from the above warranties except when damaged or failure results from defective materials or workmanship covered by warranty. The minimum warranty provisions specified above shall not diminish the terms of individual equipment manufacturer’s warranties.

TRAINING
The Audio Equipment Contractor shall provide a minimum of 4 hours instruction and training on the operation and maintenance of the systems.

CLEAN-UP
During construction periodically remove discarded containers and refuse from the job site. At the completion of the job, the system components and equipment areas are to be left clean and neat and all refuse removed from the site.

SECTION 283111

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

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.

SUMMARY

Contractor shall expand the existing system to add the new devices as indicated on the drawings and these specifications. Maintain existing system at all times. The additional equipment shall be compatible with the existing equipment. The contractor shall check the existing system (and the existing system in the other buildings on campus) and shall verify the complete operation of the system prior to making any modifications or relocating of equipment. The contractor shall provide written correspondence to the county indicating any problems that exist. The Owner shall have the option of contracting with a third party to repair any inoperative equipment, once the system has been verified to be completely operational, the contractor shall have complete responsibility for the system and shall repair any and all equipment that becomes damaged or inoperative prior to final acceptance by the county. Contractor shall maintain all devices and circuiting outside of the areas of renovations and that pass through and feed downstream devices.

The fire alarm subcontractor shall be responsible for furnishing all labor, materials, conduit and cable installation, boxes, devices, etc. in his base price.

All cabling shall be run in conduit. Minimum size of raceway shall be 3/4”c. The systems manufacturer shall furnish and install the systems cabling and this low voltage system contractor shall furnish and install the raceway system. The low voltage system contractor should install the raceway for this system wiring according to the point to point wiring diagrams submitted from the manufacturer.

B. Related Sections include the following:

1. Division 8 Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

1.15 QUALITY ASSURANCE

A. The Low Voltage System Contractor shall be normally engaged, for a period of five years or more, in the design, installation and maintenance of this type of

system and shall be the authorized distributor the equipment supplied under this contract. The contractor shall maintain his own service organization under his direct control capable of furnishing service under the warranty as specified. The contractor shall provide a letter from the manufacturing indicating that he is the authorized distributor of the equipment provided. The contractor shall also provide a letter in the submittals stating that he is in compliance with the above requirements. The architect reserves the right to request a resume.

B. The Low Voltage System Contractor shall make available to the Owner, the service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts.

C. The Low Voltage System Contractor must be licensed in the State of Georgia within the electrical trade and show proof of low voltage certification.

D. The Low Voltage System Contractor must show proof of being in the low voltage Data Communication trade for a minimum of three years.

E. The Low Voltage System Contractor shall show proof of having at least one Registered Communications Distribution Designer (RCDD) on staff.

F. All the above information must be provided at the time of the contract award, prior to signing the contract.

1.2 DEFINITIONS

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.3 SYSTEM DESCRIPTION

A. The System supplied under this specification shall be UL864 – 10th Edition Listed fire detection, 100 Channel network one-way voice communication system utilize IPv6 communications format for peer-to-peer network communication operations. Which allows node to node, or node to annunciator, communication to occur across a single pair of wires or single fiber optic cable strand. The network shall consist of a main node and multiple remote Autonomous Control Unit/Fire Alarm Control Panels/Nodes (ACU/FACP). Each node shall display all system network points and full command & control functions on color LCD touch screen display. No master slave arrangement is allowed.

B. System enhance survivability, the network shall be MESH type communications allowing for multiple Class X/A/B rings within the system. Each node shall be an equal, active functional member of the network, capable of making all local decisions, local pre-recorded voice message storage and initiating network tasks for other nodes. In the event of a node failure or communications failure between nodes, nodes shall be capable of forming sub-networks and remain operational between communicating nodes with all pre-recorded voice messages announcements. No central storage of pre-recorded voice messages will be acceptable.

C. The system shall have customized 99 User Logins with associated user defined PIN password within six user levels with the system operations.

D. Control panel must be able to support minimum of 125 Addressable NAC Power Supplies with Global Synchronization for audible temporal 3 and visuals on any one SLC Addressable Loop. All visual notification appliances shall be globally synchronized through the facility.

E. The system performance specified herein is based upon minimum design performance requirements utilizing high fidelity speakers with the following minimum selectable sound performance levels from 81.5; 84.1; 87.3; and 90.5 dBA. The speakers designed for the Fieldhouse, Gymnasiums and auditoriums have been sound modeled to provide proper voice intelligibility for open areas. Any deviations from this design, must be illustrate via professional modeling software to justify performance criteria is achieved

F. The entire system shall be UL464 Listed Audio Evacuation System, end-to-end compliance to product 520Hz Low Frequency Tone. This includes the nodes, amplifies and high fidelity speakers.

1. The system is based upon design using high fidelity speaker with the following selectable sound performance levels from 81.5; 84.1; 87.3; and 90.5 dBA.

G. Command Center or Local Operator Console (LOC) with redundant operations, audio messages, paging microphone and request for control switches & status indicators.
1. Priorities shall be configured in software for operational needs between Autonomous Control Units (ACU), Central Control Station (CCS) and Local Operators Consoles (LOCs). The system shall support a minimum of 9 priority levels
2. Color Touch Screen Display with:
    a. Display 8 simultaneous events with minimum of 768 character display.
    b. 42 character custom message
    c. 2,000 character instructional message per point
    d. Utilize Unicode symbols within the message
3. Each Command Center shall have switches with LCD Screen and/or LED annunciating control and requesting control as follows:
    a. Request Take Control

b. Request Accepted
c. Request Deny
d. Restore command center to normal operation
e. Priority request override Take Control

4. Audio Voice Communications
   a. Paging Microphone
   b. Audio Selector Switch(s) per paging zone and All Call.
5. Carbon Monoxide Annunciation
   a. Common Blue LED for Carbon Monoxide Activation
   b. Common Blue LED for Carbon Monoxide sensor end of life

H. The Emergency Voice Paging System will provide 100-Channel audio paging up to ten (10) audio paging areas via a system microphone and telephone paging access. The paging system shall be used for routine and emergency paging.
   1. Area 1 - Office
   2. Area 2 - To be determined
   3. Area 3 - To be determined

I. Provide standard internet protocol telephone access paging interface selectable with the minimum paging zones described above to the emergency voice paging system. This will allow full audio paging to selective zone using the building phone system.

J. Provide Graphical Workstation (Server desktop) located at the maintenance facility office with 22inch monitor and graphic/report printer.

K. Provide Graphical Annunciator (Client) located at Front Office and Main Control Pane with 42inch Touch Screen Control with computer.

L. Provide telephone access paging interface selectable with ten paging areas, plus all call.

M. All remote local operating console (remote annunciator/LOC) shall have LCD display, paging microphone, audio zone selection switches and by-pass switches. Provide visual indication which microphone is active during paging operations. During local microphone paging the speakers located near by the microphone shall be muted through software programmable audio control relays. The LOC shall not override the Command Center operations.

N. Systems not capable of such a display on the main panel faceplate shall include a CRT/Monitor display meeting the above requirements and battery stand-by.

1.4 BUILDING CODES and STANDARDS

A. The fire alarm equipment and installation shall comply with the current provisions of the following latest edition standards (unless otherwise noted below) applicable to the jurisdictional authorities, including their local adoptions and amendments and it shall be listed for its intended purpose of a Mass Notification and Emergency Communication Signaling System and be compatibility listed to insure integrity of

the complete system. It shall be listed to all of the UL Standards listed below, without exception.

B. National Fire Protection Association (NFPA):

1. NFPA-70 National Electrical Code (NEC)
2. NFPA-72 National Fire Alarm Code
3. NFPA 101 Life Safety Code
4. IBC International Building Code
5. IFC International Fire Code
6. IMC International Mechanical Code

C. National Electrical Manufacture's Association (NEMA)

D. Underwriters Laboratories, Inc. (UL)

1. UL-864 Control Units for Fire Protective Signaling Systems (10th Edition)
2. UL-268 Smoke Detector for Fire Protective Signaling Systems (7th Edition)
3. UL-217 Smoke Detectors for Single and Multiple Station (6th Edition)
4. UL-521 Heat Detectors for Fire Protective Signaling Systems
5. UL-464 Audible Signaling Appliances
6. UL-464 Audio Evacuation System
7. UL-1971 Visual Signaling Appliances
8. UL-38 Manually Actuated Signaling Boxes
9. UL-1481 Power Supplies for Fire Protective Signaling Systems
10. UL 2017 Standard for General-Purpose Signaling Devices and Systems
11. UL 2572 Control and Communication Units for Mass Notification Systems

E. Furnish and install additional contacts in the main fire alarm panel for the owners energy management system to monitor, alarm, trouble and supervision. In addition, the system shall be provided with (3) spare contacts.

F. System shall automatically suspend the Gym and Cafeteria sound system during alarm conditions. Upon clearing of the fire alarm, these sound systems shall automatically reset and be fully functional.

1.5 SUBMITTALS

A. The Contractor shall not purchase any equipment for the system specified herein until the Owner has approved the project submittals in their entirety and has returned them to the contractor. It is the responsibility of the contractor to meet the entire intent and functional performance detailed in these specifications. Approved submittals shall only allow the contractor to proceed with the installation and shall not be construed to mean that the contractor has satisfied the requirements of these specifications. The Contractor shall submit three (3) complete sets of documentation within 30 calendar days after award of purchase order.

B. Each submittal shall include a cover letter providing a list of each variation that the submittal may have from the requirements of the Contract Documents. In addition the Contractor shall provide specific notation on each Shop Drawing, sample, catalog cut, data sheet, installation manual, etc. submitted for review and approval, of each such variation.

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to the Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
    a. Trained and certified by manufacturer in fire-alarm system design.
    b. NICET-certified fire-alarm technician, Level IV minimum or registered Professional Engineer.

C. Product Data: Product Data sheets with the printed logo or trademark of the manufacturer of all equipment. Indicated in the documentation shall be the type, size, rating, style, and catalog number for all items proposed to meet the system performance detailed in this specification. The proposed equipment shall be subject to the approval of the Owner.

D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Comply with all recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA72.
2. Include voltage drop calculations for notification appliance circuits based on manufacturer-provided panel start voltage and point-to-point notification appliance circuit calculations. System Layout drawings prepared using the Lump Sum Method for visual strobe circuits are not acceptable.
3. Include battery-size calculations. Batteries shall be include a 20% safety factor above the minimum requirements derived from calculations, as required by NFPA 72.
4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to

placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors in accordance with 2013 edition of NFPA 72.

6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
7. Indicate speaker wattage tap settings for all speakers on the floor plans, calculate and show dB Line Loss calculations for all speaker circuits using the Lump sum method. dB Losses shall be no greater than 3.0 dB from amplifier start terminals to last device.
8. Indicate all Acoustically Distinguishable Areas on the installation shop drawings.
   Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits from end-to-end. "Home Run" indicators or other non-end-to-end wire path designations are not acceptable.
9. Floor Plans: Indicate final outlet locations showing address of each addressable device on a 1/8" scale floor plan. Show size and route of cable and conduits.

   All cabling shall be run in conduit in exposed areas. Minimum size of raceway shall be 3/4"c. All systems cables shall be terminated with punch down blocks in a separate NEMA 1 enclosure. Under no circumstances shall the system cables be spliced with twist connectors behind a device or in a pull box. The Low Voltage Contractor (Intercom, Fire Alarm, Sound Systems) shall use a minimum of an 8" x 8" x4" pull box to terminate all cables with the specified punch down blocks. Cables shall not be spliced in system pull boxes. Where cables are punched down in these boxes, the systems cables shall be properly labeled inside the box for system zone and equipment connections. All system cables shall be run in conduit.

E. Operation and Maintenance Data: For fire-alarm systems and components to be included in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data, include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA72.
2. Provide "Record of Completion Documents" according to NFPA72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Record copy of site-specific software database file, hardcopy printout and CD, with password for delivery to the owner. Proprietary system/service companies will not be acceptable.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA72 article of the same name and include the following:

a. Frequency of testing of installed components.

b. Frequency of inspection of installed components.

c. Requirements and recommendations related to results of maintenance.

d. Manufacturer's user training manuals (hardcopy) and electronic on CD.

5. Manufacturer's required maintenance related to system warranty requirements.

6. Abbreviated operating instructions for mounting at fire-alarm control unit.

F. Software and Firmware Operational Documentation:

1. CD of site-specific software database file with password, all product data sheets and AutoCAD files. Provide hard copy printout of the software program. Proprietary system/service companies will not be acceptable.

2. Provide a list of global system settings

3. Provide a list of the contents of each system cabinet and their settings

4. Provide a list of all addressable devices with their addresses and settings

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire alarm Level II technicians.

C. Project Manager Qualifications: Installation shall be supervised by personnel certified by NICET as fire alarm Level IV technicians.

D. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA70, by a qualified testing agency, and marked for intended location and application.

F. NFPA Certification: Obtain certification according to NFPA72 in the form of a placard by an approved alarm company. Verify warranty requirements; 5 years

1.7 WARRANTY and SOFTWARE SERVICE AGREEMENT

A. The contractor shall warranty all materials, installation and workmanship for five (5) years from date of acceptance, unless otherwise specified. A copy of the manufacturers' warranty shall be provided with closeout documentation and included with the operation and installation manuals.

B. The System Supplier shall maintain a service organization with adequate spare parts stocked within 25 miles of the installation. Any defects that render the system inoperative shall be repaired within 24 hours of the Owner notifying the contractor.

1.8 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. Provide quantity equal to 2% percent of amount of each type installed, but no fewer than 2 unit of each type.

a. Smoke Detectors, heat detectors, manual pull stations, duct smoke detector, monitor modules and control modules:

b. Notification appliances; speakers, speaker-strobes and strobes.

2. Keys: Ten extra set for access to locked and tamperproof components.
3. All spare part shall be housed in metal cabinet labeled "Fire Alarm Spare Parts".

1.9 DOCUMENT STORAGE CABINET

A. The cabinet shall have all fire alarm documents inside the enclosure a removable steel sleeve that will accommodate standard 8 ½ x 11 manuals and loose document records that will be protected within the enclosure. A legend sheet permanently attached to the door for system passwords and critical information and inspection notes. The FAD will have permanently and securely mounted inside a minimum of 4GB's digital flash memory drive with a standard USB B connector for uploading and downloading information. The drive shall not be accessible without tools to any person whom gains access to the records. The enclosure shall also provide 2 key ring holders with a location to mount standard business type cards for key contact personnel

1. The cabinet shall be red in color with the door cover shall be permanently screened with 1" high lettering "FIRE ALARM DOCUMENTS" with indelible ink. The access door shall be locked with a ¾" barrel lock and the hinge shall be a solid width 12" stainless steel piano hinge. The enclosure will supply 4 mounting holes.
2. The system database program shall be stored on CD/DVD/USB Drive kept inside the cabinet.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling fire alarm system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

B. The Contractor shall provide, from the acceptable manufacturer's current product lines, equipment and components, which comply, with the requirements of these Specifications. Equipment or components, which do not provide the performance and features, required by these specifications are not acceptable, regardless of manufacturer.

C. Strict conformance to this specification is required to ensure that the installed and programmed system will function as designed, and will accommodate the future requirements and operations of the building Owner. All specified operational features must be met without exception.

D. That equipment proposed to be supplied will be considered only if it meets all sections of the performance specification. Any deviations of system performance outlined in this specification will only be considered when the following requirements have been met:

1. A complete description of proposed alternate system performance methods with three (3) copies of working drawings thereof for approval by the Owner, not less than ten (10) calendar days prior to the scheduled date for submission of bids.

2. The supplier of alternate equipment shall furnish evidence that the proposed alternate system performance is equal to or superior than the system operation stated in the specification. Such evidence shall be submitted to the Owner, not less than ten (10) calendar days prior to the scheduled date for submission of bids.

3. The supplier shall submit a point-by-point statement of compliance for all sections in this specification. The statement of compliance shall consist of a list of all paragraphs within these sections. Where the proposed system complies fully with the paragraph as written, placing the word "comply" opposite the paragraph number shall indicate such. Where the proposed system does not comply with the paragraph as written, and the supplier feels the proposed system will accomplish the intent of the paragraph, a full description of the function as well as a full narrative description of how its proposal will meet its intent shall be provided. Any submission that does not

include a point-by-point statement of compliance as described herein shall be disqualified. Where a full description is not provided, it shall be assumed that the proposed system does not comply.

4. The supplier of alternate equipment shall submit a list from the alternate manufacture on the manufactures letterhead indicating the names and addresses of all authorized suppliers in the area. Proprietary products will not be considered.

5. The acceptability of any alternate proposed system shall be the sole decision of the Owner or his authorized representative

E. Approved Products: All panels and peripheral devices shall be of the standard product of single manufacturer and shall display the manufacturer's name of each component. The catalog numbers specified under this section are those of **EDWARDS**, a Carrier Company and shall constitute the type, product quality, material and desired operating features.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Mass Notification initiated event shall override any event and take the highest system priority.

B. Fire-alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Flame detectors.
4. Smoke detectors.
5. Duct smoke detectors.
6. Verified automatic alarm operation of smoke detectors.
7. Automatic sprinkler system water flow.
8. Heat detectors in elevator shaft and pit.
9. Fire-extinguishing system operation.
10. Fire standpipe system.

C. Fire-alarm signal shall initiate the following actions:

1. Activate multiple channel pre-recorded voice messages followed by temporal tone.
2. Continuously operate the visual notification appliances.

3. Identify alarm at fire-alarm control unit and remote annunciators.
4. Transmit an alarm signal to the remote alarm receiving station.
5. Unlock electric door locks in designated egress paths.
6. Release fire and smoke doors held open by magnetic door holders.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
8. Recall elevators to primary or alternate recall floors.
9. Record events in the system memory.
10. Record events by the system printer.

D. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.
3. Elevator shunt-trip supervision.

E. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging circuitry
8. High or low battery charge.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Fire-pump power failure, including a dead-phase or phase-reversal condition.
11. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.

F. Elevator Recall:

1. Smoke detectors at the following locations shall initiate automatic elevator recall. Alarm-initiating devices, except those listed, shall not start elevator recall.

    a. Elevator lobby detectors except the lobby detector on the designated floor.

    b. Smoke detector in elevator machine room.

    c. Smoke detectors in elevator hoistway.

2. Elevator lobby detectors located on the designated recall floors shall be programmed to move the cars to the alternate recall floor.

3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

    a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

G. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.

H. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

Fill out the systems annunciator display listing the locations of all devices by the owners room numbers. Obtain a copy of the owner supplied room names and numbers and use this information in the directory card for the room numbers for all systems zones. Refer to the electrical drawing detail sheets for additional information.

2.3 GRAPHICAL WORKSTATION (Server)

A. Provide Graphical Workstation (GW) that shall communicate with the fire alarm network(s) via supervised IP communications protocol with full command and control capability and with the Remote Annunciator (Clients). The GW shall be password protected to operate common control functions from the Workstation including acknowledging, silencing, and resetting of fire alarm functions as well as manually activating, deactivating, enabling and disabling of individual system points. The workstation shall be capable of generating status, maintenance and sensitivity reports. The workstation must be capable upon receipt of any event to activate an audio WAV file over the workstation speakers alerting the operator to an event, and providing audible instructions. The computer shall operate using Windows 7/10 Professional. .

B. The GW shall support a minimum of 850 Networks Systems via Ethernet using IP protocol communications. In addition the GW shall be able to support Digital Alarm Receiver unit that will monitor systems using Contact ID format via phone lines or Ethernet. The GW shall have the ability to create multiple commands between Networks to operate any sequence of operation.

C. The GW shall software shall support system configuration as follows:

1. One Server Graphical Workstation and 15 remote Graphical Annuciator (Client Workstations).

D. The GW shall have a desktop paging microphone to selectively communicate to any paging zone(s) multiple selective, combination or All Call.

1. Graphical screens shall be provided to select the manual paging virtual switch panel and desktop microphone.

E. The GW shall have a Layout Manager to manage and configure the different screen (window) layouts for the operator System Control to be display simultaneously on the screen. Each of the windows can reside in any area on the screen. Layouts can also be assigned to access groups so that they load when a user from that access group logs. A different layout can be assigned to every access group. The screen shall have dedicated areas for the following functions:

1. Event List Display: All events shall be display in the order of priority, each event is color-coded by its type. The event type, description, location, date and time and count information is displayed for each event in columns on each tab. New events are displayed by priority and remain until they are acknowledged. Once the event is acknowledged, it moves into the Acknowledged Events list. The All Events tab displays all of the events that have taken place in your system, up to a maximum of 10,000 events.

   a. Red – Mass Notification or Alarms.
   b. Gold – Supervisory.
   c. Yellow – Trouble, Monitor, Non-Security, or Security By-Pass.
   d. Orange – Security Alarm.
   e. Grey – Disabled or Security Partition Armed.
   f. Green – Restored to normal.

2. Workstation Display Filter: The GW shall be able to be configurable to filter events that would be displayed or not displayed at the workstation. Shall be able to select between; Alarms, Supervisory, Monitor, Troubles and Security events to be viewed

3. Event Action Display: The Event Action displays the device custom message minimum of 2,500 characters, and flashes corresponding event LED. The custom message shall provide instructions to the operator on what to do, information on the event/device and possible hazardous.

   a. Event Log: Provide user the ability to record entry electronically in response to the selected event. Event logs allow the user to document

up to 65,000 character entry that is stored in history and available for review.

b. System Controls: Provide screen buttons for; Acknowledge, Alarm Silence, Panel Silence, Drill, Reset, and Silence Workstation.

4. Map Window: Shall display site plan photo of building or campus, followed by photo building profile and every level of building floor plan map.

5. Image Display: Shall be able to display additional information of the event in the following format types; AVI movie, still picture/image (BMP, JPEG, WMF and RLE).

6. Browser Window: The Browser window displays HTML files linked to the Internet. This shall be able to be linked with the Building Automation System, IP Video Cameras, Weather Channel, ChemTec, or any website. Any event can be linked automatically to display webpage or IP Camera/DVR.

F. The workstation must be capable upon receipt of an event to send e-mail messages to appropriate recipients via a SMTP mail server or text message Short Message Service (SMS). Within the message shall be the event message, instructional text, date and time. System must support 100 recipients.

G. The software shall have the ability to customize each Access Level with the ability to limit system restrictions and be password protected. Provide minimum of 128 users with access levels.

H. Graphical Maps shall be import from anyone of the following formats: DXF, DWG, JPEG, RLE, TIF, BMP, and WMF. The main screen shall be Aerial Photo of the Building or Campus, followed by Photo of the Building Profile, floor plan architectural drawing, and multiple zoom fields on the floor plan.

1. Drawing display shall allow for zoom out to full floor view or zoom in to individual device location. It shall be possible for the operator to manually zoom down to any portion of a vector-based graphic without aliasing, artifacting, or pixilation of the image. Preset zoom levels shall not be considered equal. Include floor plan Legend to identify location on floor plan key view.

2. There shall be a toggle button on screen for all drawing levels that allow instant migration to the floor above or the floor below the floor currently being displayed on screen.

3. Floor plans shall have the minimum:

a. 32 Zoom field views on drawing.

b. Door swings.

c. Window locations.

d. Room number and designation of occupancy.

e. All initiating and notification device locations.

I. Server Workstation Computer shall have the following minimum operating requirements:

1. Operating software shall be MS Windows7/10 and MS SQL.
2. Dual XEON 2680 Intel processor, 3.6 GHz.
3. 25MB Cache
4. QPI speed of 8 GT/S
5. 10 core, multi-threaded to 20
6. 128GB RAM memory.
7. Two HDMI outputs for dual video.
8. Audio sound
9. Dual 1G LAN
10. 500GB Solid State Hard Drive with RAID 1 hard drive array (mirror image)
11. 24X DVD-R/W, DVD+RW, CD-R/W
12. 4 USB ports
13. 2 Serial Ports.

J. The video display shall be minimum of inch LCD display monitor or larger with built-in audio speakers.

1. 22inch desktop monitor.

K. The GW shall have secondary power source to support for minimum of 15mins operation.

2.4 GRAPHICAL MAP and REPORTS PRINTER

A. Provide a Color printer connected to the GW that will print the graphical floor plan views and system reports. The printer shall be Color printer that supports PCL (Printer Control Language) and dual paper size shall be 8-1/2 x 11 AND 11 x17.

2.5 GRAPHICAL ANNCIATOR (Client)

A. Provide Graphical Annunciator (GA) that shall communicate with the Server via supervised IP communications protocol with full command and control capability. The GA shall be password protected to operate common control functions from the Workstation including acknowledging, silencing, and resetting of fire alarm functions as well as manually activating, deactivating, enabling and disabling of individual system points. Between the Server and Client shall be Instant Messaging capability to Request/Access/Deny System Control Capabilities and programmable timer (90 seconds) for automatic control without response.

B. The workstation shall be capable of generating status, maintenance and sensitivity reports. The workstation must be capable upon receipt of any event to activate an audio WAV file over the workstation speakers alerting the operator to an event, and providing audible instructions. The computer shall operate using Windows 7/10

Professional. Any other operating system, such as but not limited to OS/2, Linux, MS XP, VISTA, DOS, or other versions of Microsoft Windows ® are not acceptable.

C. The GA shall have a Layout Manager to manage and configure the different screen (window) layouts for the operator System Control to be display simultaneously on the screen. Each of the windows can reside in any area on the screen. Layouts can also be assigned to access groups so that they load when a user from that access group logs. A different layout can be assigned to every access group. The screen shall have dedicated areas for the following functions:

1. Event List Display: All events shall be display in the order of priority, each event is color-coded by its type. The event type, description, location, date and time and count information is displayed for each event in columns on each tab. New events are displayed by priority and remain until they are acknowledged. Once the event is acknowledged, it moves into the Acknowledged Events list. The All Events tab displays all of the events that have taken place in your system, up to a maximum of 10,000 events.

    a. Red – Mass Notification or Alarms.
    b. Gold – Supervisory.
    c. Yellow – Trouble, Monitor, Non-Security, or Security By-Pass.
    d. Orange – Security Alarm.
    e. Grey – Disabled or Security Partition Armed.
    f. Green – Restored to normal.

2. Workstation Display Filter: The GA shall be able to be configurable to filter events that would be displayed or not displayed at the workstation. Shall be able to select between; Alarms, Supervisory, Monitor, Troubles and Security events to be viewed

3. Event Action Display: The Event Action displays the device custom message minimum of 2,500 characters, and flashes corresponding event LED. The custom message shall provide instructions to the operator on what to do, information on the event/device and possible hazardous.

    a. Event Log: Provide user the ability to record entry electronically in response to the selected event. Event logs allow the user to document up to 65,000 character entry that is stored in history and available for review.

    b. System Controls: Provide screen buttons for; Acknowledge, Alarm Silence, Panel Silence, Drill, Reset, and Silence Workstation.

4. Map Window: Shall display site plan photo of building or campus, followed by photo building profile and every level of building floor plan map.

5. Image Display: Shall be able to display additional information of the event in the following format types; AVI movie, still picture/image (BMP, JPEG, WMF and RLE).

6. Browser Window: The Browser window displays HTML files linked to the Internet. This shall be able to be linked with the Building Automation System,

IP Video Cameras, Weather Channel, ChemTec, or any website. Any event can be linked automatically to display webpage or IP Camera/DVR.

D. Graphical Maps shall be import from anyone of the following formats: DXF, DWG, JPEG, RLE, TIF, BMP, and WMF. The main screen shall be Aerial Photo of the Building or Campus, followed by Photo of the Building Profile, floor plan architectural drawing, and multiple zoom fields on the floor plan.

1. Drawing display shall allow for zoom out to full floor view or zoom in to individual device location. It shall be possible for the operator to manually zoom down to any portion of a vector-based graphic without aliasing, artifacting, or pixilation of the image. Preset zoom levels shall not be considered equal. Include floor plan Legend to identify location on floor plan key view.
2. There shall be a toggle button on screen for all drawing levels that allow instant migration to the floor above or the floor below the floor currently being displayed on screen.
3. Floor plans shall have the minimum:
    a. 32 Zoom field views on drawing.
    b. Door swings.
    c. Window locations.
    d. Room number and designation of occupancy.
    e. All initiating and notification device locations.

E. Workstation Computer shall have the following minimum operating requirements:

1. Operating software shall be MS Windows7/10 and MS SQL.
2. i7 4770S Intel processor, 3.4 GHz.
3. QPI speed of 5 GT/S.
4. 32GB RAM memory.
5. HDMI & DVI for dual video or alternative video adapters.
6. Audio sound.
7. Dual 1G LAN
8. 500GB Solid State Hard Drive
9. 4 USB ports
10. 42inch Touch Screen Monitor with keyboard and mouse.

F. The video display shall be minimum of inch LCD display monitor.

1. 42inch Touch Screen wall mounted – Main Control Panel and Front Office.

G. The GA shall have secondary power source to support for minimum of 15mins operation.

2.6 ETHERNET NETWORK - DEDICATED NETWORK for GA& GW

A. Provide dedicated Emergency Communications Ethernet IP Network. The IP Network shall be Multi-Mode or Single Mode fiber optic cable. The TCP/IP network switches shall be industrial grade managed network, UL864 & UL 2572 listed. The switches shall operate on a nominal 24 VDC supplied from a battery backed up fire alarm control panel or booster power supply to insure power to the switch is always available. Switches shall provide LED indicators for data rate, activity/link integrity, common trouble relay, power and loop detection.

1. Switch configuration shall be; Four, Eight, or Sixteen 10/100Base-T Ethernet ports; fixed configurations with a compact form factor.
    a. Selectable SFP transceiver modules;
        1) 100 Mbps, dual filament, single mode 10 km
        2) 100 Mbps, dual filament, multimode 2 km
        3) 1 Gbps, dual filament, single mode 70 km
2. Dual-input DC power supply and DIN rail or rack mount.
3. Class B/C.
4. Shall be EDWARDS-KIDDE, model MN-FNS series

B. Each fire alarm control panel to LAN/WAN network interface shall be an industrial grade 10/100BASE T Ethernet® device server. The interface shall have diagnostic LEDs on the front of the unit make it easy to determine its status, and incorporate flash ROM memory facilitating upgrading the operating firmware. Power shall supplied directly from the FACP, ensuring a reliable and monitored power source.

1. Shall be EST, model MN-COM-1S.

2.7 FIRE-ALARM CONTROL UNIT

A. The System supplied under this specification shall be UL864 – 10th Edition Listed fire detection, 100 Channel network one-way voice communication system utilize IPv6 communications format for peer-to-peer network communication operations. Which allows node to node, or node to annunciator, communication to occur across a single pair of wires or single fiber optic cable strand. The network shall consist of a main node Central Control Station (CCS), multiple remote control panel nodes Autonomous Control Unit/Remote Control Panels (ACU/RCP) and nodes operating as Local Operators Consoles (LOCs)/annunciators. Each node shall display all system network points and full command & control functions on color LCD touch screen display. No master slave arrangement is allowed. The control panel shall be model EDWARDS, model EST4.

B. For systems requiring multiple redundant locations for paging control, the ability to Request/Grant/Deny page privileges shall be supported in any combination. Priorities based on wiring locations are not considered equal. Priorities shall be configured in software for operational needs between Autonomous Control Units (ACU), Central Control Station (CCS) and Local Operators Consoles (LOCs). The system shall support a minimum of 9 priority levels

C. System enhance survivability, the network shall be MESH type communications allowing for multiple Class X/A/B rings within the system. Each node shall be an equal, active functional member of the network, capable of making all local decisions, local pre-recorded voice message storage and initiating network tasks for other nodes. In the event of a node failure or communications failure between nodes, nodes shall be capable of forming sub-networks and remain operational between communicating nodes with all pre-recorded voice messages announcements. No central storage of pre-recorded voice messages will be acceptable.

D. The network of control panels shall include the following features.

1. Ability to download all network applications and firmware from the configuration computer on the network or at any control panel (network node) location.
2. During System download of the database, the System shall be completely operational.
3. The system database will reside on specified Node and able to upload, from any location on the Network.
4. Each control panel (network node) shall have an LCD color touch screen display with common controls. The display shall be configurable to display the status of all system points and all combinations of alarm, supervisory, trouble, monitor, or group event messages.
5. From each LCD color touch screen display on the system shall be capable of being programmed for control functions of any node or the entire network. The LCD display shall reside on the network as a node and continue to operate with fault on the network. An LCD can be programmed to be only operation when a node is operational in stand-alone mode, with a network fault.

E. User Operator Login Credentials

1. Provide 99 User authorized operator log-in’s with custom password with the ability to operate or modify system functions such as system time, date, passwords, holiday dates, restart the system and clear the control panel event history file.

F. Each network Node control panel shall be capable of:

1. Supporting up to 2500 intelligent analog/addressable points.
2. Supporting up to ten (10) intelligent addressable loops, each loop supporting 125 detectors and 125 modules, total of 250 points.
3. Supporting multiple USB communication ports and protocol.
4. Support global synchronization of visual notification appliances controlling minimum of 125 Addressable NAC Power Supplies on any one or combination of all ten SLC circuits.

G. Color Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. The system shall provide the following event queues as a minimum each to include a count of active events for the queue type including a visible indicator showing if events have not been reviewed: Alarm, Emergency, Supervisory, Disable/Test, Trouble, Ground Fault, Monitor, FirePhone call in, Requested/Granted control

H. Shall be a color touchscreen LCD user interface control/display that shall annunciate and control system functions with:

a. Display 8 simultaneous events.
b. Minimum of 768 character display.
c. 40 character custom message
d. 2,000 character instructional message per point.
e. Utilize Unicode symbols within the message. Unicode symbols to better define messaging including but not limited to radioactive symbol, poisonous substances (skull and crossbones) symbol, biological hazard symbol and Caduceus symbol.
f. The LCD allows the use of on screen scrolling via display switches or by 'swiping' the display screen.

2. The reset, alarm silence, panel silence and drill system control switches shall provide color coding for ease of distinguishing one from the other.

3. An authorized user shall have the ability to operate or modify system functions including system time, date, passwords, holiday dates, to disable/enable devices, zones, actions, timers, sequences, restart the system and clear control panel event history file.

4. Graphical tree map representation of the project entire system shall allow an authorized user to activate/restore outputs, actions, sequences, intelligent addressable detectors or module, simulate detector smoke levels. The selection of devices, zones, actions, timers and sequences shall be made via a descriptive facility structure view.

I. Audio One-Way Voice Communications

1. The voice communication network shall be 100 audio channels to allow up to 100 simultaneous announcements/paging.

2. Enhanced system survivability, custom digital voice message shall be provided, a minimum of 750 minutes and shall be stored within every Node on the network. All custom voice messages shall be professional recorded as a .wav file format. The system shall support repeat counts of audio messages and stacking of audio messages in a FIFO configuration

3. Provide as minimum one fifty (50) watt supervised audio amplifier per paging zone. The system software shall be capable of selecting the required audio source signal for amplification. To enhance system survivability, each audio amplifier shall automatically provide an internally generated local 3-3-3, 1000 Hz temporal pattern output upon loss of the audio signal from the one-way emergency audio control unit, during an alarm condition.

4. Audio amplifiers shall be power limited and protected from short circuits conditions on the audio circuit wiring. Each amplifier output shall be a supervised, dedicated, selectable 25/70 Vrms output. Amplifiers sizes shall be minimum of 50watts and largest 250 watts.
5. Amplifier Minimum Sizing Specification shall be as follows:
    a. 250 watts per OMNI Directional Paging Speaker.
    b. 24 watt per Medium Power Speaker
    c. 7.5 Watts per Trumpet Type Loudspeaker.
    d. 1 Watts per 4 inch cone type speaker.
    e. 4 Watts per re-entrant horn-driver type speaker.
    f. Plus 25% spare capacity for each connected amplifier or speaker signal circuit switching module.

J. Provide an Emergency Voice Communication System with the following design features:
1. An audio control unit with Microphone for Paging.
2. Provide 3-position switch for each evacuation signaling zone and “All-Call”, with "Page Auto" and “Page ALERT” positions identified and two LED status indicators for each audio visual evacuation signaling "zone", one red and one yellow.
    a. These LED's shall illuminate to indicate respectively:
        1) Evacuation signals activated (red),
        2) Trouble in audio (speaker) or visual (strobe) circuit(s) (yellow).
3. Provide 2-position switch for manually activate pre-recorded voice messages, with “Message Name" positions identified and one LED status indicators, one red. Provide minimum of 12 selector switches.
    a. These LED's shall illuminate to indicate respectively:
        1) Message activated (red)
4. Provide 2-position switch for manually activate audio paging zones with “Paging Zone Name” positions identified and one LED status indicators, one red. Provide minimum of 12 selector switches.
        1) Evacuation signals activated (red),
        2) Trouble in audio (speaker) or visual (strobe) circuit(s) (yellow).
5. All LED and switch functions shall be software programmable. Switches shall be configurable for momentary, maintained, toggle, or “exclusive or” operation as required by the application. Any group of switches may use “exclusive or” in combination of 2 switches to 24 switches in a group.
6. LEDs shall be dynamically programmable for slow flash, fast flash or steady operation.
7. Configurable switches and LED indicators to support auxiliary functions with software selectable LED colors of Red, Yellow, Blue, Green or White.

K. Provide telephone access paging interface selectable with the minimum paging zones described above, plus all call.
1. Provide a Session Initiation Protocol (SIP) compliant IP gateway for interface to the Premise IP telephony network system.

2. Location: Gateway shall be located in the appropriate network resource room location and this contractor shall coordinate with the information technology drawings and the Architect for the proper location and include the required addressable fire alarm input, control, relay modules and auxiliary fire alarm audio circuitry for a complete interface to the SIP compliant gateway.
3. Gateway shall have a minimum of the following, subject to conformance with the required Fire Alarm/Mass Notification paging zones specified and/or shown on the drawings:
    a. (1) POE network RJ45 Port. POE power and UPS backup by others.
    b. (4) Analog Audio Outputs
    c. (4) Programmable Form C Relay Closures
    d. (4) Programmable Contact Closure Inputs
    e. (1) VM-186 RJ-45 Connector with 8 Pin Wiring Terminals for each Gateway Analog audio Port
4. Fire Alarm Interface minimum control requirements:
    a. Subject to the Fire Alarm Manufacturer's specific requirements, each analog audio paging zone shall have as a minimum the following:
        1) (1) Monitor Module Input for Gateway Relay Contact Closure
        2) (1) Dedicated Analog Audio Switching Circuit
        3) (1) Auxiliary line level audio input to the fire alarm control panel and/or amplifiers
        4) (1) Appropriate Line Level transformers where necessary for a functional system.

L. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions

M. Network Communications Topology

1. The peer-to-peer network shall be IPV6 network to multiple nodes and LOC/annunciators consisting of the command center, main controller, remote control panels and color LCD/LED annunciation support data transmission of data, voice audio and firefighters' telephone data on a single twisted pair or single optical fiber. The network communications format shall include Globally Unique Identifiers to help ensure only nodes communications on the network, providing cyber security. Total network response shall not exceed 3 seconds.
2. Each node is an equal, active functional node of the network, which is capable of making all local decisions in the event of a node failure or communications failure between nodes. The network shall support a back-to-back pass-through degraded mode for like copper wiring and for copper to fiber in any combination. The pass through shall maintain network connectivity on power down or catastrophic failure of a single panel, networks that do not support network pass-through shall not be considered equal.
3. When a network is wired in a Class B configuration, a single break or short on the network wiring isolates the system into two groups of nodes. Each group continues to function as a peer-to-peer IPv6 network working with their

combined databases. All pre-recorded voice messages will still be operations regardless of any network fault.

4. When wired using a Class A/X or MESH configuration, a single break or short on the network wiring causes the system to isolate the fault, and network communication continues uninterrupted, without any loss of function. Should multiple wiring faults occur, the MESH network re-configures into many sub-networks and continues to respond to alarm events from every panel that can transmit and receive network messages. All pre-recorded voice messages will still be operations regardless of any network fault.
5. Network interface controllers shall be small form factor pluggable (SFP) and shall be hot pluggable.
   a. The copper twisted pair network
      1) 2 conductor 18Awg or 16Awg low capacitance cable
      2) CAT 6/7/8 cable 22 to 24Awg
   b. The fiber optic network interface shall be:
      1) Single Mode Single or 2 strand
      2) Single Mode Long Distance Single or 2 strand
      3) Multi-Mode 2 strand

N. Circuits Requirements:

1. The node/panel communication network wiring shall be designed to support the topologies required by the project including mixes of ring, bus, star and mesh. The network shall be configured as Class A, Class B, Class X, combination Class A, Class B, Class X, as follows:
2. Signaling Line Circuits for Network Communications (Node to Node to Annunciator):
   a. Class B, Level 0
3. Signaling Line Circuits for Intelligent Analog Addressable Loop:
   a. Class B, Level 0
   b. No more than 100 detectors or 100 modules installed on a loop.
4. Initiating Device Circuit:
   a. Class B, Level 0
5. Notification Appliance Circuits:
   a. Class B, Level 0
   b. Maximum circuit loading to 2 amps for visuals.
6. Door Holder Circuits
   a. Class D, Level 0
7. Ethernet IP Network
   a. Class C, Level 0
8. Activation of alarm notification appliances, smoke control, elevator recall and other functions shall occur within 3 seconds after the activation of an initiating device.

O. Proxy Firewall - Cyber Security

1. The control panel shall have a UL864 listed Proxy Firewall for connection to site TCP/IP network for remote connectivity to internet or intranet.
2. Proxy Firewall module(s) shall protect against cyber attacks using 256 bit AES encryption, cybersecurity measures that shall meet or exceed FIPS PUB 197.
3. The system shall only transmit credentials that are encrypted. The system shall provide for multiple users, roles to ensure proper access by user for the role they perform on the system. All passwords shall use a Cypher Algorithm, password must use a hash, no password or authentication shall be exposed in any format in the system database viewable as plain text. Sensitive information shall not be logged to history or displayed on service tools (eg. passwords, PINs etc.).
4. Security relevant information, such as: failed login attempts, failed unauthorized accesses, and user modification shall be logged to panel history. Unsuccessful authentication attempts shall not leak information regarding the presence of the system or users.
5. Two 100 Mbps Small Form-factor Pluggable (SFP) network adapter ports.
6. Firewall with cyber security shall be used for connectivity:
    a. 4-CU Programming Laptop / local or remote
    b. FireWorks Workstation or Server
    c. IP Central Station
    d. Email server and SMS gateway
    e. BAS BackNet connection
    f. Elevator controller interfaces for OEO operations
    g. Remote Web services

P. Reports (Local & Remote Access)

1. The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the main LCD Color Touch Screen display and via a standard browser.
2. Reports provided by web browsers shall be capable of being saved for archiving and detailed analysis. Reports retrieved from the LCD Color Touch Screen display shall be capable of being printed on any system printer configured for the purpose
3. Utilizing remote connectivity using standard internet browser ie; Internet Explorer, Edge, Chrome, Safari, and Firefox on any device that supports the browser. Systems that require the use of a specific device type or AP for accessing reports shall not be considered equal
4. User shall require proper authentication locally or remotely; authorized Login & Password to access the system. System supports 99 customer User with PIN password.
5. System status report of the system current conditions.

6. History report shall provide a chronological listing of at least the last 10,000 system events in addition a minimum of 10,000 Alarm events shall be captured and stored. The system shall support capturing of 10,000 most recent events, this captures an incident history which cannot be overwritten until history is cleared or an additional most recent events capture is made.
7. Detector report shall provide a sensitivity listing of all detectors that shall list all of the sensitivity of all of the detectors on any given panel in the system. The system shall provide a report that provides a sensitivity (% Obscuration per foot) listing of any particular detector. The systems shall provide graphical representations of Sensitivity and Dirty levels in reports displayed on a system LCD or web browser for quick recognition of device status.
8. Carbon Monoxide reports "sensitivity" check from the panel shall report the approximate number months of CO sensor life remaining. The systems shall provide graphical representations of CO sensor life remaining in reports displayed on a system LCD or web browser for quick recognition of device status.

Q. Panel/System History
1. The panel history shall support storage of up to 20,000 events. History events shall include but not be limited to Event Type, System Command operations, Date and time of the event. Reports shall be displayed locally on the panel LCD display, printed to a system printer, review through a web browser and support exporting to .xml file format.

2. To enhance forensic examination of history, the system shall support the ability to store the FIFO event history log into a separate region of the database, not impacted by the FIFO operation of events preventing overwriting during forensic examination of an incident. Placing an archive of the History into a separate region of the database shall not interrupt FIFO of the main history or erase any portion of the main History.

3. Both FIFO history and archived history shall be available for review through the panel LCD display, be printable through the system printer, retrievable through web services interfaces and be exportable as .xlm formatted file.

R. Digital Alarm Communicator Transmitter: The system shall have an integrated off premise communications capability using a digital alarm communications transmitter (DACT) for sending system events to multiple central monitoring station (CMS) receivers. The system shall provide the CMS(s) with point identification of system events using Contact ID protocol. The dialer shall have the capability to support up to 255 individual accounts and to send account information to eight (8) different receivers, each having a primary and secondary telephone access number. System events shall be capable of being directed to one or more receivers depending on event type or location as specified by the system designed. In the event of a panel CPU failure during a fire alarm condition, the DACT degraded mode shall transmit a general fire alarm signal to the CMS.

S. IP Digital Alarm Communicator Transmitter
1. The system shall provide off premises communications capability using a native TCP/IP Ethernet based Digital Alarm Communications Transmitter

(IP/DACT) for sending system events to multiple Central Monitoring Station (CMS) receivers over an IP path.
a. IP configuration shall support, single and dual path communications.
b. IP service shall provide 128 bit AES Advanced Encryption Standard "FIPS PUB 197".
c. Up to 8 eight communication services shall be supported per module. Up to 10 modules shall be supported per system. System events shall be capable of being directed to one or more receivers depending on event type or location as specified by the system design.

T. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, shall be powered by nominal 24-V dc source.

U. Secondary Power: Shall provide 24 hours supervisory and 15 minutes of alarm with batteries, automatic battery charger, and automatic transfer switch.

2.8 REMOTE ANNUNCIATOR WITH ONE-WAY VOICE COMMUNICATION - LOCAL OPERATOR CONSOLE [(LOC) OR (FAAP)]

A. Annunciator/LOC shall be redundant of fire-alarm control unit color touch screen LCD display functions for alarm, supervisory, monitor and trouble indications and common system controls including; acknowledging, silencing, resetting, and testing. The fire alarm bypass function switches and LCD Keypad may be housed separately in a locked enclosure to prevent unauthorized use and control of fire alarm system program control and bypass, but the Paging Microphone, Audio Selector and Message Selector Switches shall be housed in a listed enclosure which is capable of being fitted with an unlocked latching knob for the enclosure, such that these emergency communication and signaling controls are readily accessible for emergency signaling.

B. For systems requiring multiple redundant locations for paging control, the ability to Request/Grant/Deny page privileges shall be supported in any combination. Priorities based on wiring locations are not considered equal. Priorities shall be configured in software for operational needs between Autonomous Control Units (ACU), Central Control Station (CCS) and Local Operators Consoles (LOCs). The system shall support a minimum of 9 priority levels.

1. Shall have the following minimum features:
   a. Color Touch Screen LCD Display
   b. Paging Microphone
   c. Audio Selector Switches
   d. Audio Message Selector Switches
   e. System Bypass Switches
2. The system shall provide the following event queues as a minimum each to include a count of active events for the queue type including a visible indicator showing if events have not been reviewed: Alarm, Emergency,

Supervisory, Disable/Test, Trouble, Ground Fault, Monitor, FirePhone call in, Requested/Granted control

2.9 REMOTE ANNUNCIATOR

A. Annunciator shall match those of fire-alarm control unit color touch screen LCD display functions for alarm, supervisory, monitor and trouble indications and common system controls including; acknowledging, silencing, resetting, and testing.

B. The annunciator shall provide the following event queues as a minimum each to include a count of active events for the queue type including a visible indicator showing if events have not been reviewed: Alarm, Emergency, Supervisory, Disable/Test, Trouble, Ground Fault, Monitor, Requested/Granted control.

2.10 NAC Power Supply:

A. The NAC power supply shall be independent unit that will provide power to visual strobe notification appliances. It shall be possible to configure the NAC's to follow the main panel's NAC or activate from intelligent synchronized modules. The booster NAC's must be configurable to operate independently at any one of the following rates: continuous synchronized, or 3-3-3 temporal. Fault conditions on the power supply shall not impede alarm activation of host NAC circuits or other power supplies. The NAC power supply must be able to provide concurrent power for notification devices, security devices, access control equipment and auxiliary devices such as door holders. . All the NAC Power Supplies shall be synchronized. The power supply shall support up to 24 amp hour batteries.

1. Power supply shall be minimum of 10 amps and UL 864 Listed.
2. Four independent 3amp NAC circuits. Each being configurable as auxiliary power.
3. All circuits shall be synchronized.
4. Shall be EDWARDS, model BPS10A

2.11 INTELLIGENT ANALOG SYSTEM SMOKE DETECTORS

A. General Requirements for Intelligent Analog Detectors

1. Integral Microprocessor: All decision are made at the detector determining if the device is in the alarm or trouble condition.
2. Non-Volatile Memory: Permanently stores serial number, and type of device. Automatically updates historic information including hours of operation, last maintenance date, number of alarms and troubles, time of last alarm1 and analog signal patterns for each sensing element just before last alarm.

3. Electronic Addressing: Permanently stores programmable system address. It shall be possible to address each intelligent module without the use of DIP or rotary switches. Devices using switches for addressing shall not be acceptable.
4. Automatic Device Mapping: Each detector transmits wiring information regarding its location with respect to other devices on the circuit, creating an As-Built wiring diagram. This will also provide enhanced supervision of the device physical location and the device message shall reside with the location and not the device address. Devices installed in the wrong location will always report the correct message of the physical location.
5. Sensitivity Range: Each analog addressable smoke detector's sensitivity shall be capable of being programmed individually as: most sensitive, more sensitive, normal, less sensitive or least sensitive. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. It shall be possible to program control panel activity to each level.
6. Pre-Alarm: Detector stores 20 pre-alarm sensitivity values to alert local personnel prior to the sensor reaching a full evacuation sensitivity. Sensitivity values can be set in 5% increments.
7. Environmental Compensation: The detector's sensing element reference point shall automatically adjust, compensating for background environmental conditions such as dust, temperature, and pressure. Periodically, the sensing element real-time analog value shall be compared against its reference value. The detector shall provide a maintenance alert signal when the detector reaches 75% (Dirty) to 99% (More Dirty) compensation has been used. The detector shall provide a dirty fault signal when 100% or greater compensation has been used.
8. Twin Status LEDs: Flashing Green LED shows normal; flashing RED shows alarm state; steady RED and steady GREEN show alarm state in stand-alone mode, visible from any direction.
9. UL Sensitivity Testing: The detector shall utilize a supervised microprocessor that is capable of monitoring the sensitivity of the detector. If the detector sensitivity shifts outside of the UL limits, a trouble signal is sent to the panel.
10. Device Replacement: The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system. The replacement detector type shall automatically continue to operate with the same programmed sensitivity levels and functions as the detector it replaced. System shall display an off-normal condition until the proper detector type has been installed or change in the application program profile has been made.

A. Intelligent 3D Multi-sensor Detector (Photo/Thermal and Time)
   1. Provide intelligent analog addressable 3D multi-sensor smoke detector is an intelligent

B. Intelligent Multi-Criteria Optical Smoke Detector

1. Provide a multi-criteria optical smoke detector utilize two forward (Blue LED & IR LED) & backward light scattering type technology to identify smoke particles within the sensor chamber, sampling the air from its surroundings without the use of other sensing elements. Each optical smoke detector shall be capable of rejecting nuisance sources and detect smoke in the full life safety window of 0.5% to 4.36% obscuration/foot. Shall be listed to UL268 7th edition. Detectors that have to operate in a special application mode that cannot achieve the full 0.5% to 4.36% life safety window or utilize sensing technology that has a fixed end of life components shall not be considered equal.
2. Detector shall be UL Certified being high resistance to nuisance sources; ie cooking, aerosols and steam, in accordance with NFPA72-2016, 29.7.3.
3. Each smoke detector shall be individually programmable to operate at any one of five (5) sensitivity settings. The detector shall also store pre-alarm and alternate pre-alarm sensitivity settings. Pre alarm sensitivity values shall be configurable in 5% increments of the alarm and alternate alarm sensitivity settings respectively. The detector shall be able to differentiate between a long term drift above the pre alarm threshold and fast rise above the threshold. The detector shall monitor the sensitivity of the smoke sensor. If the sensitivity shifts outside the UL limits, a trouble signal shall be sent to the panel. It shall be possible to automatically change the sensitivity of individual intelligent addressable smoke detectors for day and night (alternate) periods.
4. Each detector shall utilize an environmental compensation algorithm that shall automatically adjust for background environmental conditions such as dust, temperature, and pressure. The detector shall provide a maintenance alert signal when 80% (dirty) of the available compensation range has been used. The detector shall provide a dirty fault signal when 100% or greater compensation has been used.
5. Provide EDWARDS, model SIGA-OSD.

C. Intelligent Carbon Monoxide Detector

1. Provide Intelligent CO Sensor is an intelligent device that uses a CO sensor to detect carbon monoxide from any source of combustion and analyzes the sensor data to determine when to initiate a life safety CO alarm. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.
2. The detector signals to the control panel when the CO sensor reaches its end of life. The CO element shall be field replaceable.
3. The CO Detector shall activate upon the following conditions:
   a. 70 PPM for 60 – 240 minutes
   b. 150 PPM 10- 50 minutes
   c. 400 PPM 4 – 15 minutes
4. The CO activation shall be programmable type as follows: Alarm, Supervisory Latching, Supervisory Non-Latching, Monitor Latching, or Monitory Non-Latching.

D. Intelligent 135 Degree Fixed Temperature / Rate of Rise Heat Detector

1. Provide intelligent combination fixed temperature/rate-of-rise heat detectors at the locations shown on the drawings. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature and at a temperature rate-of-rise. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The intelligent heat detector shall have a nominal fixed temperature alarm point rating of 135°F (57°C) and a rate-of-rise alarm point of 15°F (9°C) per minute. The heat detector shall be rated for ceiling installation at a minimum of 50 feet (21.3m) centers and be suitable for wall mount applications.

2. Provide EDWARDS, model SIGA-HRD.

E. Intelligent Fixed Temperature Heat Detector

1. Provide intelligent fixed temperature heat detectors at the locations shown on the drawings. The heat detector shall have a low mass thermistor heat sensor and operate at a fixed temperature. It shall continually monitor the temperature of the air in its surroundings to minimize thermal lag to the time required to process an alarm. The integral microprocessor shall determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable. The heat detector shall have a nominal alarm point rating of 135°F (57°C). The heat detector shall be rated for ceiling installation at a minimum of 50 feet (21.3m) centers and be suitable for wall mount applications.

2. Provide EDWARDS, model SIGA-HFD.

F. Intelligent Dual Reporting - Fixed Temperature Heat Detector

1. Provide intelligent dual reporting fixed temperature heat detectors at the locations shown on the drawings. The dual-reporting heat detector that features a fixed 135 °F (57.2 °C) Alarm threshold plus a separate programmable Emergency threshold: Fixed temperature reporting generates an Alarm condition when the device's 135 °F (57.2 °C) is reached; Emergency reporting can be used to report elevated temperatures in evacuation elevator lobbies and machine rooms, as well as heat warnings and freeze warnings for areas that are sensitive to temperature extremes. The heat sensor monitors the temperature of the air in its surroundings and the detector analyzes the data to determine when the air temperature near the detector exceeds the device's set 135 °F (57.2 °C) Alarm threshold, or its programmed Emergency reporting point temperature range between 35°F to 125°F. The heat detector shall be rated for ceiling installation at a minimum of 50 feet (21.3m) centers and be suitable for wall mount applications.

2. Provide EDWARDS, model SIGA-H2D.

G. Intelligent Multi-Sensor Detectors Types

1. Multi-criteria sensor can be any combination of photoelectrical smoke sensing, heat and carbon monoxide (CO) detection. The combined photoelectric smoke detection/heat/CO module shall have separate sensors that adjust the detection profile in response to the input from the sensors.

    a. Provide EDWARDS, model SIGA-OSHCD

2. Multi-criteria detector can be combination of photoelectrical smoke sensing and 135 degree thermal heat detection.

    a. Provide EDWARDS, model SIGA-OSHD

3. Multi-criteria detector can be combination of photoelectrical smoke sensing and carbon monoxide (CO) detection.

    a. Provide EDWARDS, model SIGA-OSCD

4. Multi-criteria detector can be combination of fix-temperature heat and carbon monoxide (CO) detection.

    a. Provide EDWARDS, model SIGA-HCD

5. All the Multi-Sensor detector shall use only one address on the SLC.

    a. The CO activation shall be programmable type as follows: Alarm, Supervisory Latching, Supervisory Non-Latching, Monitor Latching, or Monitory Non-Latching.

H. Detector Base Types

1. Provide standard detector mounting bases suitable for mounting on 1-gang, or 4inch octagon box and 4 inch square box. The base shall, contain no electronics and support all series detector types. Bases with electronics or dip-switches are not acceptable.

    a. Provide EDWARDS, model SIGA-SB or SB4.

I. Audible Base – 520hz Low Frequency

1. Provide low frequency 520hz audible detector mounting bases suitable for mounting on 4” square x 2-1/8” (54 mm) deep box. The audible base shall produce tone sound within the frequency range of 520 Hz ±10% square wave tone.

2. The operation of the audible base shall be controlled by its respective detector processor or under program control as required by the application. The base shall support all Signature Series detector types and be capable of single or group operation. The audible base shall emit a temporal 3 alarm tone and/or temporal 4 tone.

    a. The audible bases shall be UL268 and UL464 Listed, and nominal sound level shall be 87dBA in anechoic chamber and 80 dBA in reverberant room, listed.

b. All low frequency sounder bases audible temporal 3 tone shall be synchronized through the facility. Including with building audible horns.

c. Provide EDWARDS, model SIGA-AB4G-LF.

J. Intelligent Duct Smoke Detector - Photoelectric

1. Provide intelligent photoelectric duct smoke detector at the locations shown on the drawings.

a. One form C auxiliary alarm relay rated at 2amps @ 30Vdc.
b. The operating range shall be 100ft/min to 4,000ft/min air velocity and temperature range of –20 to 158F.
c. Sample tube can be installed with or without the cover place and be rotated in 45- degree increments to ensure proper alignment with duct airflow.
d. Local magnet-activated test switch.
e. Provide EDWARDS, model SIGA-SD

f. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station in the wall at 18” below the finished ceiling under the unit. Furnish and install red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device indicating the name of the HVAC equipment that is served by this detector light. Where Detector is above 10’0’ the test station shall be wall mounted at 48” above the finished floor. Where Detector is above 10’0’ the test station shall be wall mounted at 48” above the finished floor.

2. Provide remote test station with Alarm LED and Key Switch.
a. Provide EDWARDS, model SD-TRK.

3. Relay Fan Shutdown: Rated to interrupt fan motor control circuit. Furnish and install separate device for each motor start. Connect to motor start as required for fan shutdown during alarm condition.
a. Provide EDWARDS, model SIGA-CRH.

2.12 INTELLIGENT MODULES

A. It shall be possible to address each intelligent module without the use of DIP or rotary switches. Devices using switches for addressing shall not be acceptable. The personality of multifunction modules shall be programmable at site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller.

1. Integral Microprocessor: All decisions are made at the module determining if the device is alarm or trouble condition.

2. Non-Volatile Memory: Permanently stores serial number, and type of device. Automatically updates historic information including hours of operation, number of alarms and troubles, time of last alarm.

3. Automatic Device Mapping: Each detector transmits wiring information regarding its location with respect to other devices on the circuit, creating an As-Built wiring diagram. This will also provide enhanced supervision of the device physical location. The device message shall reside with the location and not the device address. Devices installed in the wrong location will always report the correct message of the physical location.

4. Twin Status LEDs: The modules shall have a minimum of 2 diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status.

5. Input and output circuit wiring shall be supervised for open and ground faults.

6. Two styles of modules shall be available, those designed for gang box mounting, and where multiple modules are required in a single location, plug in modules shall be provided with a Universal Input/Output motherboard.

B. Intelligent Input Module. The Input Module shall provide one or two supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers. The single input module shall support the following circuit types:

- Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
- Normally-Open Alarm Delayed Latching (Waterflow Switches)
- Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
- Normally-Open Active Latching (Supervisory, Tamper Switches)

1. Provide EDWARDS model SIGA-CT1 or CT2 or SIGA-MCT2

C. Intelligent Relay Module. Provide addressable control relay circuit modules shall provide one (1) form C dry relay contacts rated at 24Vdc @ 2 amps (pilot duty) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers.

1. Provide EDWARDS, model SIGA-CR or SIGA-MCR

D. Intelligent High Current Relay Module. Provide addressable control relay circuit modules shall provide two (2) form C dry relay contacts rated at 24Vdc @ 7 amps (pilot duty) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware. The module shall be suitable for mounting on North American deep 4-inch square.

1. Provide EDWARDS, model SIGA-CRH

E. NAC Control Module: Provide intelligent NAC control module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation. The gang box -mounted version shall be suitable for mounting in North American 2 ½" (64mm) deep 2-gang boxes and 1 ½" (38mm) deep 4" square boxes with 2-gang covers, or European 100mm square boxes. The plug-In version shall plug into a universal multi-module motherboard. The NAC control module shall support the following operations:

- 24volt NAC circuit
- Audio notification circuit 25v or 70v
- Telephone Power Selector with Ring Tone (Firefighter's Telephone)
- Visual Synchronized Output to Genesis appliances or to NAC Power Supply.

1. Provide EDWARDS, model SIGA-CC1 or –CC1S or SIGA-MCC1 or MCC1S.

F. Sounder Base Tone Control Module: Provide intelligent temporal pattern generator is an addressable device that generates sound patterns for fire (Temporal 3) or carbon monoxide (Temporal 4) to sounder bases. The module shall be suitable for mounting on North American 2 ½" (64mm) deep 1-gang boxes and 1 ½" (38mm) deep 4" square boxes with 1-gang covers. NAC control module shall support the following operations:

- 24volt NAC circuit
- Synchronized audible tone to all sounder bases and building audibles.
- Alarm signal continues until the system resets or is manually silenced from the control panel.
- Visual Synchronized Output to Genesis appliances or to NAC Power Supply.

1. Provide EDWARDS, model SIGA-TCDR

G. Elevator Interface Cabinet

1. Provide red metal cabinet enclosure with word FIRE in white letters on the cover. Inside will be four intelligent relays (Primary Recall, Alternate Recall, Fire Hat and Shunt Trip), one monitor input (Shunt Trip AC Power Supervision) and 120vac relay (Shunt Trip AC Power Supv).
2. Label all the relays and input modules for the function.
3. Provide EDWARDS, model MFC with SIGA-UIO6, -MCR, MCT2 and MR-101.

2.13 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. The manual pull station will have an intelligent module integral of the unit.

3. Station Reset: key operated switch shall match the control panel key.
4. Manual pull stations that initiated an alarm condition by opening the unit are not acceptable.
5. Provide EDWARDS, model SIGA-278.

2.14 NOTIFICATION APPLIANCES

A. All appliances shall be of the same manufacturer as the Fire Alarm Control Panel specified to insure absolute compatibility between the appliances and the control panels, and to insure that the application of the appliances are done in accordance with the single manufacturers' instructions.

B. All appliances shall be wall or ceiling mounted white body and marking of FIRE, and shall be UL 1971 & UL 464 listed Fire Protective Service.

C. Mass notification appliance shall be wall or ceiling mounted white body and marking of ALERT, and shall be UL 1971, UL1638 & UL 464 listed Fire Protective Service

D. Notification Appliances – Visual

1. Provide clear lens strobes that provide a smooth light distribution pattern field selectable candela 15 cd, 30 cd, 75 cd, and 110 cd flash output rating, UL1971 listed with in-out screw terminals shall be provided for wiring. The strobe (15, 30, 75, 110) candela rating shall be view from the side window to verify the setting. All strobes shall be synchronization to within 10 milliseconds for an indefinite period shall not require the use of separately installed remote synch modules. The strobes shall mount to one-gang electrical box.
2. High candela clear lens strobes that provide field selectable candela 95cd, 115cd, 150cd and 177cd flash output rating, UL1971 listed with in-out screw terminals shall be provided for wiring.
3. Provide EDWARDS, model Genesis Series devices.

E. Notification Appliances – Mass Notification – Visual

1. Provide amber lens strobes that provide a smooth light distribution pattern field selectable candela 13 cd, 26 cd, 65 cd, and 95 cd flash output rating, UL1638 listed with in-out screw terminals shall be provided for wiring. The strobe (A, B, C, D) candela rating shall be view from the side window to verify the setting. All strobes shall be synchronization to within 10 milliseconds for an indefinite period shall not require the use of separately installed remote synch modules. The strobes shall mount to one-gang electrical box.
2. High candela Amber lens strobes that provide field selectable candela 82cd, 100cd, 130cd and 155cd flash output rating, UL1971 listed with in-out screw terminals shall be provided for wiring.

3. Provide EDWARDS, model Genesis Series devices.

F. Notification Appliance – High Fidelity Speaker

1. High Fidelity Speakers shall have a 4" Mylar/paper cone. The rear of the speakers shall be completely sealed protecting the cone during and after installation. In and out screw terminals shall be provided for wiring. Speakers shall provide 1/4w, 1/2w, 1w, and 2w power taps for use with 70V systems. The actual speaker wattage & strobe candela setting shall be view from the device window to verify the wattage setting, without removing the device. To make any changes to the speaker wattage will only require the removal of the cover plate.

2. High Fidelity Speaker listed frequency response of 400 to 4,000 Hz and listed sound output of 90.5 dBA at 10 feet, as measured in reverberation room per UL-1480. Speaker shall be listed in compliance to produce 520Hz low frequency tone signal.

3. The following selectable sound level output:
   a. 1/4watt – 81.5 dBA
   b. ½ watt – 84.1 dBA
   c. 1 watt – 87.3 dBA
   d. 2 watt – 90.5 dBA

4. Provide EDWARDS, model Genesis G4HF & GCHF Series devices.

G. Notification Appliance – 8 inch Cone Speaker with Round Ceiling Baffle

1. Provide 8 inch diameter ceiling mounted speakers at the locations shown on the drawings. In and out screw terminals shall be provided for wiring. Speaker baffles shall be round or square steel with white finish as required. Provide square surface mount boxes with matching finish where required. Speakers shall provide 1/2w, 1w, 2w, and 4W power taps for use with 25V or 70V systems. At the 4 watt setting, the speaker shall provide a 94 dBA sound output a frequency of 1000 Hz. when measured in an anechoic chamber at 10 ft.

2. Speaker shall be mounted to speaker-back box and speaker support truss for suspended ceiling mounting.

3. Provide surface mounted back box mounted to ceiling deck in open exposed areas.

4. Provide EDWARDS, Model 965 series.

H. Notification Appliance - Re-entrant Speakers

1. Provide 4 inch diameter red re-entrant speakers at loud ambient locations or for outdoor weatherproof installation. Weatherproof boxes shall be provided for outdoor mounting. Speakers shall provide 2w, 4w, 8w, and 15w power taps. The re-entrant speakers shall utilize a high-efficiency compression

driver. Cone type drivers are not acceptable. At the 15 watt setting, the speaker shall provide a 102 dBA sound output over a frequency range of 400-4000 Hz. when measured in reverberation room per UL-1480.

2. Combination speaker strobes shall meet both sections of above.
3. Provide EDWARDS, model 757 Series devices.

I. Trumpet Type Loudspeaker

1. Provide a trumpet speaker at the locations shown on the drawings. The trumpet speaker shall be able to operate within any ambient temperature environment ranging from 66°C (150°F) to -35°C (-30°F), with weather-resistant unit shall be constructed of heavy-gauge treat aluminum. Model shall be a double re-entrant type with 15 watts RMS audio power rating compression driver producing a UL-rated sound pressure level of 102dB measured at 15 watts, 10ft. (3dB increment rating) within a frequency range of 400 Hz to 4 kHz. Impedance shall be 8 ohms and sound dispersion 70°. Power taps shall be available at 1, 2, 3.8, 7.5, 15 watts for 70V line. Trumpet loudspeaker assembly shall be furnished with mounting bracket allowing adjustment on either a vertical or horizontal plane with a single locking pin and including provisions for mounting, banding, or strapping. Wiring terminals for amplifier output shall be fully enclosed and a vandal-resistant adapter cover shall provide connection facilities for cable or conduit. Dimensions: 77/8" W x 83/4" H x 95/16" D (200 x 222 x 237mm). Unit shall be finished in either gray baked epoxy or red baked epoxy. Color shall be verified with Owner prior to ordering and installation.
2. Provide EDWARDS, model HPSA-15.

J. OMNI Directional Type – UL1480 Listed Loudspeaker for Fire Protective Use
1. The speaker shall have five sides for OMNI directional that produce 360 degree of acoustical energy with high fidelity output for intelligibility.
2. Speaker shall be 70VRMS with field selectable taps can easily be changed among the 40W, 90W, 125W and 250W power ratings. The speaker has an integrated blocking capacitor that allows the fire alarm control panel to conduct circuit supervision. Each speaker meets UL Standard 1480 (Speakers for Fire Protective Signaling Systems).
3. Speaker shall be both indoor and outdoor NEMA3R rated, dimension of 12.4” Dia x 8” Height and weights 20lbs.
4. Speaker shall be capable of producing sound output of 129db peak and frequency range of 175Hz – 8 Khz.
5. Provide EDWARDS-KIDDE, model MN-HSM25P5N

K. Directional Speaker
1. The speaker shall have be design for weatherproof – moist appliactions with ABS plastic.
2. Model shall be a non-re-entrant compression loaded transducer with a 3” polyimide diaphragm and power handling of 45W continuous. The coil shall be a nominal 8 ohm impedance and ferro-fluid shall surround the coil to provide heat dissipation.

3. Speaker shall have performance rating with power settings shall be: 136 dB, 134 dB, 131 dB, and 129 dB. Speaker shall contain in-line capacitor to allow DC supervision of wiring and be supplied with three feet of conduit with flying leads. Frequency response shall be 375Hz – 15kHz. Dimensions shall be 10.1”H x 10.1”W x 11.3”D.
4. Provide EDWARDS, model MNTCPA

L. LED TESTUAL DISPLAY SIGN
1. Provide an Emergency Notification LED Textual Sign that is UL1638 Listed with full color display (RGB).
2. Unit shall support up to 10 pre-defined textual messages activated by contact closure and full custom textual messages using the software programmer.
3. In normal mode the unit shall display the time and day of week.
4. Viewing distance
   a. Single Line 4.7inches – up to 200feet
   b. Dual Line 2.3 inches – up to 100ft
   c. Units size shall be 8.3”(H) x 22.5” (H) x 2.75” (THK)
5. Units shall have 60 minutes of battery back-up operation.
6. On each side of the sign shall be integral visual strobe and programmable operation.
7. Units size shall be 8.3”(H) x 22.5” (H) x 2.75” (THK), shall operate on POE or 12/24Vdc.

2.15 GUARDS FOR PHYSICAL PROTECTION

A. Provide welded mesh of size and shape for the manual pull stations, smoke detectors, notification appliances at location noted on the drawings.

B. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

2.16 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 120-V ac, 24-V ac or dc.
4. Provide EDWARDS, model 1500 series or DH Series.

2.17 INSPECTION BAR CODES

A. Inspection bar codes shall be installed on all initiating devices, annunciators, control panels and power supplies.

B. Inspection bar codes used by the system must utilize Code 3 of 9 or other approved format, and contain a minimum of eight (8) digits that comprise a unique serial identifier within the Web-based Reporting System. There shall be no duplication of serial numbers. Serial number shall be printed below the bar code for identification purposes.

C. Inspection bar codes shall be limited in size to no more than 2” (5cm) in width, and 3/8” (2 cm), in height and shall include a Mylar® or other protective coating to protect the bar code from fading due to sunlight or exposure.

D. Inspection bar codes shall be installed on each device in such a manner as to require that scanning of the bar code take place no further than 12” from the device during inspection.

2.18 WIRE AND CABLE

A. Signaling Line Circuits – Network Data: Twisted pair, not less than No. 18 AWG or as recommended by the manufacturer.

B. Signaling Line Circuits – Intelligent Loop: Non-Twisted pair, not less than No. 16 AWG or as recommended by the manufacturer.

1. Circuit Integrity Cable: Provide as required to meet NFPA or Local Code requirements.

2. CI Cable shall meet article 760, power limited fire alarm service.

C. Notification Appliance Circuits –

1. Audio: Twisted pair, not less than No. 16 AWG or as recommended by the manufacturer.

2. Visual. Non-Twisted pair, not less than No. 12 AWG or as recommended by the manufacturer.

2.19 Power:

Power supply shall have a dedicated fused safety switch for this connection at the service entrance equipment. Paint the switch box red and identify it with "FIRE ALARM SYSTEM POWER."

Interconnect fire alarm system to the new tone generator system in the intercom system. Such that upon activation of any initiation device, a preset audible alarm will be sent on all intercom speakers. In addition, the contractor shall furnish and install all control between the two systems such that upon silencing the alarm on the fire alarm panel it automatically silences the tone generator on the intercom system.

System shall include hardware and support for dedicated BACnet/Modbus monitoring by the EMS system.

All electrical power, equipment, and systems (Generator, Fire Alarm, Intercom, Gym Sound System, etc.,). Electrical equipment and distribution shall be completely installed and operational 45 days prior to Substantial Completion. Electrical power and system completion shall also include completion of all certifications, tests and closeout documentation.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 and NEC Article 760 for installation of fire-alarm equipment.

B. Equipment Mounting: Install fire-alarm control unit on finished floor with tops of cabinets not more than 72 inches above the finished floor.

C. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing [**control**] [**monitoring**] equipment as necessary to extend existing [**control**] [**monitoring**] functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

D. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.

2. Comply with NFPA72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A [**or Appendix B**] in NFPA 72.
5. HVAC: Locate detectors not closer than **5 feet** from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

E. Duct Smoke Detectors: Comply with NFPA72 and NFPA90A. Install sampling tubes so they extend the full width of duct.

F. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

G. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

H. Notification Appliance Devices: Install between 80 and 96 inches on the wall.

I. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

J. Annunciator: Install with top of panel not more than 56 inches above the finished floor.

3.2 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 8 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighter smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated air-conditioning duct systems.
4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
9. Supervisory connections at elevator shunt trip breaker.
10. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
11. Supervisory connections at fire-pump engine control panel.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."

B. Install framed instructions in a location visible from fire-alarm control unit.

C. All initiating devices shall have bar code label installed visibly on the device. This bar code shall be used for digital inspection of the fire alarm system using Building Reports.Com.

3.4 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by Architect, Engineer and authorities having jurisdiction.

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

C. Perform tests and inspections.

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

D. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA72.

3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: During the warranty period, each year test fire-alarm system complying with visual and testing inspection requirements in NFPA72. Use forms developed for initial tests and inspections.

J. Detector Sensitivity Testing: During the warranty period, each year the contractor is to perform detector sensitivity testing and provide report to the Owner. Unless, the system is UL Listed to perform automatic sensitivity testing without any manual intervention and should detector fall outside of sensitivity window, the system will automatically indicated a devices trouble. A copy of UL letter is to be provided as proof of system operation

3.6 DEMONSTRATION

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

B. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI and CI, **is not permitted**.
3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.
4. All cables shall be run in conduit.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made. All locations shall be indicated on the point to point wire diagrams.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

F. Wiring to Remote Alarm Transmitting Device: 1-inch (25-mm) conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.8 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.9 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. The manufacturer shall aid the owner’s representative and help test and trouble shoot the system prior to substantial completion. Perform the following field tests and inspections and prepare test reports:

1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
4. Testing: Follow procedure and record results complying with requirements in NFPA 72.

a. Detectors that are outside their marked sensitivity range shall be replaced.

5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

A point by point checkout with the Owner's representative shall be scheduled and performed prior to the 45 test period. Manufacturer shall certify system in written format prior to the requested point to point system check out.

6. Furnish and install a complete half size laminated set of as built fire alarm point to point wiring diagrams indicating all device locations, device zone numbers and names, panel locations, power sub panel locations, circuiting routing, slice locations, and be capable of showing installed conditions accurately. These drawings shall be furnished to the owner prior to substantial completion of the project. Furnish and install an additional copy to be stored in a tube mounted at the main fire alarm control panel. Coordinate the exact location with building official.

3.10 ADJUSTING

A. Annual Test and Inspection: One year after date of Final Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section Closeout Procedures."

END OF SECTION 283111

SECTION 311111

SITE CLEARING AND DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, shrubs, groundcovers, plants and grass to remain.
2. Removing existing trees, shrubs, groundcovers, plants and grass that interfere with work to be done or are noted to be removed.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing and removing site utilities.
7. Temporary erosion and sedimentation control measures.
8. Removing and disposing of all trash, debris, etc.

B. Related Sections include the following:

1. Division 1 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities.
2. Division 1 Section "Execution Requirements" for verifying utility locations and for recording field measurements.
3. Section 312300 "Earthwork" for soil materials, excavating, backfilling, site grading, placement of topsoil and finish grading of lawn and landscape areas.
4. Section 329210 "Finishing of Lawn and Landscape Areas" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.3 DEFINITIONS

A. Unscreened Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil,

clay lumps, gravel, and other objects more than 2 inches in diameter, and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Screened Topsoil: Topsoil that has been mechanically sifted and passes through a ¾ inch by ¾ inch screen.

C. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site and disposed of in a legal and lawful manner. Stripped topsoil shall only be taken off site with the Owner’s express written consent and only after all site needs are met.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Record drawings, according to Division 1 Section "Project Record Documents," identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

A. Contractor shall coordinate and attend along with all site subcontractors, an on-site pre-sitework meeting with City of Woodstock.

B. Contractor shall verify that all site clearing occurs within the boundary/property lines, particularly in areas where clearing approaches adjacent common property lines or noted buffers. Limit clearing to areas noted on the plans and to areas required for the installation of utilities.

C. Regulatory Requirements: Comply with governing EPD (Georgia Environmental Protection Division) notification regulations before beginning work. Comply with hauling and disposal regulations of authorities having jurisdiction. Submit copy of notification to Architect.

1.7 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
3. Provide trained flagmen and install traffic control devices. Operate warning lights in accordance with authorities having jurisdiction and to warn motorists of construction activity.

B. Improvements on Adjoining Property: If necessary, Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing. Georgia "Call Before You Dig" Utilities Protection Center: (811).

E. Do not commence site clearing operations until temporary erosion and sedimentation control measures and initial phase of stormwater ponds have been completed. Those measures that cannot be installed prior to site clearing must be installed concurrent with site clearing such that all cleared areas are fully contained at the end of each day's activities.

PART 2 – PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 312300 "Earthwork."

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

B. Flowable Fill: Non-excavatable controlled low strength flowable fill shall meet the Georgia Department of Transportation Specification Section 600.

PART 3 – EXECUTION

3.1 PREPARATION

A. Contractor shall be responsible for all construction layout work. Layout shall be performed by a land surveyor registered as such in the State of Georgia. Contractor shall supply their surveyor with data disk obtained from the Engineer by request through the Architect. Engineer requires execution of a hold harmless agreement for electronic file transfer.

B. Protect and maintain benchmarks and survey control points from disturbance during construction.

C. Locate and clearly flag trees and vegetation to remain or to be relocated.

D. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner

E. Provide surface water control during construction operations to direct runoff water to sediment ponds and barriers and to prevent damage to adjacent properties.

3.2 TEMPORARY EROSION AND SEDIMENTATION

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction, sediment and erosion control Drawings, and in response to intermediate construction conditions.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established. Provide inspections in accordance with NPDES Permit No. GAR 100001. Maintain erosion controls on a daily basis.

C. Contractor shall remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION / SITE PROTECTION

A. Erect and maintain temporary fencing around tree protection zones and project perimeter before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within fenced area.
2. Do not permit vehicles, equipment, or foot traffic within fenced area.
3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.

2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
3. Coat cut faces of roots more than 1-1/2 inches in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
4. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

1. Employ an arborist, licensed in Georgia, to submit details of proposed repairs and to repair damage to trees and shrubs.
2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Architect.

3.4 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

D. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material. Fill abandoned piping in accordance with section below.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.

E. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.5 ABANDONMENT BY GROUT FILLING

A. Lines noted to be abandoned in place shall be filled by pumping flowable fill into the lines. The line shall be completely filled, leaving no voids or air spaces.

B. A pressure grout pump of suitable size shall be utilized in the grouting of the lines. Unless otherwise approved by the Engineer, the grout shall be pumped into the lines in an up-slope manner to remove trapped air or water and from the inlet (injection) end to the exit end (vent). Samples of any outgoing water/fluids (exit end) shall be made until the grout mix collected is the same as the grout being injected.

C. The grouting method shall adequately provide for the removal and legal disposal of existing sewer materials and fluids in the system.

3.6 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
3. Use only hand methods for grubbing within tree protection zone.
4. Dispose of all vegetation removed in a legal and lawful manner.
5. Grind all trees and limbs and spread wood chips around perimeter of site for additional erosion control measures. Place wood chips between double rows of silt fence.
6. Do not use mechanical machinery to remove trees and root systems along stream banks.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

2. After fill placement, grade surface to meet adjacent contours and to provide surface drainage.

3.7 TOPSOIL STRIPPING

A. Remove sod, grass, brush, roots, wood, glass, stones, broken concrete, brick, concrete block, etc. before stripping topsoil.

B. Strip topsoil to whatever depths are encountered, from building pad and pavement areas and from all other cut and fill areas.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile stripped topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover or grass to prevent windblown dust.

1. Do not stockpile topsoil within tree protection zones.

2. Install Type NS silt fencing around low side of all soil stockpiles.

D. Allow testing company to review topsoil stripping and stockpiling. Stockpile cleanest topsoil for respreading on areas to be landscaped and sodded around buildings.

E. Once site areas have been graded to the proper subgrade elevations, topsoil shall be spread to the depths indicated in Section 312300 – Earthwork. Topsoil shall be spread on all disturbed areas that are to be grassed and/or landscaped. Contractor shall remove and stockpile all topsoil encountered in areas to be graded.

3.8 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Sawcut and remove all slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

C. Use of explosives will not be permitted for demolition.

3.9 DISPOSAL

A. Disposal: Remove obstructions, demolished materials, and waste materials including trash and debris, demolished materials, etc. and legally dispose of them off Owner's property. Burning or burial of debris on-site shall not be allowed.

END OF SECTION 311111

SECTION 312300

EARTHWORK

PART 1 - GENERAL

1.1 SCOPE

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

B. This section covers stripping and stockpiling topsoil, re-distributing topsoil, grading, hauling, excavating, rock removal for excavations, fill and backfilling required for site work, all required underground utilities and footings, temporary grading or ditching and sediment control to protect the site and adjoining property from water and silt damage. Rock removal includes drilling, blasting, crushing and pneumatic hammering and disposal required to construct the project. All excavation shall be considered classified. The Contractor's price/proposal shall include all earth excavation, undercutting and structural fill placement and all other excavating, backfilling and filling to provide the Owner with the finished grades and subgrades shown on the grading plans and a completed project.

C. Excavation for Site Utilities, Plumbing, Mechanical /Electrical Work: Excavation and backfill required in conjunction with underground site utilities, plumbing, mechanical and electrical utilities, and buried mechanical and electrical appurtenances shall be accomplished in accordance with this Section, including testing.

D. Removal and offsite disposal of mass and trench rock and partially weathered rock and unsuitable soils and all required excavation and backfilling necessary to complete work specified in Division I Allowances and Unit Prices.

1.2 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. The Manual for Erosion and Sediment Control in Georgia, Fifth Edition, as published by Georgia Soil and Water Conservation Commission, "Best Management Practices" apply to all land disturbing activities.

1.3 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks, pavements, parking areas, driveways, lawns and grasses, and areas to be landscaped.
2. Excavating and backfilling for buildings and structures.
3. Floor slab base material for slabs-on-grade and granular backfill.
4. Excavating and backfilling for utility trenches.
5. Excavating and backfilling pits for buried utility structures.
6. Grading stormwater and detention ponds.
7. Removing sediment from stormwater and detention ponds.
8. Excavating test pits to determine extent of fill materials, soft surface soils and rock encountered during the initial subsurface exploration.
9. Spreading of topsoil and finish grading on all areas to be sodded and landscaped, including landscape islands in paved areas.

B. Related Sections include the following:

1. Division 1 Section "Allowances" for quantity allowance provisions related to unit-price rock excavation and authorized additional excavation.
2. Division 1 Section "Unit Prices" for unit-price rock excavation and authorized additional excavation provisions.
3. Division 1 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities.
4. Section 311111 "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
5. Section 329210 "Finishing Lawn and Landscape Areas" for finish grading, including preparing and placing topsoil and planting soil for lawns.
6. Section 312315 “Rock Removal.”
7. Section "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.

1.4 UNIT PRICES

A. Unit prices for earthwork are included in Division 1 Section "Unit Prices."

B. Quantity allowances for earthwork are included in Division 1 Section "Allowances."

C. Rock Measurement: Shall be as defined in Division 31 Section “Rock Removal.”

1.5 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe to a minimum of 12 inches in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill. Offsite borrow areas shall be approved by the Geotechnical firm prior to use.

D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for allowances and unit prices.
2. Bulk Excavation: Excavation more than 6 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

E. Fill: Soil materials used to raise existing grades.

F. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation (Mass Rock) or ½ cu. yd. for footing, trench, and pit excavation (Trench Rock) that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings:

1. Excavation of Footings and Trenches (Trench Rock): Late-model, track-mounted hydraulic excavator; having a short tip radius bucket not wider than 42 inches equipped with rock teeth, and having a minimum flywheel power rating of 123 KW (165 hp);such as Caterpillar 322CL, John Deere 230C LC, or a Komatsu PC220LC-7or approved equivalent.
   a. Trench rock shall consist of rock associated with linear excavations for storm or utility pipes or footings with a width of six feet (6’) or less.
2. Bulk Excavation (Mass Rock): Late-model, track-mounted dozer (Caterpillar D8K or larger or equivalent); pulling a single tooth ripper with a minimum drawbar pull of not less than 56,000 pounds; measured according to SAE J-732. Single tooth ripper shall be pulled across the rock surface at least two times in 8 directions of the compass, for a total of 16 passes.
   a. Bulk excavation (mass rock) shall consist of rock associated with linear excavations that have a width greater than six feet (6’) and all surface rock encountered that requires removal in order to achieve finished grades or subgrades.
3. Any material that may be classified as rock shall be evaluated by the Geotechnical Engineer or his representative prior to excavation. No claims for payment of rock excavation will be paid for unless the classification and evaluation of the material is witnessed and verified by a representative of the Geotechnical Testing Company and witnessed by a representative of the Owner and Architect.

G. Soil Materials: Defined under Part 2 "Products", if not defined here.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base, drainage fill, or topsoil materials.

J. Unscreened Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

K. Screened Topsoil: Topsoil that has been mechanically sifted and passes through a ¾ inch by ¾ inch screen.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.6 SUBMITTALS

A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
2. Laboratory compaction curve according to ASTM D 698 for on-site soil material proposed for fill and backfill.

B. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

C. Photographic documentation of each section of storm drainage taken structure to structure at time pipe is bedded in stone shall be provided to the Owner prior to backfilling trench with soil.

1.7 REGULATORY REQUIREMENTS

A. Verify and comply with all Federal, OSHA, State, County, City or local requirements concerning earthwork, excavation, and related activities.

B. WARNING: NO PERSON(S) SHALL ENTER MANHOLES OR OTHER UNDERGROUND STRUCTURES, TRENCHES, OR EXCAVATIONS WITHOUT PROTECTIVE BREATHING APPARATUS AND AT LEAST ONE OTHER PERSON PRESENT FOR SAFETY AND MONITORING AT ALL TIMES. CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE OSHA RULES AND REGULATIONS.

1.8 QUALITY ASSURANCE

A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code."

B. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548. Soil tests, field density tests, and testing of footing subgrades, observation and report of predensification shall be made by a Geotechnical Testing Agency (Geotechnical Engineer) and paid for in accordance with Division 1 Section "Testing Laboratory Services".

C. Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

1. Protect structures, utilities, sidewalks, pavement and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
2. The Contractor, and all sub-contractors, shall be responsible for all safety measures, procedures, or devices as required by OSHA, Federal, State or local authorities. No person shall enter a manhole or other underground structure without protective breathing apparatus, and at least one other person present for safety. All earthwork, trenching, and grading operations shall conform to minimum OSHA requirements for safety, shoring, bracing, and protective measures.

D. Barricade open excavations occurring as part of this work and post with warning lights.

1. Operate warning lights as recommended by authorities having jurisdiction.

1.9 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory, Suitable Soils for project requirements excluding reinforced backfill for mechanically stabilized earth walls: Satisfactory (suitable) soil materials are limited to soils classified in accordance with ASTM D 2487 Soil Classification Groups GC, SC, CL, GW, GP, GM, SW, SP, SM and ML or a combination of these groups; free of non-soil materials and rock fragments, larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Suitable soils shall have a liquid limit less than 50, plastic index less than 30 and a Standard Proctor maximum dry density (ASTM D-698) of at least 95 pounds per cubic foot.

B. Unsatisfactory Soils: Soil Classification Groups OL, CH, MH, OH, and PT according to ASTM D 2487 or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 3 percent of optimum moisture content at time of compaction. Rework of these soils shall be at the Contractor's expense.

C. Unsuitable soil/materials are soils or materials defined as Soil Classification Groups OL, CH, MH, OH and PT and/or that are not suitable or appropriate for their intended use as determined by the Testing Agency or the Engineer of Record.

D. Partially Weathered Rock Materials: Partially weathered rock materials are present on the site. These materials or a portion of these materials may be suitable for reuse as structural fill provided the rock material breaks down under the action of compacting equipment to reasonably well-graded materials that can be satisfactorily compacted. The presence of cobble size or boulder size material, which does not break down under the action of compactor equipment will limit the suitability of partially weathered rock materials. Engineering judgement by the Geotechnical Engineer will be required in the field to evaluate the acceptability of partially weathered rock materials for reuse as structural fill.

Materials determined by the Geotechnical Engineer to be unsuitable for structural fill shall be utilized on site in non-structural areas to the fullest extent practical as directed by the Engineer. These materials shall not be hauled off site until directed by the Architect.

E. Blast Rock: Bask rock shall be utilized on site in non-structural areas to the fullest extent practical as directed by the Geotechnical Engineer. Blast rock materials shall not be hauled off site until directed by the Architect.

F. Base Course: Graded, crushed aggregate base conforming to Georgia Department of Transportation specifications.

G. Backfill and Fill Materials for Trench Backfill: Satisfactory, suitable soils as defined above in Paragraph 2.1A with the following exceptions:

1. Initial Backfill: Initial backfill shall not contain non-soil and rock fragments exceeding two inches in any dimension.

2. Final Backfill: Final backfill shall not contain non-soil and rock fragments exceeding 3 inches in any dimension.

H. Floor Slab Base Material: Floor slab base material shall be #89 aggregate meeting the Georgia Department of Transportation Specifications for Road and Bridge Construction Section 800 (latest edition).

I. Drainage Course: Washed, #57 Stone meeting the Georgia Department of Transportation Specifications for Road and Bridge Construction Section 800 (latest edition).

J. Stormwater Pond Core and Keyway Material: Imported or onsite clay material consisting of soils classified as ML, CL or SC and having a maximum permeability of 1×10^{-5} cm/sec tested in accordance with ASTM D5084.

2.2 ACCESSORIES

A. Warning/Detection Tape: Tape shall be composed of a solid aluminum foil encased in a protective plastic jacket. Colors may be solid or striped. Tape shall be permanently printed with no surface printing allowed. Tape width shall be a minimum of 3 inches and shall be buried at a depth between one and two feet deep. Detection tape shall be installed over all water and sanitary sewer mains, sanitary service laterals and storm drainage. Tape shall be colored as follows:

1. Blue: Water systems.
2. Green: Sewer systems.
3. Green: Storm Sewer Systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing," during earthwork operations.

3.2 SHORING AND BRACING

A. Stability of Excavations: Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

B. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.

D. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

E. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

3.3 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

C. Convey water removed from excavations and rainwater to collecting or run-off areas. Establish and maintain temporary drainage ditches and other diversions outside excavation limits for each structure. Construct temporary drainage ditches to divert groundwater and subsurface water away from building and paving areas. Do not use footing excavations as temporary drainage ditches. Do not permit construction drainage onto adjacent property.

3.4 EXPLOSIVES

A. Explosives: Obtain written permission from Owner and authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

1. Perform blasting without damaging adjacent structures, property, or site improvements.
2. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

B. Use of explosives to be in conformance with local, state and any governing jurisdictional agency safety requirements. Notification of adjacent property owners to be in accordance with requirements of Section 312315 – Rock Removal.

3.5. EXCAVATION, GENERAL

A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth or rock. Do not excavate rock until it has been classified and cross sectioned by the Geotechnical Engineer. The Contract Sum will be adjusted for rock excavation according to unit prices and allowances included in the Contract Documents.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; blasting, ram hammering; or ripping of material not classified as rock excavation will be classified as earth excavation.

2. Rock excavation includes removal and off-site disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction. Rock will be measured in accordance with Division 31 Specification "Rock Removal."

3.6 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 0.10 feet. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

3.7 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.8 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe at elevations indicated or below frost line, whichever is deeper.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated or required for safety purposes.

1. Clearance: 12 inches each side of pipe or conduit unless pipe is in rock, in which case excavation shall be 6 inches clear on each side of pipe.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Allow for bedding courses as required for each item.
a. Sanitary Sewer Bedding – See Details.

b. Storm Drainage – See Details.
c. Provide photographic documentation of all pipe runs, structure to structure, at time of installation, after backfilling with stone and prior to backfilling with soil.

2. DO NOT BED OR BACKFILL STORMWATER POND OUTFLOW STORM SEWER PIPES AND STORM SEWER PIPES WITH A SLOPE GREATER THAN 5 PERCENT WITH STONE.

3.9 SUBGRADE INSPECTION, PREDENSIFICATION, PROOFROLLING AND TEST PITS

A. Notify Geotechnical Engineer when excavations have reached required subgrade and when fill areas have been cleared and grubbed and topsoil removed.

B. If Geotechnical Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Excavate test pits as directed by Geotechnical Engineer to determine limits of unsuitable materials and soft, loose soils and areas of potential rock. Excavate unsuitable materials and unsatisfactory materials as directed by Geotechnical Engineer.

D. The entire stripped subgrade for building, sidewalks, paving and fill areas shall be scarified and compacted and then proof-rolled as recommended by the Geotechnical Engineer. The compaction efforts shall be sufficient to densify the subgrade of areas to receive fill to a minimum density of 95% in accordance with ASTM-D-698 for a depth of 12 inches. All at grade areas and cut surfaces shall be scarified and compacted to at least 98% of the same criteria.

E. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck or other rubber tired equipment weighing 18 tons minimum.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Geotechnical Engineer, and replace with compacted backfill or other materials as directed by Architect.

F. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Geotechnical Engineer, without additional compensation.

3.10 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.11 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials, topsoil and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of trees to remain.
2. Place Type NS silt fencing around low side of soil stockpiles.

3.12 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, ice, vegetation, or other deleterious matter.

3.13 UTILITY TRENCH BACKFILL

A. Do not backfill trenches until tests and inspections have been made and backfilling authorized by the Engineer or authorities having jurisdiction.

B. Do not backfill storm drain lines until bedded pipe is photographically documented.

C. Place backfill on subgrades free of mud, frost, snow or ice.

D. All storm drain trenches shall be backfilled with stone per the details shown on the Drawings. DO NOT BED OR BACKFILL STORMWATER POND OUTFLOW STORM SEWER PIPES AND STORM SEWER PIPES WITH A SLOPE GREATER THAN 5 PERCENT.

E. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

F. Place and compact initial backfill of satisfactory soil, free of particles larger than 2 inches in any dimension, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Backfill voids with satisfactory soils while installing and removing shoring and bracing.

H. Place and compact final backfill of satisfactory soil to final subgrade elevation.

I. Install warning/locator tape directly above utilities, one to two feet below finished grade.

3.14 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 5 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use satisfactory soil material.
4. Under building slabs, use satisfactory soil material, to floor slab base material.
5. Under footings and foundations, use satisfactory soil material.

C. Place soil fill on subgrades free of mud, frost, snow, ice, vegetation or deleterious matter.

3.15 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 3 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 1 percent and is too wet to compact to specified dry unit weight.

3.16 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure to prevent wedging.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049 for soils which will not exhibit a well-defined moisture-density relationship.

1. Footings, Utility Trenches, Building and Pavement Structural Fill Zones, Building Slabs, Steps and Pavements: Compact to at least 98 percent of the Standard Proctor Maximum Dry Density.
2. Lawn or Landscape Areas Outside of Building and Pavement Structural Fill Zones: Compact each layer of backfill or fill soil material to 95%.
3. Base Material for Building Slab: Compact with mechanical equipment to consolidate and smooth stone material. Allow testing company to review completed areas prior to proceeding with construction.

NOTE: Structural Fill Zone for building and pavement areas shall be defined by the area directly beneath the building and pavement plus extending 25 feet horizontally beyond the limits of each area and also the area encompassed by a 1 to 1 slope down to residual soils beginning at the 25-foot point.

3.17 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated, allowing for minimum depth of topsoil. Compact with uniform levels or slopes between points where elevations are shown or between such points and existing grades.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Curbs, Walks, Lawns, and Unpaved Areas: Plus or minus 1/2 inch. Backfill against curbs and pavement edges flush to provide smooth finish in areas to grassed. Grade areas to receive sod to allow for 1-1/2 inch thickness.
2. Pavements: Plus or minus 1/2 inch.

C. Grading Inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.18 GRADING AND CONSTRUCTING STORMWATER PONDS

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated. Compact with uniform levels or slopes between points where elevations are shown or between such points and existing grades.

1. Provide a smooth transition between adjacent existing grades and new grades.

2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
3. Excavate pond keyway area to existing clay material.
4. Furnish and place approved clay material for pond core and keyway as indicated on the Drawings.

3.19 GRADING OF ALL LAWN AND LANDSCAPE AREAS (UNDER DIVISION 31 SECTION "EARTHWORK")

A. General: Uniformly grade lawn and landscape areas including adjacent transition areas. Smooth finish surfaces within specified to within plus or minus 0.10' between points where elevations are shown or between such points and existing grades. Grade areas adjacent pavement to slope as indicated on the drawings and to prevent ponding of water or sudden changes of grade.

B. Topsoil Placement:

1. All areas of the site that are graded and are to be landscaped, seeded or sodded shall have a uniform layer of unscreened topsoil spread prior to final grading. Smooth and compact finished surface with uniform levels between points where elevations are shown or between such points and existing grades. Topsoil thickness shall be as follows:
   a. Lawn and Landscape Areas Around Building (areas to be sodded): 4 inches of topsoil.
   b. Slopes and Pond Bottoms: 4 inches of topsoil.
2. Grade elevation of topsoil relative to walks, curbs, paved surfaces, and drainage structures, manhole tops, valve boxes, etc. to conform to the following criteria.
   a. Sodded Lawn Areas - One and one-half inches below finish grade to allow for placement of sod.

C. Temporary and Permanent Grassing shall be performed in accordance with Division 32 Section "Landscape Work."

3.20 BASE COURSE

A. Place base course on subgrades free of mud, frost, snow, ice, vegetation or deleterious matter.

B. On prepared subgrade, place base course under pavements as follows:

1. Place base course material over subgrade course under hot-mix asphalt pavement.
2. Shape base course to required crown elevations and cross-slope grades.
3. Place base course 8 inches or less in compacted thickness in a single layer, unless mandated otherwise by Authorities having jurisdiction.
4. Where indicated on the Drawings, place base course that exceeds 8 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
5. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 100 percent of maximum dry unit weight according to ASTM D 1557.

C. Pavement Shoulders: Place shoulders along edges of base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.21 FIELD QUALITY CONTROL:

A. Quality Control Testing During Construction: Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed. An experienced geotechnical engineer shall observe the pre-densification of the building and parking areas. One copy of results of all Compaction Test and observations of pre-densification shall be submitted to Owner, Architect and Engineer.

1. Testing company shall perform field density tests in accordance with ASTM D 2937 (thin-walled tube method), ASTM D 2922 (nuclear method), or sand cone testing method ASTM D 1556.
2. Pavement Subgrade Areas and Building Slab Subgrade: Make at least one field density test for each one-foot lift for every 3,000 sq. ft. of building subgrade area and 5,000 sq. ft. in pavement subgrade areas.
3. Lawns: Make at least one field density test for each one-foot lift for every 7,500 sq. ft. of subgrade area.
4. Topsoil Thickness: Test topsoil thickness one test per 5,000 sq. ft. of lawn area.

B. Footing Subgrades: All footing subgrades shall be examined by an experienced geotechnical engineer or his representative immediately prior to placement of reinforcing steel. Auger and penetrometer testing, augmented by hand probing, shall be performed on all footings in accordance with the following:

1. Auger and penetrometer testing: Minimum of one test for each 25 lineal feet of footing subgrade.
2. Probe rod testing: Minimum of one test for each spread footing and one test for each 10 lineal feet of continuous footing.

C. If in opinion of Engineer, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction to meet the requirements specified herein. Re-testing of areas shall be at the Contractor's expense.

3.22 PROTECTION

A. Protect Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth required; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove waste material, trash, and debris, and legally dispose of it off Owner's property.

3.24 INSUFFICIENT FILL MATERIAL

A. If the quantity or classification of onsite grading material is insufficient to meet project requirements, the Contractor shall obtain the required material from offsite sources as part of the Base Bid. No additional payment will be made to compensate the Contractor for obtaining the required materials from offsite sources.

3.25 EXCESS EXCAVATED MATERIAL

A. If the quantity of grading material is in excess of the quantities necessary to provide subgrade and finish grade elevations indicated on the drawings the excess material shall be disposed offsite by Contractor as part of the Base Bid. No additional payment will be made for offsite disposal of excess materials.

END OF SECTION 312300

SECTION 312315

ROCK REMOVAL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

B. Division 0 Section - "Proposal Form"

C. Section 312300 - "Earthwork"

1.2 SCOPE OF WORK

A. Removal of all rock materials discovered during excavation for the purpose of construction. Removal shall include intermittent drilling, ram hammering, ripping and/or blasting incidental thereto and disposal of excavated materials.

B. When necessary for prosecution of the Work, the use of explosives to assist rock removal may be exercised by Contractor only after ram hammering, ripping and intermittent drilling have been diligently pursued and determined ineffective by the Owner. Use of explosives shall be in compliance with all local, State, Federal and other Governmental regulations applying to transportation, storage, use and control of explosives. Blasting procedures shall be conducted in accordance with the Georgia Blasting Standards Act of 1978, latest revision.

1.3 RELATED WORK

A. Section 312300 - "Earthwork"

1.4 REFERENCES

A. NFPA 495 – Code for the manufacture, Transportation, Storage, and Use of Explosive Materials.

B. OSHA 2207 – Construction Industry Standards, Subpart T – Demolition.

1.5 QUALITY ASSURANCE

A. Geotechnical Firm – Geotechnical Engineer shall observe the testing of rock for compliance with definitions in Division 31 Section - "Earthwork." Geotechnical firm shall make report of all measurements of rock excavated in a written report format prior to submittal of payment by the Contractor.

B. Explosives Firm – Company specializing in explosives for disintegration of subsurface rock with documented experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to Georgia Blasting Standards Act of 1978 and local requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Rock (Definition) – Rock is defined in Division 31 Section - "Earthwork."

PART 3 – EXECUTION

3.1 GENERAL

A. Rock excavation near existing utility lines and mains or other structures shall be conducted with utmost care to avoid damage. Injury or damage to other structures and properties shall be promptly repaired to the satisfaction of owner and by Contractor at his own expense.

B. Rock excavation for all structures and adjacent trenches under this contract and any other rock excavation directed by Owner shall be completed before construction of any structure is started in the vicinity.

C. Unless otherwise directed by Architect, excavated rock material shall be disposed of onsite to fullest extent practical before being disposed of offsite.

D. Contractor shall correct unauthorized rock removal by backfill to grade with compacted crushed stone.

3.2 INSPECTION

A. Contractor shall coordinate potential rock removal and blasting with Owner to allow Owner to review site conditions prior to materials being classified as rock.

B. Contractor shall verify site conditions and note irregularities affecting work of this Section prior to performing any operations involving explosives.

C. Beginning work of this Section means acceptance of existing condition.

D. Rock shall be excavated 6 inches in each direction beyond the horizontal limits of excavation and 6 inches below footing grades or trench depths.

E. Space below grade for pipe shall then be backfilled with crushed rock or gravel or other approved materials and tamped to proper grade.

3.3 ROCK REMOVAL – MECHANICAL METHOD

A. Excavate for and remove rock by the mechanical method using equipment that has the draw bar pulling power or bucket curling force greater than that outlined in Division 2 Section - "Earthwork."

3.4 ROCK REMOVAL – EXPLOSIVES METHODS

A. If rock is uncovered requiring the explosives method for rock disintegration and removal, the Engineer shall be notified immediately so that the surface can be examined.

B. The Contractor shall notify any owners of adjacent buildings or structures, and any public utility owners having structures or other installations above or below ground, in writing prior to use of explosives.

C. The Contractor shall permit only authorized and qualified persons to handle and use explosives.

D. Smoking, firearms, matches, open flame lamps, and other fires, flame or heat producing devices and sparks shall be prohibited in or near explosive magazines or while explosives are being handled, transported or used.

E. No person shall be allowed to handle or use explosives while under the influence of intoxicating liquors, narcotics, or other dangerous drugs.

F. All explosives shall be accounted for at all times. Explosives not being used shall be kept in a locked magazine, unavailable to persons not authorized to handle them. The Contractor shall maintain an inventory and use record of all explosives. Appropriate authorities shall be notified of any loss, theft, or unauthorized entry into a magazine.

G. No explosives or blasting agents shall be abandoned.

H. It shall be Contractor’s responsibility to incorporate the use of seismic monitoring during rock excavation, by use of explosives. Contractor shall maintain all seismic records and blasting logs to be furnished to Engineer upon request.

I. Disintegrate rock and remove from excavation.

J. Cut away rock at excavation bottom to form level bearing.

K. Remove shaled layers to provide sound and unshattered base for pipe and footing foundations.

L. Unless otherwise directed by Architect, excavated rock material shall be deposited onsite in non-structural areas and choked-in with soil and compacted. A minimum of 2’ of compacted soil shall be spread over top of rocks.

M. Contractor shall correct unauthorized rock removal or overbreak in accordance with backfilling and compaction requirements at his own expense.

3.5 FIELD QUALITY CONTROL

A. Provide for visual inspection of bearing surfaces and cavities formed by removed rock for inspection by Architect or his representative prior to new construction.

3.6 MEASUREMENT OF ROCK REMOVAL

A. All measurements for rock removal shall be made by the Geotechnical Engineer and reported to the Owner, Architect, and Engineer in written daily field reports submitted on a daily basis.

B. Measurements for trench rock excavation for piping installation will be made to the width of the pipe plus six inches (6") on both sides of the pipe, but in no case shall the trench width be less than three feet (3'-00"). Vertical measurement of the excavated rock shall include only the area directly above the trench width to the top of the rock to include six inches below the invert of the pipe. No measurement for laying back sides of excavations or for additional excavation at concrete structures, junction boxes, manholes, inlets, etc. will be made. This excavation will be considered incidental to the installation.

C. Elsewhere excavate rock to a depth of 8" below proposed concrete slabs and pavements, 24" outside of concrete work for which forms are required, 12" outside of perimeter footing, and 12" below finished grade in areas to receive landscaping and seeding. All measurements shall be based on these dimensions.

D. Quantities shall be verified by the Architect and Engineer.

3.7 SUBMITTAL FOR PAYMENT FOR ROCK REMOVAL

A. All submittals for payment for rock removal shall be made in the same month's or the next month's pay application. Application for payment for rock removal which exceeds the second pay application is subject to denial by Architect and Owner.

END OF SECTION 312315

SECTION 312500

EROSION, SILTATION AND DUST CONTROL

PART 1 - GENERAL

1.1 RELATED SECTIONS

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

1.2 SCOPE

A. The work specified in this Section consists of providing, maintaining and removing temporary erosion, sedimentation and pollution controls.

B. This work shall consist of control measures during construction until final acceptance to control water runoff, erosion, siltation, and unreasonable amounts of dust. Permanent measures, which will remain in place after completion, are shown on the plans. Temporary measures are also shown on the plans or required by notes on the plans or project specifications. Measures to adequately control dust and erosion and siltation throughout project construction, at different stages of construction, are required whether or not shown on the plans. This control shall be accomplished through the use of berms, dikes, sediment basins, sediment barriers, sediment traps, slope drains, grasses, and other devices.

C. All requirements of complying with NPDES General Permit No. GAR 100001 are listed in the Drawings and shall be the sole responsibility of General Contractor including all filing with GA EPD and fees to state and local governments.

D. Basic Principles:

1. Comply with all applicable Federal, State (Georgia Erosion and Sedimentation Control Act) and local ordinances.
2. Conduct the earthwork and excavation activities in such a manner to fit the topography, soil type and condition.
3. Minimize the disturbed area and the duration of exposure to erosion elements.
4. Stabilize disturbed areas immediately.
5. Safely convey run-off from the site to an outlet such that erosion will not occur off site.
6. Retain sediment on site that was generated on site.
7. Minimize encroachment upon watercourses.
8. Control and minimize dust from the construction site.

E. Temporary Erosion and Sedimentation Control: In general, temporary erosion and sedimentation control procedures shall be directed toward:

1. Preventing soil erosion at the source.
2. Preventing silt and sediment from entering any waterway if soil erosion cannot be prevented.
3. Preventing silt and sediment from migrating downstream in the event it cannot be prevented from entering the waterway.

F. Permanent Erosion Control: Permanent erosion control measures shall be implemented to prevent sedimentation of the waterways and to prevent erosion of the Project site.

1.3 QUALITY ASSURANCE

A. General: Perform all work under this Section in accordance with all pertinent rules and regulations including, but not necessarily limited to, those stated above and these Specifications.

B. Conflicts: Where provisions of pertinent rules and regulations conflict with these Specifications, the more stringent provisions shall govern.

PART 2 - PRODUCTS

2.1 SEDIMENT BARRIER

A. Silt Fence: Silt fence shall be as shown on the Standard Detail Drawings.

B. Stone Check Dams: Stone shall conform to the requirements of Section 805.01 of the Georgia Department of Transportation Standard Specification, latest edition, for Stone Dumped Rip Rap except the stone shall be have a graded size of 2” to 10” at the greatest dimension.

C. Hay Bales: Hay bales shall be clean, seed-free cereal hay. Hay bales can be used in conjunction with silt fence but not as a substitute for silt fence.

2.2 CONSTRUCTION EXIT STONE

A. Use sound, tough, durable stone resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Aggregate size shall be in accordance with the National Stone Association Size R-2 (1.5 to 3.5-inch stone).

2.3 RIP-RAP

A. Stone Rip Rap: Use sound, tough, durable stones resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Unless shown or specified otherwise, stone rip rap shall be Type 1.

1. Type 1 Rip Rap: Rip rap size shall conform to Section 805.01 of the Georgia Department of Transportation Standard Specification for Type 1 Stone Dumped Rip Rap except the stone size shall have a graded size of 4” to 10” at the greatest dimension.
2. Type 3 Rip Rap: Rip rap size shall conform to Section 805.01 of the Georgia Department of Transportation Standard Specifications for Type 3 Stone Dumped Rip Rap except the stone size shall have a graded size of 4” to 10” at the greatest dimension.
3. 200 Pound Rip Rap: Minimum weight of individual stones shall be 200 pounds.

2.4 FILTER FABRIC

A. All filter fabric to be placed under rip-rap aprons shall be Georgia Department of Transportation Class ‘C’ fabric. Fabric shall be 180-N as manufactured by Mirati, 4552 as manufactured by Amoco, N07 as manufactured by Geolon or FX-7OS as manufactured by Carthage. Fabric shall be secured to ground per manufacturer’s recommendations.

2.5 GRASSING

A. Refer to Section 329000 - Landscape Work for grassing requirements.

2.6 EROSION CONTROL BLANKETS

A. General: Refer to Stormwater Pollution Prevention Plans for locations and type of erosion control blankets to be used.

1. Type 1 - 3:1 and Less Steep Slopes: Use straw fiber blankets sewn between two photo-degradable nets. Blankets shall be S150 as manufactured by North American Green,

Curlex II as manufactured by American Excelsior Company, or Landlok S2 as manufactured by SI Geosolutions.

2. Type 2 - 2½:1 and Steeper Slopes: Use erosion control fabric intended for permanent installation on slopes. Fabric shall have (2) U.V. stable nets. Top net shall be 5 lb. black and bottom net shall be 3 lb. black. Nets shall be stitched on 1½" centers. Fabric shall be P300P as manufactured by North American Green or equal by SI Geosolutions, American Excelsior or Landlok.
3. Type 3 - Waterways and Swales: Use blankets of curled wood or coconut fiber matrix sewn between two heavy-weight, UV stabilized nets. Blankets shall be C125 as manufactured by North American Green, Curlex III as manufactured by American Excelsior Company, or Landlok C2 as manufactured by SI Geosolutions.

PART 3 - EXECUTION

3.1 GENERAL

A. Standards: Provide all materials and promptly take all actions necessary to achieve effective erosion and sedimentation control in accordance with the Federal Clean Water Act of 1987, as amended, local enforcing agency guidelines and these Specifications.

B. Implementation: The Contractor shall have the responsibility to actively take all steps necessary to control soil erosion and sedimentation.

3.2 DUST CONTROL

A. Dust shall be controlled by keeping dry areas damp by sprinkling with water or other means.

B. Contractor shall be responsible for all repair of damage caused to adjacent properties.

3.3 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Temporary erosion and sedimentation control procedures should be initially directed toward preventing silt and sediment from entering the waterways. The preferred method is to provide an undisturbed natural buffer, extending a minimum of twenty five feet from the water, to filter the run-off. Should this buffer prove infeasible due to construction activities being too close to the water, or if the amount of sediment overwhelms the buffer, the Contractor shall place silt fences to filter the run-off and, if necessary, place permanent rip rap to stabilize the bank.

B. Silt dams, silt fences, traps, barriers, check dams, appurtenances and other temporary measures and devices shall be installed as indicated on the approved plans and working drawings, shall be maintained until no longer needed, and shall then be removed. Deteriorated hay bales and dislodged filter stone shall be replaced with new materials.

C. Where permanent grassing is not appropriate, and where the Contractor's temporary erosion and sedimentation control practices are inadequate, the Owner may direct the Contractor to provide temporary vegetative cover with fast growing seedings.

D. All erosion and sedimentation control devices, including check dams, shall be inspected by the Contractor at least weekly and after each rainfall occurrence and cleaned out and repaired by the Contractor as necessary.

E. Temporary erosion and sedimentation control devices shall be installed and maintained from the initial land disturbance activity until the satisfactory completion and establishment of permanent vegetation. At that time, temporary devices shall be removed and disposed of offsite.

F. Temporary vegetative measures, such as Disturbed Area Stabilization are defined as Mulching Only, (Ds1), Temporary Seeding (Ds2), Permanent Vegetation (Ds3) and Sodding (Ds4) shall

be installed as per the approved erosion, sedimentation and pollution control plan and meeting the requirements of the "Manual for Erosion and Sediment Control in Georgia", latest edition.

3.4 PERMANENT EROSION CONTROL

A. Permanent erosion control measures shall be implemented as soon as practical for each area of the Project. In no event shall implementation be postponed when no further activities related to completed areas will impact that portion or segment of the Project.

3.5 GRASSING

A. General: Grassing shall be performed as shown on the approved Erosion Control Plan and in accordance with Specification Section 329000.

3.6 RIP-RAP

A. Unless shown otherwise on the Drawings and/or approved Erosion Control Plan, rip rap shall be placed where ordered by the Owner. Carefully compact backfill and place rip rap to prevent subsequent settlement and erosion.

B. Preparation of Foundations: The ground surface upon which the rip rap is to be placed shall be brought in reasonably close conformity to the correct lines and grades before placement is commenced. Where filling of depressions is required, the new material shall be compacted with hand or mechanical tampers.

C. Placement of Filter Fabric: The surface to receive fabric shall be prepared to a relatively smooth condition free from obstructions, depressions and debris. The fabric shall be placed with the long dimension running up the slope and shall be placed to provide a minimum number of overlaps. The strips shall be placed to provide a minimum width of one foot of overlap for each joint. The filter fabric shall be anchored in place with securing pins of the type recommended by the fabric manufacturer. Pins shall be placed on or within 3-inches of the centerline of the overlap. The fabric shall be placed so that the upstream strip overlaps the downstream strip. The fabric shall be placed loosely so as to give and therefore avoid stretching and tearing during placement of the stones. The stones shall be dropped no more than three feet during construction. The fabric shall be protected at all times during construction from clogging due to clay, silts, chemicals or other contaminants. Any contaminated fabric or any fabric damaged during its installation or during placement of rip rap shall be removed and replaced with uncontaminated and undamaged fabric at no expense to the Owner.

D. Placement of Rip Rap: The rip rap shall be placed on a 6-inch layer of crushed stone overlaying the filter fabric. This 6-inch layer shall be placed to maximize the contact between the soil beneath the filter fabric and the filter fabric. Rip rap shall be placed with its top elevation conforming to the natural slope of the stream bank and stream bottom. Stone rip rap shall be dumped into place to form a uniform surface and to the thickness specified on the Drawings.

3.7 REMOVAL

A. At completion of project and once all pervious areas are stabilized with permanent vegetation, the Contractor shall remove all temporary erosion control measures installed for the project and shall dispose of all removed items offsite. Removal and disposal shall include all temporary items installed including silt fencing fabric, wire fabric, steel and wood posts. Removal and disposal shall also include temporary devices installed in storm water ponds such as floating skimmers, perforated risers, stone filter rings, etc.

B. All areas disturbed as a result of the removal of the erosion control measures shall be graded smooth and regrassed and mulched.

END OF SECTION 312500

SECTION 31 31 16

TERMITE CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Soil treatment.
2. Slab penetration barrier treatment of exclusion sealant at plumbing / column penetrations at the lowest level.

B. Related Requirements:

1. Section 06 10 00 "Rough Carpentry" for wood preservative treatment by pressure process.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
2. Include the EPA-Registered Label for termiticide products.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each type of termite control product.

C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

D. Regulatory Requirements: Formulate and apply termiticides according to the EPA-Registered Label.

E. Sample Warranties: For special warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.

1.5 FIELD CONDITIONS

A. Soil Treatment:

1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.6 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites, including Formosan termites (Coptotermes formosanus). If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain termite control products from single source from single manufacturer.

2.2 SOIL TREATMENT

A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.

1. Manufacturers: Subject to compliance with requirements, provide one of the following:
   a. BASF Corporation, Agricultural Products.
   b. Bayer Environmental Science.
   c. Ensystex.
   d. Syngenta.

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than three years against infestation of subterranean termites.

2.3 EXCLUSION SEALANT

A. Exclusion Sealant: Provide barrier sealant, used to seal gaps between plumbing and steel columns at concrete surface. Product's to be EPA-Registered Labeled.

1. Products: Subject to compliance with requirements, provide the following:
   a. Polyguard Products Inc., TERM Sealant Barrier.

B. Primer: Provide primers used to prepare the surface for application of sealant.

1. Products: Subject to compliance with requirements, provide the following:
   a. Polyguard Products Inc., 650 LT Liquid Adhesive or Polyguard 343 Spray Adhesive.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

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

3.2 PREPARATION

A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade and Basement Slabs: Underground-supported slab construction, including footings, building slabs, and attached slabs as an

overall treatment. Treat soil materials before concrete footings and slabs are placed.

2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.

3. Crawlspaces: Soil under and adjacent to foundations. Treat adjacent areas, including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.

4. Masonry: Treat voids.

5. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.

B. Post warning signs in areas of application.

C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.4 PROTECTION

A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

3.5 INSTALLATION OF SLAB PENETRATION BARRIER TREATMENT

A. Top of slab must be clean, smooth, and dry and must be clear of excess concrete.

B. Prepare the pipe / column penetration by sanding its surface. Wipe clean. Prime as required by manufacturer.

C. Apply exclusion sealant completely around all penetrations. There should be a 1/2-inch thickness of sealant at every interface of the pipe / column and the horizontal concrete. There should be no gaps, openings, or crevices anywhere around the penetrations.

3.6 MAINTENANCE SERVICE

A. Continuing Maintenance Proposal: Provide from termite-control-treatment Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1. Include annual inspection for termite activity and effectiveness of termite treatment according to manufacturer's written instructions.

END OF SECTION

SECTION 321313

CONCRETE PAVING, SIDEWALKS & CURB AND GUTTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.2 DESCRIPTION OF WORK

A. Extent of concrete curb and gutters and concrete paving is shown on the drawings.

B. Prepared subgrade is specified in Division 31 Section "Earthwork."

C. Concrete and related materials are specified herein.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Comply with local governing regulations if more stringent than herein specified.

B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C94 requirements for production facilities.

1.4 SUBMITTALS

A. Furnish samples, manufacturer's product data, test reports, and materials' certifications as required in referenced sections for concrete.

1.5 PREINSTALLATION CONFERENCE

A. Contractor shall conduct preinstallation conference at project site to comply with requirements in Division I Section “Project Management and Coordination.”

1.6 JOB CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Utilize flagmen, barricades, warning signs and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.

1. Use flexible spring steel forms or laminated boards to form radius bends as required.

B. Coat forms with a non-staining form release agent that will not discolor or deface surface of concrete.

C. Expansion Joint Materials: Recycled rubber one-half inch in thickness.

2.2 CONCRETE MIX, DESIGN AND TESTING

A. Design mix to produce normal-weight concrete consisting or Portland cement, aggregate, air-entraining admixture and water to produce the following properties:

1. Compressive/Flexural Strength:
   a. Pedestrian sidewalks, plazas, courtyards and curb and gutter: 3000 psi
   b. Vehicular driveways: 4500 psi (600 psi flexural strength)
2. Compressive strength shown above is required minimum at 28 days, unless otherwise noted.
3. Slump Range: 3” to 5”.
4. Air Content: 5% to 8%.
5. Fiber Mesh: 1.5 pounds polypropylene fiber per cubic yard for concrete used for sidewalks and driveways.
6. NO WATER SHALL BE ADDED ON-SITE.
7. Curing compound shall be used on all concrete paving, sidewalks and curb and gutter. Curing compound shall be 1100-Clear as manufactured by W.R. Meadows or equal.

2.3 REINFORCEMENT

A. Shall be as indicated on the drawings.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

B. Proof-roll prepared subbase surface to check for unstable areas and need for additional compaction. Do not begin paving work until such conditions have been corrected and area ready to receive paving.

3.2 FORM CONSTRUCTION

A. Set forms to required grades and lines with gutter pitched to drain in locations indicated by the grades shown on the plans. Rigidly brace and secure all forms. Install sufficient quantity of forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement.

B. Check completed formwork for grade and alignment to following tolerances:

1. Top of forms not more than 1/8" in 10'.
2. Vertical face on longitudinal axis, not more than 1/4" in 10'.

C. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage.

3.3 CONCRETE PLACEMENT

A. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

B. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocation of joint devices.

C. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

D. Deposit and spread concrete in a continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2-hour, place a construction joint.

E. Curbs and Gutters: Automatic machine may be used for curb and gutter placement at Contractor's option. If machine placement is to be used, submit revised mix design and laboratory test results which meet or exceed minimum specified. Machine placement must produce curbs and gutters to required cross-section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified.

3.4 JOINTS

A. General: Construct expansion, weakened-plane (contraction), and construction joints true-to-line with face perpendicular to surface of concrete. Construct transverse joints at right angles to the centerline, unless otherwise indicated.

B. When joining existing structures, place transverse joints to align with previously placed joints, unless otherwise indicated.

C. Weakened-Plane (Contraction) Joints: Provide weakened-plane (contraction) joints at 15 feet on center. Construct weakened-plane joints for a depth equal to at least 1/4 concrete thickness, as follows:

1. Tooled Joints: Form weakened-plane joints in fresh concrete by grooving top portion with a recommended cutting tool and finishing edges with a jointer.
2. Inserts: Use embedded strips of metal to form weakened-plane joints. Set strips into plastic concrete and carefully remove strips after concrete has hardened.

D. Construction Joints: Place construction joints at end of placements and at locations when placement operations are stopped for a period of more than 1/2-hour, and at every third contraction joint.

1. Construct joints as shown or, if not shown, use standard metal keyway-section forms.
2. Where load transfer-slip dowel devices are used, install so that one end of each dowel bar is free to move.

E. Expansion Joints: Provide premolded recycled rubber for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks and other fixed objects, unless otherwise indicated.

3.5 CONCRETE FINISHING

A. After striking-off and consolidating concrete, smooth surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture.

B. After floating, test surface for trueness with a 10' straightedge. Distribute concrete as required to remove surface irregularities and refloat repaired areas to provide a continuous smooth finish.

C. Work edges of slabs, gutters, back top edge of curb, and formed joints with an edging tool, and round to 1/2" radius, unless otherwise indicated. Eliminate tool marks on concrete surface.

D. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point-up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by Architects.

E. All horizontal surfaces shall be given a broom finish as described in this Project Manual.

F. All vertical surfaces and non-walking surfaces shall be given a rubbed finish as described in Division 3 Section "Cast-in-Place Concrete."

G. All concrete paving, sidewalks and curb and gutters shall receive concrete curing compound applied as per manufacturer's recommendations.

H. Remove exposed fibers from finished concrete sidewalks.

3.6 REPAIRS, PROTECTIONS AND CLEANING

A. Repair or replace broken or defective concrete, as directed by Architect.

B. Allow testing company to drill test cores where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Pressure wash sidewalks, curb and gutters and paving to remove stains, discolorations, dirt and other foreign material just prior to final inspection.

END OF SECTION 321313

SECTION 321316

ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 0 and Division 1 Specification Sections, apply to this section.

B. Georgia Department of Transportation Specifications, latest edition.

1.2 RELATED SECTIONS

A. Division 31 Section "Earthwork" for subgrade and aggregate base courses.

1.3 DESCRIPTION OF WORK

A. Extent of asphalt concrete paving work is shown on the drawings. This work shall include the base and asphaltic concrete paving of the thicknesses and types shown on the drawings for all areas noted on the plans to be paved.

1.4 SUBMITTALS

A. Material Certificates: Provide copies of materials, certificates signed by material producer and Contractor, certifying that each material item complies with, or exceeds specified requirements.

1.5 JOB CONDITIONS

A. Base course may be placed when air temperature is above 30 F (-1 C) and rising.

B. Grade Control: Establish and maintain required lines and elevations.

1.6 PREINSTALLATION CONFERENCE

A. Contractor shall conduct preinstallation conference at project site to comply with requirements in Division 1 Section “Project Management and Coordination.”

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Use locally available materials and gradations which exhibit a satisfactory record of previous installations. All materials shall meet Georgia Department of Transportation Specifications.

B. Base Course: Crushed aggregate base conforming to the Georgia Department of Transportation Specification Section 310.

C. Asphalt Cement: AASHTO M 226 (ASTM D 3381) for viscosity-graded material and AASHTO M 20 (ASTM D 946) for penetration-graded material.

D. Prime Coat and Tack Coat: Bituminous prime coat and tack coat shall conform to the Georgia Department of Transportation Specification Sections 412 and 413, respectively.

E. On Site Pavement Markings:

1. Thermoplastic striping in accordance with Georgia Department of Transportation Specifications for all pavement striping and pavement markings including parking stripes as indicated on the Drawings.
2. Fire Lane Pavement Striping shall be as noted on Drawings.
3. All other pavement markings shall be white unless noted otherwise on the Drawings.

F. Curb Painting: Paint curbs and paint lettering as indicated on the Drawings. Paint shall comply with Georgia Department of Transportation Standards and Specifications.

2.2 ASPHALT-AGGREGATE MIXTURE

A. Provide plant-mixed, hot-laid asphalt-aggregate mixture complying with Georgia Department of Transportation Standard Specification Section 400 and the Drawings.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Compact base course to 100 percent of its maximum dry density as determined by the Modified Proctor ASTM D 1557.

B. Proof roll prepared base surface to check for unstable areas and areas requiring additional compaction immediately prior to paving.

C. Notify Engineer of unsatisfactory conditions. Do not begin paving work until deficient base areas have been corrected and are ready to receive paving.

D. Prime Coat and Tack Coat: Apply in accordance with Georgia Department of Transportation Specification Sections 412 and 413 and details shown on the Drawings. If prime coat is not indicated on the details, it will not be required.

3.2 PLACING BASE COURSE AND ASPHALT MIX

A. General: Place and test base and asphalt pavement in accordance with latest Georgia Department of Transportation Standard Specifications Section 400.

B. Base Course: Place base course on a prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness, maintain optimum moisture content for compacting base material during placement operations.

C. Asphaltic Concrete: Place asphalt concrete mixture on prepared surface, spread and strike-off. Place inaccessible and small areas by hand. Place each course to required grade, cross-section, and compacted thickness.

D. Paver Placing: Place in strips not less than 10' wide, unless otherwise acceptable to Engineer. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.

E. Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density and smoothness as other sections of asphalt concrete course.

3.3 ROLLING / COMPACTING

A. General: Begin rolling when mixture will bear roller weight without excessive displacement. Compact pavement mixture in accordance with Georgia Department of Transportation Specification Section 400.

B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

C. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.

D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated. Each asphalt layer shall be compacted to at least 93% of the Maximum Theoretical Laboratory Specific Gravity of the submitted and approved job mix formula for each asphalt course or 97% of the 50 Blow Marshall Laboratory Density as determined for production asphalt material. Asphalt and ambient temperatures are to be in conformance with Georgia DOT Specification Section 400 during installation.

F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut-out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades: to protect paving from traffic until mixture has cooled enough not to become marked.

3.4 TRAFFIC AND LANE MARKINGS

A. Cleaning: Sweep and clean surface to eliminate material and dust.

B. All pavement markings shall be in accordance with the Manual for Uniform Traffic Control Devices.

C. Refer to Drawings for color, size and type of pavement markings.

D. Apply pavement markings with mechanical equipment to produce uniform straight edges. Apply per manufacturer’s recommendations.

E. Protect completed areas until pavement markings have cured.

3.5 FIELD QUALITY CONTROL

A. General: Testing Company shall test aggregate base density and in-place asphalt concrete courses for compliance with requirements for compaction, thickness and surface smoothness. Repair or remove and replace unacceptable paving as directed by Engineer.

B. Quality Control Testing during Construction: Allow testing service to inspect and approve subgrades and intermediate pavement layers before further construction work is performed. An experienced geotechnical engineer shall observe the proof-rolling of the aggregate base immediately prior to paving and shall inspect asphalt binder surfaces prior to placement of final asphalt layers. One copy of results of all Compaction Test and observations of proof-rolling shall be submitted to Owner, Architect and Engineer.

1. Testing company shall perform field density tests in accordance with ASTM D 2937 (drive cylinder method), ASTM D 2167 (rubber balloon method), as applicable, or nuclear method ASTM D 2922.

2. Pavement Base Material: Make at least one field density test for each 5,000 sq. ft. of pavement base area.

C. Testing company shall perform a minimum of 8 asphalt core tests at locations directed by Engineer.

D. Thickness: In-place compacted thickness will not be accepted if exceeding following allowable variation from required thickness:

1. Base Course: 1/2"
2. Binder & Surface Course: 1/4"

E. Surface Smoothness: Test finished surface of each asphalt concrete course for smoothness, using 10' straightedge applied parallel with, and at right angles to centerline of paved area. Surfaces will not be accepted if exceeding the following tolerances for smoothness.

1. Wearing Course Surface: 3/16".

F. Check surface areas at intervals as directed by Engineer.

G. Correcting Deficient Paving: If test results determine that the average thickness of base or binder and surface course exceeds the allowable variation, the Contractor shall resurface the entire paving area with surface course materials at no expense to the Owner. The minimum thickness for asphaltic resurfacing shall be 1 inch.

END OF SECTION 321316

SECTION 323113

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this section.

1.2 SUMMARY

A. This Section includes the following:

1. Polymer coated (black) galvanized steel chain link fence and gates.
2. Refer to Site Layout Plans for fencing heights and gate locations and sizes.

B. Related Sections: The following sections contain requirements that relate to this section:

1. Section 311111"Site Clearing" for clearing for fence installation.
2. Section 312300 "Earthwork" for filling and grading work.

1.3 SUBMITTALS

A. Product Data in the form of manufacturer's technical data, specifications, and installation instructions for fence and gateposts, fabric, gates, operators, and accessories. Provide samples (6 inch sections) of fence fabric and typical line posts for review.

B. Shop Drawings showing location of fence, gates, each post, and details of post installation, extension arms, gate swing, hardware, and accessories.

C. Maintenance data for polymer finishes.

1.4 QUALITY ASSURANCE:

A. Single-Source Responsibility: Obtain chain link fences and gates as complete units, including necessary erection accessories, fittings, and fastenings from a single source or manufacturer.

1.5 PREINSTALLATION CONFERENCE

A. Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS:

A. Contractor shall engage services of licensed surveyor to provide horizontal control and layout for fencing.

B. Field Measurements: Verify layout information for fences and gates shown on the Drawings in relation to the property survey and existing structures. Verify dimensions by field measurements. Provide and install stakes for fence layout for review by Owner/Architect prior to beginning installation of posts. Stake all corners, gate locations, points of deflection and along straight runs at 100-foot intervals.

C. Contractor shall clear and remove trees, brush, etc. as required to complete fence installation.

PART 2 - PRODUCTS

2.1 FABRIC

A. Selvage: Polymer coated fabric shall be knuckled at both selvages.

B. Steel Chain-Link Fence Fabric: Fabricated in one-piece widths for fencing 12 feet and less in height to comply with ASTM A392 Chain Link Fence Manufacturers Institute (CLFMI) CLF 2445and requirements indicated below.

C. Fencing Mesh and Wire Schedule:

1. 2-inch mesh, 9 gage core wire plus polymer coating (6 gage after coating) fabric shall be used for all permanent fencing.

2.2 FINISHES

A. Finish Coating: ASTM A392, Type II, Class I, zinc-coating applied after weaving.

1. Fabric: Not less than 1.2 oz. zinc per square foot.
2. Framing: Not less than 1.8 oz. zinc per square foot.

B. Polymer Coating (Thermally Fused): ASTM D668, Class I over metallic-coated steel wire. All fabric, posts, rails, fittings and accessories shall be polymer coated.

C. Polymer Coating: Polymer coating for all fencing materials shall be black.

2.3 FRAMING

A. Round member sizes are given in actual outside diameter (OD) to the nearest thousandth of inches. Round fence posts and rails are often referred to in ASTM standard specifications by nominal pipe sizes (NPS) or the equivalent trade sizes in inches. The following indicates these equivalents all measured in inches:

B. Strength requirements for posts and rails conforming to ASTM F 669.

C. Pipe shall be straight, true to section, material, and sizes specified, and shall conform to the following weights per foot:

NPS in Inches	Outside Diameter (OD) in inches	Type I Steel	Type II Steel
1	1.315	1.68	1.35
1-1/4	1.660	2.27	1.84
1-1/2	1.900	2.72	2.28
2	2.375	3.65	3.12
2-1/2	2.875	5.79	4.64
3	3.500	7.58	5.71
3-1/2	4.000	9.11	6.56
4	4.500	10.79	____
6	6.625	18.97	____
8	8.625	28.55	____

D. Steel Framework, General: Posts, rails, braces, and gate frames.

1. Type I Round Posts: Hot-dipped galvanized steel pipe conforming to ASTM F 1083, plain ends, standard weight (schedule 40) with not less than 1.8 oz. zinc per sq. ft. of surface area coated.

2. Type II Round Posts: Manufactured from steel conforming to ASTM A 569 or A 446, grade D, cold formed, electric welded with minimum yield strength of 50,000 psi and triple coated with minimum 0.9 oz. zinc per sq. ft. after welding, a chromate conversion coating and a clear polymer overcoat. Corrosion protection on inside surfaces shall protect the metal from corrosion when subjected to the salt spray test of ASTM B 117 for 300 hours with the end point of 5 percent Red Rust.

E. Roll-Formed Steel Shapes: C-sections, produced from structural steel conforming to ASTM A570, Grade D. Comply with ASTM F 1043, Material Design Group II, with minimum yield strength of 45,000 psi (310 MPa); and the following coating requirements:

1. Coating: Type A, consisting of not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq.m) average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq.m) zinc coating per ASTM A 653/A653M.

F. Steel posts for fabric heights up to 6 feet:

1. End, corner, and pull post
   a. Up to 6 feet: 2.875 inch OD Type I or II steel pipe.
2. Line or intermediate posts
   b. Up to 6 feet: 2.375 inch OD Type I or II steel pipe or rolled-formed steel C-section equivalent.

G. Steel posts for fabric heights over 6 and not exceeding 12':

1. End, Corner, Pull Post. 2.875 O.D. Type I or II
2. Line or intermediate Post 2.375 O.D. Type I or II or rolled-formed steel C-section equivalent.

H. Swing Gate Posts: Furnish posts to support single gate leaf, or one leaf of a double-gate installation, according to ASTM F 900, sized as follows for steel pipe posts:

1. Steel posts for fabric height of 6 feet or less and gate leaf width:
   a. 4 to 12 Feet: 3.00-inch OD pipe weighing at least 5.71 lb per ft.

I. Top Rail: Manufacturer's longest lengths (17 to 21 feet) with swedged-end or expansion-type coupling, approximately 6 inches long for joining. Provide rail ends or other means for attaching top rail securely to each gate corner, pull, and end post. Provide top rail for all line posts.

1. Round Steel: 1.660-inch OD Type I or II steel pipe or rolled formed steel 1.625"x 1.25" channel-shaped top rail.

K. Center and intermediate rails shall be the same as top rail.

2.4 FITTINGS AND ACCESSORIES:

A. Material: Comply with ASTM F 626. Mill-finished aluminum or galvanized iron or steel to suit manufacturer's standards.

1. Steel and Iron: Unless specified otherwise, hot-dip galvanize pressed steel or cast-iron fence fittings and accessories with at least 1.2 oz. zinc per sq. ft. as determined by ASTM A 90.
2. Aluminum: Die cast conforming to ASTM B 26, aluminum-alloy 360 or sand cast conforming to ASTM B 85, aluminum-alloy 365, ZG61A, or Tenzalloy.

B. Tie Wires: 12 gage (0.106 inch diameter) galvanized steel with a minimum of 0.80 oz. per sq. ft. of zinc coating of surface area in accordance with ASTM A 641, Class 3 or 9 gage (0.106 inch diameter) aluminum wire alloy 1100-H14 or equal, to match fabric core material.

C. Post Brace Assembly: Manufacturer's standard adjustable brace at end and gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for brace, and truss to line posts with 3/8-inch diameter rod and adjustable tightener. Provide manufacturers standard galvanized steel or cast iron or cast aluminum cap for each end.

D. Post and Line Caps: Provide weather tight closure cap for each post. Provide line post caps with loop to receive top rail.

E. Tension or Stretcher Bars: Hot-dip galvanized steel with minimum length 2 inches less than full height of fabric, minimum cross-section of 3/16 inch by 3/4 inch and minimum 1.2 oz. zinc coating per sq. ft. of surface area. Provide one bar for each gate and end post, and two for each corner and pull post, except where fabric is integrally woven into post.

F. Tension and Brace Bands: Minimum 3/4-inch wide hot-dip galvanized steel with minimum 1.2 oz. zinc coating per sq. ft. of surface area.
   1. Tension Bands: Minimum 14 gage (0.074 inch) thick.
   2. Tension and Brace Bands: Minimum 12 gage (0.105 inch) thick.

G. Concrete: Provide concrete consisting of Portland cement, ASTM C 150, aggregates ASTM C 33, and clean water. Mix materials to obtain concrete with a minimum 28-day compressive strength of 2500 psi. Use at least 4 sacks of cement per cu. yd., 1-inch maximum size aggregate, maximum 3-inch slump, and 2 to 4 percent entrained air.

H. Tension Wire: 7 gage steel, metallic-coated coil spring wire, in accordance with ASTM A 824, located at bottom of fence.

2.5 GATES:

A. Fabrication: Fabricate perimeter frames of gates from metal and finish to match fence framework. Assemble gate frames by welding. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware, and accessories. Space frame members maximum of 8 feet apart unless otherwise indicated.

   1. Provide same fabric as for fence unless otherwise indicated. Install fabric with tension bars and bands at vertical edges and with tie wires at top and bottom edges.
   2. Install diagonal cross-bracing consisting of 3/8 inch-diameter adjustable-length truss rods on gates to ensure frame rigidity without sag or twist.

B. Swing Gates: Comply with ASTM F 900.

   1. Steel: Gates up to 8 feet wide
   2. Up to 6 feet high: Fabricate perimeter frames of minimum 1.660 inch OD Type I or II steel pipe or 1.90" o.d. tubular shaped steel.

C. Gate Hardware: Provide hardware and accessories for each gate, galvanized per ASTM A 153, and in accordance with the following:

   1. Hinges: Size and material to suit gate size, non-lift-off type, offset to permit 180-deg gate opening. Provide 1-1/2 pair of hinges for each leaf over 6 foot nominal height.
   2. Latch: Forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch.
   3. Keeper: Provide keeper for gates, which automatically engages gate leaf and holds it in open position until manually released.

4. Gate Stops: Provide gate stops for the double gates, consisting of mushroom-type flush plate with anchors, set in concrete and designed to engage center drop rod or plunger bar. Include locking device and padlock eyes as integral part of latch, permitting both gate leaves to be locked with single padlock.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install fence in compliance with ASTM F 567. Do not begin installation and erection before final clearing and grading is completed, unless otherwise permitted. Install fabric with knuckled edge up and twisted edge at bottom where applicable.

B. Excavation: Drill or hand-excavate (using post-hole digger) holes for posts to diameters and spacings indicated, in firm, undisturbed or compacted soil.

1. If not indicated on drawings, excavate holes for each post to minimum diameter recommended by fence manufacturer, but not less than 4 times largest cross-section of post.
2. Unless otherwise indicated, excavate hole depths approximately 3 inches lower than post bottom, with bottom of posts set not less than 36 inches below finish grade surface.
3. Do not damage geotextile fabric supporting retaining walls. Fabric shall be cut as required to allow advancement of hold for fence post.

C. Setting Posts: Center and align posts in holes 3 inches above bottom of excavation. Space maximum 10 feet o.c., unless otherwise indicated.

1. Protect portion of posts above ground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment and hold in position during placement and finishing operations.
   a. Unless otherwise indicated, extend concrete footings flush with grade and trowel to a crown to shed water.

D. Top Rails: Run rail continuously through line post caps, bending to radius for curved runs and at other posts terminating into rail end attached to posts or post caps fabricated to receive rail. Provide expansion couplings as recommended by fencing manufacturer.

E. Brace Assemblies: Install braces at end and gateposts and at both sides of corner and pull posts. Locate horizontal braces at mid height of fabric on fences with top rail and at two-thirds fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

F. Fabric: Leave approximately 1 inch between finish grade and bottom selvage unless otherwise indicated. Pull fabric taut and tie to post, rails, and tension wires. Install fabric and anchor to framework so that fabric remains in tension after pulling force is released. Install fabric to sides of fence posts as follows:

1. Perimeter Fencing: Exterior of project boundary
2. Mechanical Yards and Stormwater Ponds: Exterior of mechanical yards

G. Tension or Stretcher Bars: Thread through or clamp to fabric 4 inches o.c., and secure to end, corner, pull, and gate posts with tension bands spaced not over 15 inches o.c.

H. Tie Wires: Use U-shaped wire of proper length to secure fabric firmly to posts and rails with ends twisted at least 2 full turns. Bend ends of wire to minimize hazard to persons or clothing.

1. Maximum Spacing: Tie fabric to line posts 12 inches o.c. and to rails and braces 24 inches o.c. Tie fabric to gate frames 6" o.c.

I. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

J. Tension Wire: Tension wire to be stretched taut and secured to each line post with a tie wire and secured to each terminal post with a brace band prior to installation of fence fabric. Secure fence fabric to tension wire with 9 gauge hog rings at 18 inches on center.

3.2 GATE INSTALLATION

A. Gates: Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

END OF SECTION 323113

SECTION 329000

LANDSCAPE WORK

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. Division 1 Section "Summary of Work"

C. Section 312300 "Earthwork"

D. Section 329210 "Finishing Lawn and Landscape Areas"

1.2 DESCRIPTION

A. This section includes provisions for the following items:

1. Temporary seeding and mulching including use of sand
2. Permanent seeding and mulching including the use of Polyacrylamide (PAM) materials
3. Soil Amendments
4. Sodding Landscape Areas
5. Herbicide and Insecticide Treatment.

B. The following sections contain requirements that relate to this section:

1. Section 312300 "Earthwork"
2. Section 329210 "Finishing Lawn and Landscape Areas"

1.3 SOURCE QUALITY CONTROL

A. Contractor shall schedule pre-installation meeting prior to beginning any final grassing, seeding or sodding.

B. General: Ship landscape materials with certificates of inspection required by governing authorities. Comply with regulations applicable to landscape materials.

C. Do not make substitutions: If specified Sod material is not obtainable, submit proof of non-availability to Architect, together with proposal for use of equivalent material.

D. Analysis and Standards: Package standard products with manufacturers certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.

1.4 SUBMITTALS

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

B. Plant and Material Certifications and Analysis:

1. Certificates of inspection as required by governmental authorities.
2. Manufacturers or vendor's certified analysis for soil amendments and fertilizer materials.
3. Label data substantiating that planting materials comply with specified requirements.
4. Analysis of soil materials including sand.

C. Maintenance Instructions: Typewritten instructions recommending procedures to be established by Owner for maintenance of landscape work for one full year. Submit prior to expiration of required maintenance period(s).

1.5 PREINSTALLATION CONFERENCE

A. Contractor shall conduct preinstallation conference at project site to comply with requirements in Division I Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE AND HANDLING

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

B. Sod: Time delivery so that sod will be placed or planted within 24 hours after harvesting. Protect sod against drying and breaking of rolled strips.

C. Trees and Shrubs: Store trees and shrubs in secure area until planting. Protect from extreme weather.

1.7 JOB CONDITIONS:

A. Utilities: Determine location of underground utilities and perform work in a manner which will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

B. Excavation: When conditions detrimental to sod growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Architect before planting.

1.8 SEQUENCING AND SCHEDULING

A. Proceed with, and complete, landscape work as rapidly as portions of site become available.

B. Temporary seeding will be required on the disturbed areas of the site. Temporary seeding shall consist of planting seed and mulching all disturbed areas left exposed for more than 14 days.

C. The Contractor shall till all areas that were temporarily grassed to not less than 6 inches and recondition soil as provided herein prior to establishing permanent vegetation.

D. The Contractor shall perform all necessary work including, but not limited to, fine grading, hand raking, fertilizing, pulverizing, seeding, sodding, landscaping, etc.

E. Refer to the Landscape Plans and Erosion Control Plans for areas to be sodded and areas to be seeded.

PART 2 - PRODUCTS

Topsoil: Topsoil will be respread over areas to be landscaped under Division 31 Section "Earthwork."

2.1 SOIL AMENDMENTS

A. Lime: Natural dolomitic limestone containing not less than 85 percent of total carbonates with a minimum of 30 percent magnesium carbonates, grounds so that not less than 90 percent passes a 10 mesh sieve and not less than 50 percent passes a 100-mesh sieve.

B. Aluminum Sulfate: Commercial grade.

C. Mulch: Organic mulch free from deleterious materials and suitable for top dressing of trees, shrubs, or plants and consisting of the following:

1. Shredded and treated cypress mulch over landscape fabric weed barrier. Install weed barrier with staples per manufacturers recommendations.

D. Commercial Fertilizer: Complete fertilizer of neutral character with some elements derived from organic sources and containing the following percentages of available plant nutrients:

1. For lawns, provide fertilizer with percentage of nitrogen required to provide not less than 1 pound of actual nitrogen per 1,000 sq. ft. of lawn area and not less than 4 percent phosphoric acid and 2 percent potassium. Provide nitrogen in a form that will be available to lawn during initial period of growth; at least 50 percent of nitrogen to be organic form. Fertilizer for lawn areas shall be a complete formula 10-10-10 or approved equal.

E. Sand: Coarse sand meeting the Georgia Department of Transportation Specification Section 801.2.02.

2.2 GRASS MATERIALS

A. Sod: Provide strongly rooted sod, not less than 1 year old, free of weeds and undesirable native grasses, and machine cut to pad thickness of 3/4 inch (plus or minus 1/4 inch), excluding top growth and thatch. Provide only sod capable of vigorous growth and development when planted (viable, not dormant).

1. Provide sod for lawn areas of uniform pad sizes with maximum 5 percent deviation in either length of width. Broken pads or pads with uneven ends will not be acceptable. Sod pads incapable of supporting their own weight when suspended vertically with a firm grasp on upper 10 percent of pad will be rejected. Sod shall be Tift 419 Bermuda.

B. Seed: Seed shall be delivered to the site in the original sacks as received from the producer, and each sack shall be tagged in accordance with the agricultural seed laws of the United States and State of in which the project is located. Each sack shall be tagged showing the dealers guarantee as to the year grown, percentage of purity, percentage of germination and the date of the test by which the percentages of purity and germination were determined. All seed sown shall have a date of test within six months of the date of sowing.

1. Any seed delivered prior to use, shall be stored in such a manner that it will be protected from damage by heat, moisture, rodents, or other cause.
2. Seed Mixture:

a. Lawn Areas Not Sodded: 100 lbs. minimum of Common Bermuda Seed per acre plus the appropriate temporary seed mixture shown in the grassing schedule on the Drawings.
b. Refer to grassing schedule on Drawings for planting mixture and permanent vegetative cover required for slope areas.

C. Wood Pulp Fiber Mulch: Wood pulp fiber mulch for hydroseeding shall meet the requirements of Section 718.02 of the Georgia Department of Transportation Standard Specifications, latest edition. Wood fiber mulch shall be applied at the rate of 1000 pounds per acre.

2.3 POLYACRYLAMIDE MATERIALS (PAM)

A. Contractor shall incorporate the use of Polyacrylamide (PAM) with all temporary and permanent seeding for the entire project. PAM materials shall be applied at the rates recommended by the manufacturer. The PAM product shall be added to hydro-seeders at job site and quantity of materials included shall be verified by Owners Representative for each batch used on the project.

B. Anionic PAM application shall comply with all Federal, State and Local laws, rules or regulations governing Anionic PAM use. The Contractor is responsible for securing required permits.

C. Users of Aniomic PAM shall obtain and follow all materials safety data requirements and Manufacturer's recommendations.

D. Contractor shall comply with Manufacturer's recommendations for preparation, mixing and application of Aniomic PAM for specific material forms to be utilized.

2.4 WEED BARRIER

A. Weed barrier fabric shall be installed beneath mulch in all shrub bed and mulch bed areas. Weed barrier shall be 5 oz./sq. yd. woven, needle punched, polypropylene fabric with 20 year warranty as manufactured by Dewitt, Fabriscape or Rolanka International. Secure fabric to ground with staples per manufacturers recommendations.

PART 3 - EXECUTION

3.1 PREPARATION, GENERAL

A. Mix specified soil amendments and fertilizers with topsoil at rates specified on the drawings. Delay mixing of fertilizer if planting will not follow placing of planting soil within a few days.

B. For lawns, mix planting soil either prior to planting or apply on surface of topsoil and mix thoroughly before planting.

1. Mix lime with dry soil prior to mixing of fertilizer.
2. Prevent lime from contacting roots of acid-loving plants.

3.2 PREPARATION FOR TEMPORARY GRASSING

A. Where temporary grass is to be planted, prepare soil for planting as follows: Till to a depth of not less than 6 inches. Apply soil amendments and initial fertilizers as specified. Remove high areas and fill in depressions. Till soil to a homogenous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter.

B. Apply specified commercial fertilizer (10-10-10) at 1500 pounds/acre and thoroughly mix into upper 2 inches of topsoil along with Lime applied at the rate of 2 tons per acre. Delay application of fertilizer if lawn planting will not follow within a few days. All seeded areas shall be mulched with wheat straw at the rate of 2-1/2 tons per acre.

3.3 PREPARATION FOR PLANTING LAWNS

A. Where lawns are to be planted, prepare soil for lawn planting as follows: Till in all temporary vegetation to a depth of not less than 6 inches. Apply soil amendments and initial fertilizers as specified. Remove high areas and fill in depressions. Till soil to a homogenous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter.

1. Prior to preparation of planting areas, remove existing grass, vegetation and turf.
   Do not turn existing vegetation over into soil being prepared for lawns.
2. Allow for sod thickness in areas to be sodded.
3. Apply specified commercial fertilizer at rates specified and thoroughly mix into upper 2 inches of topsoil. Delay application of fertilizer if lawn planting will not follow within a few days.

B. Fine grade lawn areas to smooth, even surface with loose, uniformly fine texture. Roll, rake, and drag lawn areas, remove ridges and fill depressions, as required to meet finish grades. Fine grading shall include, but not be limited to, pulverizing with a Gill Pulverizer or equal equipment and shaping with a tractor and box blade and hand rakes. Remove stones, pebbles, earth clods, etc. larger than 3/4 inch diameter. Coordinate work with Owner and requirements of Section 2 "Finishing of Lawn and Landscape Areas."

C. Moisten prepared lawn areas before sodding or seeding if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.

D. Restore lawn areas to specified condition, if eroded or otherwise disturbed after fine grading and prior to planting.

3.4 SODDING LAWNS

A. Refer to Landscape Plans for areas to be sodded.

B. Lay sod within 24 hours from time of stripping. Do not plant dormant sod or if ground is frozen. Do not plant damaged or dry sod.

3.5 REMOVE NETTING FROM SOD PRIOR TO PLACEMENT ON ALL AREAS OF THE SITE.

A. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to subgrade or sod. Tamp or roll lightly to ensure contact with subgrade. Work sifted soil into minor cracks between pieces of sod; remove excess to avoid smothering of adjacent grass.

1. Anchor sod on slopes with wood pegs to prevent slippage.

B. Water sod thoroughly with a fine spray immediately after planting.

3.6 HYDROSEEDING

A. Hydroseeding: All lawn and slope areas not to be landscaped with trees and shrubs or sod shall be hydroseeded. Seed shall be mixed with wood pulp fiber mulch and applied in a slurry. The slurry mixture shall be agitated during application to keep the ingredients thoroughly mixed. The mixture shall be spread uniformly over the area within one hour after being placed in the hydroseeder.

B. The mixing and application of mixture shall conform to the requirements of Section 700 of the Georgia Department of Transportation Specifications, latest edition.

3.7 PLANTING STORMWATER POND AREAS

A. Refer to Landscape Plans for Planting requirements in stormwater ponds.

3.8 MAINTENANCE OF LAWN AREAS

A. Begin maintenance immediately after planting.

B. Begin maintenance of seeded grass, sod, trees and shrubs immediately after each area is planted and continue until Substantial Completion. If seeded grass and sodded grass is not fully established at the time of Substantial Completion, continue maintenance until an acceptable lawn is established.

C. Maintain all trees, shrubs, plants, sodded and seeded areas not less than 60 days after substantial completion.

D. Maintain lawns and plants by watering, fertilizing, weeding, applying herbicides and insecticides, mowing, trimming, and other operations such as rolling, regrading and replanting as required to establish a smooth, acceptable lawn, free of eroded or bare areas.

E. Contractor shall include in the base bid furnishing and rolling all sodded areas two separate times with a one-ton roller and topdressing these areas one time with topdresser spreader to a depth of ¼" with sand specified herein. Topdressing shall be done between the first and second rolling. Thoroughly dampen (not wet) sodded areas prior to second rolling. Notify Architect 48 hours prior to beginning topdressing

F. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep planted areas uniformly moist to a depth of 4 inches (100 mm).
1. Water grass at the minimum rate of 1½ inch per week.

G. Mow grass as soon as there is enough top growth to cut with mower set at specified height cutting more than 40 percent of the grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.

H. Post-Fertilization: Apply fertilizer to lawn after first mowing and when grass is dry.

I. Use fertilizer that will provide actual nitrogen of at least 1 lb per 1000 sq. ft. of lawn area.

3.9 CLEANUP AND PROTECTION

A. During landscape work, keep pavements clean and work area in an orderly condition.

B. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

3.10 INSPECTION AND ACCEPTANCE

A. When landscape work is completed, including maintenance, Architect will, upon request, make an inspection to determine acceptability.

1. Landscape work may be inspected for acceptance in portions as agreeable to Architect, provided each portion of work offered for inspection is complete, including maintenance.
   a. When inspected work does not comply with requirements, replace rejected work and continue specified maintenance until reinspected by Architect and found to be acceptable.
2. As soon as the grassed areas have become established, a final inspection of the work will be made, provided a written request for such inspection is given to the Owner. If the work is found to be satisfactory and in accordance with all requirements of the contract documents, the work will be accepted.
   a. It shall be the Contractor's responsibility to provide satisfactory Growth and Coverage. Growth and Coverage on areas grassed as specified shall be considered to be in reasonably close conformity with the intent of the Contract when the vegetation, exclusive of that from seed not expected to have germinated and shown growth at the time, has reached a point of maturity such that each area shows a satisfactory visible growth with not bare spots larger than one square foot. Bare spots shall be scattered, and the total bare areas should not comprise more than 1/100 of any given area.
   b. Areas that fail to obtain a satisfactory growth and coverage shall be regrassed, at no additional cost to the Owner, until a satisfactory stand is established.
   c. All seeded and sodded areas are to be established a minimum of 60 days prior to request for substantial completion acceptance.

END OF SECTION 329000

SECTION 329210

FINISHING LAWN AND LANDSCAPE AREAS

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 work.

B. Section 312300 - "Earthwork"

C. Section 329000 - "Landscape Work"

1.2 DESCRIPTION

A. This section includes provisions for the following items:

1. Fine grading of all areas to be landscaped.
2. Cleanout of sediment filled areas around inlets and in detention ponds.
3. Finish grade at all sidewalks and paved areas.
4. Finish grade at all storm structures, electrical manholes, sanitary manholes and curbs.
5. Finish grades of swales, berms, landscape islands, and all other yard areas.

B. The following sections contain requirements that relate to this section:

1. Section 312300 "Earthwork"

1.3 QUALITY CONTROL

A. General: Review plans to familiarize equipment operators, foremen, and superintendent of requirements for final grading.

B. Visit site to review conditions prior to starting work. Starting work shall mean that conditions are acceptable as they exist.

1.4 PREINSTALLATION CONFERENCE

A. Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 JOB CONDITIONS

A. Utilities: Determine location of underground utilities, manholes, water valves, sanitary cleanouts, and perform work in a manner which will avoid possible damage. Hand rake and hand excavate, as required.

1.6 SEQUENCING AND SCHEDULING

A. Do not begin finish grading operations until conditions allow for permanent vegetative covers to be planted.

B. Proceed with final grassing and mulching as rapidly as portions of the site are fine graded.

C. Maintain finish grading and final grassing to prevent washing and rill erosion until a complete stand of grass is growing and accepted by the Owner.

PART 2 – PRODUCTS: Not Used.

PART 3 – EXECUTION

3.1 PREPARATION, GENERAL

A. Review plans to identify low points, catchment areas, swales, conveyances, berms, diversions, detention ponds, cut and fill slopes, etc.

B. Review graded site to identify all areas which hold water or store sediment.

C. Review plans to identify all paved areas, utility boxes, manholes, sanitary cleanouts, storm water cleanouts, valve boxes, utility vaults, etc.

D. Review installed location of each item and check elevations as necessary to identify each item that needs to be adjusted to grade and coordinate rework of paving and utilities or mark utility for future grade adjustments.

3.2 LOW POINTS & CATCHMENT AREAS

A. Clean out around each inlet to ensure that sediment build-up from construction is removed and firm ground is exposed.

B. Backfill around all inlets to compensate for removal of sediment and to build up the grade to allow positive drainage to the inlet.

C. In low points and catchment areas formed by a series of inlets, transition grade between inlets and at each end of the catchment areas to allow for high points that break the water to the inlet.

3.3 SWALES AND CONVEYANCES

A. Remove all sediment build up from construction from all swales prior to beginning work.

B. Smooth grade swales and conveyances shown on plans to remove high points and backfill low points.

C. Swales and conveyances shall be graded to prevent standing water.

D. Swales within catchment areas shall be graded with high points between inlets as described above.

3.4 BERMS & DIVERSIONS:

A. Grade berms and diversions to the width and height indicated on the plans.

B. Finish grading of berms and diversions shall include correcting all points weakened during construction activities by concentrated runoff, construction traffic, etc.

C. Finish grading of berms and diversions shall include rounding out the tops of berms to prevent sharp grade transitions which will hamper later maintenance.

3.5 STORMWATER PONDS:

A. Finishing of stormwater pond areas shall include dewatering, to allow for the required planting of the pond areas.

B. Contractor shall provide pumps, etc. to accomplish dewatering.

C. Refer to Landscape Plans for planting requirements for detention ponds.

D. Remove trash, debris and volunteer trees, etc. from ponds prior to final landscaping and at completion of project.

3.6 CUT & FILL SLOPES:

A. Smooth grade and compact all cut and fill slopes to remove all rill erosions and washes.

B. Reapply erosion control blankets, as necessary.

3.7 GRADING ADJACENT PAVED AREAS:

A. Finish grading adjacent paved areas, curbs and walkways shall be subject to the following criteria:

1. Sodded Areas: Set 1- ½" below.

3.8 YARD AREAS:

A. Yard areas shall be graded to avoid any sudden changes in grade, waviness, moguls, hillocks, low points, etc., unless specifically noted on the plans.

B. All yard areas shall be graded to allow lawn maintenance equipment to freely operate without "skinning" the ground or jostling and bouncing the operator.

3.9 MANHOLES, INLETS, VAULTS, VALVE BOXES & CLEANOUTS:

A. All manholes, inlets, valve boxes and cleanouts shall be set flush with finish grade unless specifically detailed to protrude above finished grade.

B. Finish grader shall coordinate with installer to correct faulty grades or grade to top elevations of structures.

C. Water Vaults shall be set above grade to prevent water from entering and flooding these vaults.

D. Electrical and telecommunications vaults shall be set flush with grade, unless otherwise indicated on electrical drawings.

END OF SECTION 329210

SECTION 331116

SITE WATER DISTRIBUTION & FIRE PROTECTION

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 SCOPE

A. This section of the Specifications describes products to be incorporated into the water lines buried 5 feet beyond the building, if any, and requirements for the installation and use of these items. The Contractor shall furnish all products and perform all labor necessary to fulfill the requirements of these Specifications.

B. Contractor shall coordinate all connections to water main, if any, with Cherokee County Water and Sewerage Authority.

C. The piping serving the fire protection system shall be installed by a Fire Protection Contractor with a Certificate of Competency issued by the Georgia State Fire Marshall's Office.

1.3 APPLICABLE STANDARDS

A. Supply all products and perform all work in accordance with applicable American Society for Testing and Material (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), National Fire Protection Association (NFPA), National Sanitation Foundation (NSF), or other recognized standards. Latest revisions of all standards are applicable. If requested by the Owner, submit evidence that manufacturers have consistently produced products of satisfactory quality and performance for a period of at least two years.

B. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

1.4 MANUFACTURERS

A. Whenever a product is identified in the Specifications by reference to manufacturers' or vendors' names, trade names, catalog numbers, etc., the Contractor may freely choose from those referenced products which ones he wishes to provide. Otherwise products shall meet the criteria set forth in the specifications for each item.

1.5 WARRANTY

A. Water distribution systems installed by Contractors which are accepted by the Owner for ownership, operation and maintenance shall be warranted and guaranteed for a period of one year from the date of final acceptance that the completed system is free from all defects due to faulty products or workmanship, and that the Contractor shall make such corrections as may be necessary by reason of such defects upon notice by the Owner.

1.6 CONSTRUCTION DRAWINGS

A. The term construction drawings shall mean drawings, prints, descriptive literature, test reports, samples, calculations, schedules, material lists and information and items of similar meaning.

1.7 SUBMITTALS REQUIRED

A. The Contractor shall furnish to the Engineer, Owner and local water purveyor for review in accordance with the procedure outlined below, drawings and descriptive literature for all manufactured or fabricated products. Additional information such as special drawings, schedules, calculations and curves, shall be provided as specifically requested by the Engineer and/or Owner.

B. The Contractor shall furnish to the Architect and Cherokee County Water and Sewerage Department As-Built Drawings of the installed water system. Drawings shall comply with Cherokee County Water and Sewerage Authority Water Main Standards, Section 604, latest revision.

1.8 DRAWINGS FOR CONSTRUCTION

A. Drawings or other submittals not bearing the Engineer's review notation shall not be issued to subcontractors or utilized for construction purposes. The Contractor shall maintain at the job site a complete set of construction drawings bearing the Engineer's review.

PART 2 – PRODUCTS

2.1 GENERAL

A. Furnish all pipe, fittings, valves, tapping sleeves and valves, hydrants, and all other materials required for completion of the work. Furnish materials in accordance with the following:

2.2 PIPE

A. Water Distribution Pipe Smaller Than 4”: Copper Tube and Fittings

1. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
   a. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22 wrought-copper, solder-joint fittings. Furnish wrought-copper fittings.
   b. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
   c. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. 4 Inch - 12 Inch – Ductile Iron Pipe (DIP): Ductile iron pipe shall conform to AWWA C151 and shall be a minimum of Class 51 for 3 and 4 inch and Class 50 for 6 and 8 inch. Sizes will be as shown on the Drawings. Pipe and fittings shall be cement lined in accordance with AWWA C104. Pipe and fittings shall be furnished with a bituminous outside coating.
   1. Joints shall be push-on type for pipe and standard mechanical or flanged restrained joints for fittings unless otherwise noted. Push-on and mechanical joints shall conform to AWWA C153 with gasket conforming to AWWA C111.
   2. Provide the appropriate gaskets for mechanical or flange joints. Gaskets for flange joints shall be made of 1/8-inch thick cloth reinforced rubber; gaskets may be ring type or full-face type and must comply with the indicated water pressures in this specification.

3. Provide the necessary bolts for mechanical or flange connections. Bolts for flange connections shall be steel with American Regular unfinished square or hexagon heads. Nuts shall be steel with American Standard Regular hexagonal dimensions, all as specified in ANSI B 17.2. All bolts and all nuts shall be threaded in accordance with ANSI B.1.1. Coarse Thread Series, Class 2A and 2B fit.
4. All pipe shall be furnished in lengths of at least 18 feet.

C. Warning tape for all pipe shall be per Division 2 Section "Earthwork."

D. Acceptance of all pipe will be on the basis of the Engineer's review and the manufacturer's written certification that the pipe was manufactured and tested in accordance with the applicable standards.

2.3 DUCTILE IRON FITTINGS AND ACCESSORIES

A. Fittings shall be restrained joint ductile iron furnished in accordance with ANSI Specifications A21.10 (AWWA C110), latest revision, and shall be a minimum of 250 psi pressure class rating. Joints shall be mechanical joint with retainer glands with set screws. Cement mortar lining shall be furnished for all pipe.

1. Mechanical joints shall be ductile iron compact pattern in accordancewith AWWA C153.
2. Glands, gaskets and bolts shall conform to AWWA C111.
3. Retainer glands shall be EBAA Mega-Lug or approved equal.

B. 3 INCH AND SMALLER GATE VALVES (GV): Gate valves 3 inches and smaller shall have bronze body, bronze rising stem, solid wedge and threaded bronze bonnet in accordance with UL 262 and FMG Approved with 175 psi working pressure.

C. 4 - 12 INCH GATE VALVES (GV): Gate valves shall be mechanical joint end fitted with retainer glands, resilient seat, iron body, bronze mounted, non-rising stem with O-ring stemseals, open left with 2" square operating nut. Gate valves 3" through 12" shall be designed for a water working pressure of 250 psi and a test pressure of 400 psi. Valves 14" and larger shall be designed for a water working pressure of 150 psi and a test pressure of 300 psi. Valves 4" through 12" will be designed for installing in a vertical position. Valves larger than 12" will be designed for a horizontal installation and equipped with bevel gearing, gear case, tracks, rollers, scrapers and by-pass valves. All valves shall be furnished with valve marker and concrete collars installed as set forth in Cherokee County Water and Sewerage Authority's Standard Specifications.

D. Gate valves shall be UL listed and FMG Approved and conform to AWWA standard specification C-509, latest revision for "Ordinary Water Works Service," with interior coating of epoxy complying with AWWA C550.

E. Valve Boxes (VB): All gate valves shall be equipped with valve boxes. Valve boxes shall comply with AWWA M44 for cast iron valve boxes. Valve boxes shall be heavy roadway type and have a minimum shaft diameter of 5-1/4". The valve boxes shall be cast iron two-piece slip or screw type with drop covers marked "WATER." The valve boxes shall be adjustable to 6 inches up or down from the nominal required cover over the pipe. Typical valve box details are shown on the plans.

1. All valve boxes shall be equipped with concrete collar as detailed on the plans.
2. Provide one operating wrench with stem of length to operate the deepest buried valve, and socket matching valve operating nut.

F. Tapping Sleeves and Valves (TS&V): Tapping sleeves shall be American Flow Control Series 2800 for lines 12" and smaller or American Flow Control Series 1004 for lines

larger than 12", or an alternate acceptable to the Cherokee County Water and Sewerage Authority. Valves shall be gate valves furnished in accordance with the specifications shown above, with flanged connection to the tapping sleeve and mechanical joint connection to the branch pipe. The necessary bolts, glands, and gaskets shall be furnished.

G. OS&Y, Rising Stem, Resilient Seated Gate Valves: Shall conform to AWWA C500 and shall be allowed for use in the backflow preventers, only.

H. Fire Hydrants (FH): All fire hydrants shall conform to the requirements of AWWA C 502 UL 246 and FMG Approved for 250 psi working pressure. Hydrants shall be the compression type, closing with line pressure. The valve opening shall be 5-1/4 inches. Hydrants shall match Cherokee County Water Authority's Standards.

1. In the event of a traffic accident, the hydrant barrel shall break away from the standpipe at a point above grade and in a manner which will prevent damage to the barrel and stem, preclude opening of the valve, and permit rapid and inexpensive restoration without digging or cutting off the water.
2. The means for attaching the barrel to the standpipe shall permit facing the hydrant a minimum of eight different directions.
3 Hydrants shall be fully bronze mounted with all working parts of bronze. Valve seat ring shall be bronze and shall screw into a bronze retainer.
4. All working parts, including the seat ring shall be removable through the top without disturbing the barrel of the hydrant.
5. The operating nut shall match those on the existing hydrants. The operating threads shall be totally enclosed in an operating chamber separated from the hydrant barrel by a rubber O-ring stem seal and lubricated by a grease or oil reservoir. A stop nut shall be positioned in the top operating mechanism so that the valve cannot contact the bottom of the shoe when fully open.
6. Hydrant shall be a non-freezing design and provided with a simple, positive, and automatic drain which shall be fully closed whenever the main valve is opened.
7. Hose and pumper connections shall be breech-locked, pinned, and then caulked with lead; or threaded and pinned, to seal them permanently into the hydrant barrel. Each hydrant shall have two 2-1/2 inch hose connections, and one 4-1/2" diameter pumper connection. Equip each connection with cap and chain. Threads shall match the latest requirements of the State Fire Insurance Commission.
8. Hydrants shall be furnished with a mechanical joint shoe connection to the spigot of the 6-inch hydrant lead. The lead shall be 6" ductile iron with rods or retainer glands connecting the fire hydrant to a 6" gate valve. Gate valve shall connect to main line using a locked hydrant tee equal to American Pipe Model A-10180. When the hydrant is close enough to the valve to allow its use, the hydrant shall be connected to the valve by using a locked hydrant adapter, equal to American Pipe Model A-10895.
9. Minimum depth of bury shall be 4.0 feet to top of pipe. Provide extension section where necessary for vertical installation and in accordance with manufacturer's recommendations. The minimum height from the ground surface to the bottom of the hose nozzle shall be no less than 24".
10. All outside surfaces of the barrel above grade shall be painted with two coats red, reflective enamel paint to match water company standards.

I. Water Meters and Backflow Preventers: Refer to Drawings for requirements. Contractor shall furnish all materials and pay all cost for meters and backflow preventers, and necessary vaults and appurtenances.

J. Concrete Vaults: Furnish concrete vaults w/lid and access hatches per Cherokee County Water and Sewerage Authority Standards.

K. Post Indicators: Indicator post for underground gate valves in the firemain shall be U.L. listed, FM approved, cast iron body with steel operating rod with locking lug, operating handle and indicator target protected by plexiglass cover. Body and operating rod length shall be field adjustable to the required depth of bury. Indicator posts shall be Stockham G-951, Nibco NIP-1A or American/Darling 1P71.

L. Fire Protection Components Security: Post Indictor Valves and Backflow Preventer to be secured in the open position. Post Indicator Valves to be padlocked at hasp. Backflow Preventer to utilize 3/8" chain through O.S. & Y Hand Wheels. Each to be secured by Padlocks provided by the Owner.

M. Fire Department Connections (Siamese Connections): Fire Department connections shall be freestanding with cast-bronze body, thread inlets according to NFPA 1963 and matching Cherokee County Fire Department hose threads and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose connection inlet; brass sleeve meeting Cherokee County Fire Department's height requirements; and round escutcheon plate with marking "AUTO SPKR" and/or "STANDPIPE." Fire department connections shall comply with UL 405.

PART 3 – EXECUTION

3.1 GENERAL

A. Unloading: Furnish equipment and facilities for unloading, handling, distributing and storing pipe, fittings, valves and accessories. Make equipment available at all times for use in unloading. Do not drop or dump materials. All materials dropped or dumped will be subject to rejection without additional justification.

B. Handling: Handle pipe, fittings, valves and accessories carefully to prevent shock or damage. Handle pipe by rolling on skids, forklift, or front loader. Do not use material damaged in handling.

C. Distribution: Distribute and place pipe and materials to not interfere with traffic. Do not string pipe more than 300 feet beyond the area where pipe is being laid. Do not obstruct drainage ditches.

D. Storage: Store all pipe which cannot be distributed along the route. Make arrangements for the use of suitable storage areas. Do not interfere with other contractors right to access.

E. Construction Along Highways, Streets and Roadways: Install pipe lines and accessories along highways, streets and roadways in accordance with the applicable regulations of the City, and/or the Department of Transportation with reference to construction operations, safety, traffic control, road maintenance and repair.

F. Protection of Traffic: Provide and maintain suitable signs, barricades and lights for protection of traffic.

1. Replace all highway signs removed for construction as soon as possible. Do not close or block any highway, street, or roadway without first obtaining permission from the proper authorities.
2. Provide flagmen to direct and expedite the flow of traffic.

G. Construction Operations: Perform all work along highways, streets and roadways to least interfere with traffic.

H. Stripping: Where the pipe line is laid along road shoulders, strip and stockpile all sod, topsoil and other material suitable for shoulder restoration.

I. Trenching, Laying and Backfilling: Do not open the trench any further ahead of pipe laying operations than is necessary. Backfill and remove excess material immediately behind laying operations. Complete excavation and backfill for any portion of the trench in the same day.

J. Shaping: Reshape damaged slopes, side ditches, and ditch lines immediately after completing backfilling operations. Replace topsoil, sod and any other materials removed from shoulders.

K. Excavated Materials: Do not place excavated material along highways, streets and roadways in a manner which obstructs traffic. Sweep all scattered excavated material off of the pavement.

L. Drainage Structures: Keep all side ditches, culverts, cross drains, and other drainage structures clear of excavated material and free to drain at all times.

M. Maintaining Highways, Streets, Roadways and Driveways: Maintain streets, highways, and roadways in suitable condition for movement of traffic until completion and final acceptance of the work. Use steel running plate to maintain traffic until pavement replacement is completed.

1. NOTE: Traffic must be maintained at all times. When one lane is closed, flagmen must be utilized to maintain traffic flow.
2. Repair all driveways that are cut or damaged immediately. Maintain them in a suitable condition for use until completion and final acceptance of the work.

N. Existing Underground Utilities and Obstructions: It is the responsibility of the Contractor to locate all existing utilities along the path of his construction. The drawings shall indicate underground utilities or obstructions that are known to exist. Where these or unforeseen underground utilities are encountered, the location and alignment of the water main may be changed, upon written approval of the Engineer and Owner, to avoid interference.

O. Connections to Existing Pipe Lines: Before laying pipe, the Contractor shall locate the points of connection to existing pipe lines and uncover as necessary for the Engineer and Owner to confirm the nature of the connection to be made. The Contractor shall furnish materials and make the connection to all existing pipe lines. The Contractor will be observed during construction of tie-ins by the Utility Owner and the Engineer. The Contractor shall use all available practices and resources to minimize the time the customers are without water. The Contractor shall notify Water Purveyor's Customers of Water outages at least 24 hours in advance.

P. Laying Pipe

1. General: Unless specifically indicated on the plans or called for in the specifications, water lines shall be constructed with restrained joint fittings and mechanical joint valves.
2. Field Inspection: All pipe and accessories shall be laid, jointed, tested for defects and for leakage with pressure and chlorinated in the manner herein specified in the presence of the Engineer or his authorized representative and subject to their approval.

Q. Handling Pipe and Accessories

1. Care: Pipe, fittings, valves and other accessories shall be unloaded at the point of delivery, hauled to and distributed at the site of the project by the contractor; they shall at all times be handled with care to avoid damage. In loading and unloading they shall be lifted by hoists or slid or towed on skid-ways in such a manager as to avoid shock. Under no circumstances shall they be dropped. Pipe handled on skidways must not be skidded or rolled against pipe already on the ground.
2. At Site of Work: In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench and shall be laid on high ground so that it will not be in a drainage way.
3. Bell Ends, How Faced: Pipe shall be placed on the site of the work parallel with the trench alignment and with the bell ends facing the direction in which the work will proceed, unless otherwise directed by the Engineer.
4. Pipe Kept Clean: The interior of all pipe, fittings and other accessories shall be kept free from dirt and foreign matter at all times.

R. Alignment and Grade

1. General: All pipe shall be laid and maintained in the required lines and grades, with fittings and valves at the required locations, with joints centered and spigots home, and with all valve stems plumb.

S. Depth of Pipe: The top of the barrel of the pipe shall have a minimum cover of forty-eight inches. A greater depth of cover is required in certain sections of the main, such as railroad crossings, valve locations and other sections of special construction, and within State and Federal highway rights-of-way.

T. Excavation and Preparation of Trench

1. See Division 2 Section "Earthwork" for additional requirements.
2. Pipe Foundation: The pipe shall be laid upon a sound earthen foundation cut true and even so that the barrel of the pipe will have a bearing for its full length.
3. Care of Surface Materials for Re-Use: If local conditions permit their re-use, all surface materials suitable for re-use in restoring the surface shall be kept separate from the general excavation material.
4. Trenching by Machine or by Hand: The use of trench digging machinery will be permitted except in places where operation of same will cause damage to existing structures above or below ground; in which case hand methods shall be employed. Excavation shall be made by ladder type machine or backhoe.

U. Pipe Installation

1. All copper pipe shall be installed according to CDA's "Copper Tube Handbook". All pipe shall be wrapped and coated in accordance with this manual.
2. Manner of Hauling Pipe and Accessories: Proper implements, tools and facilities shall be provided and used by the contractor for the safe and convenient execution of the work. All pipe, fittings and valves shall be carefully lowered into the trench piece by piece by means of derrick ropes or other suitable tools or equipment, in such manner as to prevent damage to pipe to pipe or accessories be dropped or dumped into the trench.
3. Pipe Kept Clean: All foreign matter or dirt shall be removed from the pipe, and it shall be kept clean by approved means during and after laying.
4. Laying of the Pipe: The spigot shall be centered in the bell, the pipe forced "home" and brought into true alignment; it shall be secured there by earth carefully tamped under and on each side of it, excepting at the bell holes. Care shall be taken to prevent dirt from entering the joint space. No "blocking up" of pipe or joints will be permitted. The joint shall be made as hereinafter described.

5. Install continuous underground warning tape during backfilling of trench for underground water distribution in addition to copper tracer wire. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 2 Section "Earthwork."
6. Trench Water Entering Pipe: At times when pipe laying is not in progress, the open ends of the pipe shall be closed by approved means and no trench water shall be permitted to enter the pipe.
7. Cutting Pipe: Cutting of pipe for inserting valves, fittings or closure pieces shall be done in a neat workmanlike manner without damage to the pipe.
8. Bell Ends Face Direction of Laying: Unless otherwise directed, pipe shall be laid with bell ends facing in the direction of laying; and for lines on an appreciable slope, bells shall, at the discretion of the engineer face up-grade.
9. Permissible Deflections at Joints: Wherever necessary to deflect pipe from a straight line, either in the vertical or horizontal plane to avoid obstructions, the degree of deflection shall be according to manufacturer's recommendations.
10. Unsuitable Conditions for Laying Pipe: No pipe shall be laid in water.
11. Jointing Pipe-Mechanical Joints: The following steps shall be taken in making mechanical joints:
    a. All lumps, blisters and excess coal-tar enamel shall be removed from socket and spigot of the pipe.
    b. Wash socket and plain end with soapy water containing chloride solution; then slip gland and gasket over plain end. The small side of gasket and lip gland shall face bell.
    c. Paint gasket with soapy solution containing chlorine.
    d. Push gasket into position, being sure it is evenly seated in socket.
    e. Slide gland into position; insert bolts and run nuts up finger tight.
    f. Tighten bolts to uniform tightness with correct ratchet wrench. The first bolt tightened shall be the bottom bolt, then top. All other bolts shall be tightened in sequence at 180 degrees apart.
12. Setting Valves, Valve Boxes and Fittings:
    a. General: Gate valves and pipe fittings shall be set and jointed to new pipe in the manner heretofore specified for cleaning, laying and jointing pipe.
13. Valve Boxes: Cast iron valve boxes shall be firmly supported and maintained centered and plumb over the wrench nut of the gate valve, with box cover.
14. Plugging Dead Ends: Standard plugs shall be inserted into the bells of all dead ends of pipes, tees or crosses and spigot ends shall be capped. Plugs or caps shall be jointed to the pipe or fittings in the manner specified above.
15. Thrust Blocking: Concrete having compressive strength of not less than 1500 psi shall be used as a cradle or thrust blocking where shown on the plans or where directed by the Engineer. Bends exceeding 22-1/4 degrees, crosses with one opening plugged, and all tees shall be backed with concrete as a thrust block. Blocking shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on ground in each instance shall be that shown on the plans. The blocking shall be so placed that the pipe fitting joints will be accessible for repair. No extra payment will be made for the thrust blocks. Contractor shall notify the Fire Marshal’s office for inspection of all Thrust Block locations. Fire Marshal’s sign off sheet shall be turned over to the Architect.

V. Pressure and Leakage Tests (See Subsection 'X' for additional testing)

1. All fire hydrants are to be flow tested in the presence of the Architect and Civil Engineer. Once tested they shall be tagged with date and time of test. Do not shut off valve after flow test is completed.
2. Pressure During Test: Immediately after the pipe and fire hydrants have been laid and backfilled, but prior to the placement of pavement, each valved section of newly laid pipe shall be subjected to a leakage and pressure test. For any

section being tested the pressure applied shall be such that at the highest point in the section, the pressure shall be 200 pounds per square inch. Test shall be conducted as per NFPA-13. Test on fire protection supply shall be witnessed by Fire Marshall, Owner and Architect/Engineer.

3. Procedures: Each valved section of pipe shall be slowly filled with water and the specified test pressure, measured at the point of highest elevation shall be supplied by means of a pump connected to the pipe in a satisfactory manner. The pump, pipe connection, and all necessary apparatus, gauges, and meters shall be furnished by the contractor. The contractor shall furnish all necessary labor and assistance in conducting the tests. The owner will furnish, through connections made by the contractor to existing mains, water for filling the lines for making the test.
4. Expelling Air Before Tests: Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made, if necessary, at points of highest elevation and afterward tightly plugged.
5. Examination Under Pressure: At intervals during the test, the route of the pipe line shall be inspected to locate any leaks or breaks. Any cracked or defective joints, cracked or defective pipe, fittings or valves discovered in consequence of this pressure test shall be removed and replaced with sound material in the manner provided and the test shall be repeated until satisfactory results are obtained.
6. Leakage: No detectable leakage will be allowed during the pressure testing.

W. Other Testing:

1. All water mains and fire hydrants and their appurtenances shall be subject to all testing required by Cherokee County Water and Sewerage Authority and the State Fire Marshall's Office.
2. Backflow Preventers:
   a. Initial Testing: Contractor shall test backflow preventers prior to water meters being installed. Testing shall be in accordance with Cherokee County Water and Sewerage Standards.
   b. Final Testing: Contractor shall test backflow preventers within 14 days of substantial completion of project. Submit copies of test results to CCWSA, Owner and Architect.

X. Backfilling:

1. Time of Backfilling: As soon as practicable after the completion of laying and jointing of the pipe, the trench shall be backfilled, and at not time shall the completed backfilling of the trench be more than 300 feet behind the pipe laying.
2. Backfill Procedure at Pipe Zone: Select backfill material free from rock fragments shall be deposited in the trench simultaneously on both sides of the pipe for the full width of the trench and to an elevation of twelve inches above the top of the barrel of the pipe. The backfill material shall be moistened if necessary, tamped in thin (about 4-inch) layers and thoroughly compacted under and on each side of the pipe to provide solid backing against the external surface of the pipe.
3. Backfill Procedure Above the Pipe Zone: Succeeding layers of backfill may contain coarser materials and shall be compacted thoroughly to the natural ground surface. Refer to Division 2 Section "Earthwork" for requirements of trench compaction.
4. Restoration of Surfaces: The contractor shall replace all curbing, sidewalks, gutters, shrubbery, fences, sod, and other surfaces disturbed to a condition equal to that before the work began, furnishing all labor and materials incidental thereto.

Y. Disinfection of Mains:

1. The contractor shall disinfect all new mains, furnishing all labor, equipment and material necessary for the complete disinfection of the mains as hereinafter provided. Mains shall be disinfected by the application of a chlorinating agent into the water used for the initial filling of the mains. The chlorinating agent may be chlorine gas-water mixture, calcium hypo-chlorite in water, or chlorinated lime of known chlorine content in water and shall be fed through a suitable solution feed device. The chlorinating agent shall be applied at or near the beginning point from which the main is being filled and shall be injected into the main through a corporation cock tapped into the horizontal exit of the newly laid main. The water being used to fill the line shall be controlled to flow into the section to be sterilized very slowly and the rate of application of the chlorinating agent shall be in such proportion to the rate of the water entering the pipe that the chlorine dose applied to the water shall be at least 50 ppm. The chlorine treated water shall be retained in the new main at least 24 hours and a 10 ppm of residual chlorine shall remain after the 24 hour period. Following chlorination all treated water shall be flushed from the mains until replacement water shall have a chlorine content of not more than 0.1 ppm in excess of the residual in water from the supplying main and in any event not less than 0.2 ppm. Samples of the water shall be taken from several points in the new lines and submitted to a State Approved lab for bacteriological analysis. Should the analysis show contamination, the system shall be re-chlorinated and further samples taken and submitted for analysis until no contamination is indicated.

END OF SECTION 331116

SECTION 333313

SITE SANITARY SEWER CONSTRUCTION

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. Scope: This section of the Specifications describes products to be incorporated into the sanitary sewer. Requirements for the installation and use of these items shall be governed by the Cherokee County Water and Sewerage Authority's (CCWSA) Sanitary Sewer Main Standards. These specifications cover the sanitary sewer mains system indicated on the Civil (C) Drawings. The Contractor shall furnish all products and perform all labor necessary to fulfill the requirements of these Specifications. Contractor shall coordinate installation of sanitary sewer system with the Cherokee County Water and Sewerage Authority.

1.2 SEWER CONNECTION FEES

A. The Owner will pay the sewer tap fees and all impact fees, if applicable.

1.3 STANDARD AND MATERIALS

A. The sanitary sewer system materials and construction shall meet the requirements of the Cherokee County Water and Sewerage Authority's Standards and Specifications. Sanitary sewer mains shall be ductile iron pipe conforming to the following:

B. Ductile Iron Pipe: Ductile Iron Pipe shall be designed in accordance with AWWA C150. The thickness and class of the pipe shall be governed by AWWA C150. Ductile Iron Pipe shall be manufactured in accordance with AWWA C151 and shall have an outside bitumastic coating per AWWA C151.

1. The interior lining of the pipe and fittings shall be Protecto 401 ceramic epoxy with a minimum thickness of 40 mils.

C. PVC Sewer Pipe: Polyvinyl Chloride (PVC) sewer pipe and fittings shall meet the requirements of ASTM D 3034, SDR 26 and all other requirements stated in Cherokee County Water and Sewerage Authority’s Standards and Specifications.

D. Pipe Bedding: Refer to Drawings for the required bedding of the sanitary sewer lines.

E. A copy of Sanitary Sewer Main Standards for the Cherokee County Water and Sewerage Authority may be obtained from Cherokee County Water and Sewerage Authority in Canton, GA (770-479-1813), or obtained online at www.ccwsa.com.

F. Prior to acceptance of completed sanitary line and manholes, contractor shall provide to Owner/Architect a complete televised documentation of sewer system in a DVD format and provide copies/certifications of all other testing required by CCWSA Standards and Specifications.

1.4 PREINSTALLATION CONFERENCE

A. Contractor shall conduct preinstallation conference at project site to comply with requirements in Division I Section "Project Management and Coordination."

END OF SECTION 333313

SECTION 334116

STORM DRAINAGE

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. Georgia Department of Transportation Specifications and Details, latest edition or revision.

1.2 SUMMARY

A. This Section includes gravity-flow, nonpressure storm drainage with the following components:

1. Cleanouts.
2. Drains.
3. Precast concrete drainage structures.

B. Related Sections include the following:

1. Division 31 Section "Earthwork" for excavation, trenching, and backfilling requirements.

1.3 DEFINITIONS

A. RCP: Reinforced Concrete Pipe.

B. HDPE: High Density Polyethylene Plastic Pipe/Smooth Interior (and exterior) Corrugated Polyethylene Pipe.

C. D.I.P.: Ductile Iron Pipe

D. PVC: Polyvinyl Chloride Plastic Pipe.

E. CMP: TYPE 2 Aluminized Metal Pipe.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Drainage Piping: Pipe shall be as specified under Part 2 - Products.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Special pipe fittings.
2. Drains.
3. Channel drainage systems.
4. Storage and leaching chambers.

B. Shop Drawings: For the following:

1. Drainage Structures: Include elevations, sections, details, frames and covers, reinforcing, thickness and grate type for each type structure indicated on the plans.

C. Field quality-control test reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

B. Handle manholes according to manufacturer's written rigging instructions.

C. Handle stormwater inlets according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPING MATERIALS

A. 12 Inch and Smaller Storm Sewers: Pipe and fittings shall meet all the requirements of ASTM-D 3034, SDR35, with gasketed joints meeting ASTM F-477, or HDPE (Smooth Interior Corrugated Polyethylene Pipe) as per AASHTO M294. Joints and fittings for HDPE shall be gasketed PVC joints and fittings meeting requirements of ASTM D3034.

B. 15 Inch and Larger Storm Sewers: Refer to drawings for areas where a specified type of pipe must be used. Unless a specific type of pipe is called for on the Drawings, the Contractor shall have the option of installing one of the types of storm sewers listed below.

1. Reinforced Concrete Pipe (RCP): Reinforced concrete pipe (RCP) shall meet the requirements of ASTM Designation C-76, and the latest revisions thereof. Pipe joints shall be either tongue and groove with mortar joint or "O" ring type joints. Pipe shall

meet GA D.O.T. Specifications and shall be stamped by D.O.T. Refer to the storm sewer profiles for required pipe classifications.

2. Ductile Iron Pipe (D.I.P.): Ductile iron pipe shall conform to AWWA C151 and shall be a minimum of Pressure Class 350. Fittings shall be in accordance with AWWA C153. Gaskets shall be in accordance with AWWA C111.

3. Smooth Interior Corrugated Polyethylene Pipe (HDPE), 4"-60":

   a. Polyethylene Pipe shall be high density polyethylene corrugated pipe with an integrally formed smooth interior in accordance with ASTM F2648.
   b. Pipe shall be joined using a bell and spigot joint meeting ASTM F2648. The joint shall be soil-tight and gaskets shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubrication supplied by the manufacturer shall be used on the gasket and bell during assembly.
   c. Fittings shall conform to ASTM F2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of ASTM F2306.
   d. Installation shall be in accordance with ASTM Recommended Practice D2321 or as specified by the Project Engineer or local approving agency.

4. Aluminized Steel Type 2 Pipe

   a. Aluminized Steel Type 2 culvert pipe material and connecting bands shall meet the requirements of the current AASHTO M-274M. They shall be fabricated into helically corrugated pipe meeting the requirements of AASHTO M-36M and ASTM A 760.
   b. All aluminized corrugated steel culvert pipe shall have corrugations with the ends of pipe sections reformed to annular corrugations.
   c. Culvert pipe shall meet the structural requirements for the corrugations outlined below:

Pipe Diameter	Minimum Gauge	Corrugations Size
15" - 48"	16	2-2/3" x ½"
54" - 66"	16	3" x 1"
72" - 84"	14	3" x 1"
96"	12	3" x 1"

   d. Perforated Pipe shall be perforated in accordance with AASHTO M36.

2.3 MISCELLANEOUS STORM APPURTENANCES

A. Cast-in-place concrete shall have minimum compressive strength of 3000 psi at 28 days. Slump shall be 3" + 1". Reinforcing shall be sufficient to match ASTM C478.

B. Brick: Brick for manholes and catch basins shall be first quality, sound, hard burned, perfect shaped brick, presenting a smooth regular shape. Brick shall not absorb more than 16 percent of water by weight when submerged in water for 24 hours, having been in a thoroughly dry state prior to placing in water. Where pre-cast structures are not feasible for use or at the Contractor's options, brick shall be used to form structures to the dimensions indicated for each structure on the detail sheets.

C. Mortar: All cement used in mortar shall conform to ASTM Designation C150, and the latest revision thereof. All mortar used shall be composed of one part Portland Cement and two parts of fine sand.

D. Cast Iron: Cast iron for manhole frames and covers and catch basin frames and grates, and manhole steps shall conform to the shape and dimensions shown on the Plans, and shall be clean and perfect, free from sand and blow holes or other defects. Cast iron shall conform to ASTM Designation A-48-74 for Class No. 30 gray cast iron.

E. Storm Sewer Bedding: Storm Sewer Bedding for storm sewer construction shall be as indicated on the Drawings.

2.4 CLEANOUTS

A. Cleanouts: Shall be as shown on the plan details for storm sewer with countersunk, tapered-thread, brass closure plug, and concrete collar.

1. Top-Loading Classification(s): Heavy duty.
2. Sewer Pipe Fitting and Riser to Cleanout: Shall be as shown on the Drawings.

2.5 DRAINAGE STRUCTURES

A. Standard Precast Concrete Drainage Structures: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.

1. Base Section: 6-inch minimum thickness for floor slab and 6-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
2. Riser Sections: 6-inch minimum thickness, lengths to provide depth indicated, and diameter provided for piping and deflections as shown on plans.
3. Top Section: Provide necessary adapters, brick construction, precast concrete trays and intermediate tops necessary to accommodate inlet tops as shown on the details.
4. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
5. Steps: Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 36-inches. Steps shall be as shown in the detail Drawings.
6. Pipe Connections: All pipe connection to precast concrete structures shall be grouted in place on both interior and exterior with full bed of grout. Grout thickness shall match structure wall thickness.

2.6 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to details. Curb inlet hoods shall be USF 5167 standards, unless shown otherwise.

B. Drop Inlets: Made with horizontal opening, of materials and dimensions according to details. Include heavy-duty frames and grates with H-20 load rating.

C. Junction Boxes: Heavy-duty frames and grates (H-20 Load Rating) according to details.

D. Catch Basins: Shall be constructed as indicated by Georgia Department of Transportation Standard Details (included by reference).

E. Area Drains: Shall be as detailed on the Drawings.

F. Detention Structures: Shall be as detailed on the Drawings.

G. Downspout Boots: Shall be as detailed on the Drawings.

H. Trench Drains: Shall be as detailed on the Drawings.

2.7 PIPE OUTLETS

A. Head Walls: Pre-Cast or Cast-in-place reinforced concrete, with apron and tapered sides, per details on the plans, or as referenced by Georgia Department of Transportation Standards.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 PIPING APPLICATIONS

A. Gravity-Flow, Nonpressure Sewer Piping: Use the following pipe materials previously specified for each run of pipe. Where a specific type of pipe has not been identified, the Contractor may freely choose from the available listed products.

3.3 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into stormwater structure is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow, at slope indicated.
2. Install ductile-iron culvert piping according to ASTM A 716.
3. Install ductile-iron and special fittings according to AWWA C600 or AWWA M41.
4. Install corrugated steel piping according to ASTM A 798/A 798M.
5. Install PE corrugated sewer piping according to CPPA's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."
6. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
7. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

F. Bed and haunch pipe per details shown on the Drawings.

NOTE: DO NOT PLACE STONE BEDDING AND HAUNCHING ON DETENTION/STORMWATER POND OUTFALL PIPING OR PIPES WITH SLOPE GREATER THAN 5 PERCENT.

3.4 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:

1. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
2. Join corrugated steel sewer piping according to ASTM A 798/A 798M.
   a. Pipe joints for non-perforated underground stormwater detention system shall be banded using "O: ring gaskets to provide a water tight joint.
3. Join corrugated PE piping with joints and fittings in accordance with ASTM F2648 and ASTM F2306.
4. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric gasket joints.
5. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.

3.5 CLEANOUT INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in cast-in-place concrete block.

3.6 DRAINAGE STRUCTURE INSTALLATION

A. Construct catch basins to sizes and shapes indicated by each size and type of pipe specified.

B. Set frames and grates to elevations indicated, secure to structure with full bed of mortar.

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping from building and downspouts as indicated on Civil, Plumbing and Architectural Drawings.

1. Use commercially manufactured wye fittings for piping branch connections.

2. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making branch connections. Remove debris or other extraneous material that may accumulate.

3.8 FIELD QUALITY CONTROL

A. Provide photographic documentation of all stone bedding on each pipe run prior to initial backfill.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

2. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
3. Reinspect and repeat procedure until results are satisfactory.

C. Contractor shall clean and pump out pipes and provide qualified personnel as necessary for all inspections by Owner, Architect or Engineer.

3.9 CLEANING

A. Clean interior of piping of dirt and superfluous materials.

B. Clean all structures of dirt and superfluous materials.

END OF SECTION 334116