SECTION 22 00 10 - BASIC REQUIREMENTS – PLUMBING CONSTRUCTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for plumbing system installations. Administrative and procedural requirements are included in this Section and in various Division 1 Sections.

1.3 PERMITS AND FEES

A. Refer to Non-Technical Specifications, General Conditions for information relating to permits and fees.

1.4 PROJECT SCHEDULE

A. Refer to applicable Non-Technical Specification Sections for contract completion time and project construction schedule.

1.5 SHOP DRAWINGS AND SUBMITTALS

A. Follow the procedures specified in the Division 01 sections. Also refer to individual sections of the Division 22 specifications for additional shop drawing and Submittal requirements.

B. It is the responsibility of the contractor to thoroughly review any and all shop drawings prior to submission to the Architect/Engineer. The contractor’s review shall include verifying conformance to the project documents. The contractor will also be responsible for verifying the quantities of materials are adequate.

C. All shop drawings shall be submitted with a cover sheet indicating the name of the project, the Architects and Engineers name, the name of the vendor and the contractor. There must be sufficient space on the title sheet to allow the appropriate stamping by both the Architect and the Engineer. Shop drawings and submittals not conforming to the above may be returned without review.

D. All shop drawing submittals will include a listing of any and all exceptions to the requirements indicated in the specifications and on the drawings. Where there are no exceptions, the submittals shall indicate such. Submittals that do not have this listing will not be reviewed.

1.6 COORDINATION DRAWINGS

A. Coordination drawings are required. Refer to applicable Division 01 sections for the work required by this Contractor in preparing Coordination Drawings.

1.7 INSTALLATION ACCESSIBILITY

A. The installation of all equipment and appurtenances shall be done so that access and clearances meet the requirements of the equipment manufacturer and all applicable codes.

1.8 ACCEPTABLE MANUFACTURERS

A. The design of the mechanical systems is based on the equipment manufacturer indicated on the drawings. Although individual sections of the specifications may list other manufacturers, these manufacturers will be accepted only if the following occurs:

1. Performance, as judged by the engineer, must be equal to the design-based equipment.
2. Operating characteristics, as judged by the engineer, must be identical to those of the design-based equipment.
3. Physical size of the equipment must be such that it can be installed in the available space, maintaining all required clearances for access / maintenance and meet the architectural requirements of the project such as installed height, length, width and operating weight. The contractor shall be responsible for verifying the equipment meets this requirement.
4. The contractor will be responsible for any costs associated with additional supports, changes in electrical wiring, or piping changes that may be required if equipment other than the design based is used.

1.9 RECORD DOCUMENTS

A. Prepare record documents in accordance with applicable Division 01 sections. In addition to the requirements specified, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
4. Contract Modifications, actual equipment and materials installed.
5. Record Documents are to be prepared and/or revised to indicate the room names and numbers to be used by the owner after the projects is complete.

1.10 OPERATING AND MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with applicable Division 01 sections.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. When materials and products are stored on site, provide protection from weather and temperatures that may cause damage to the items.

1.12 EXTRA MATERIALS

A. Various specification sections may indicate extra materials that are to be provided with the respective equipment. Where indicated the contractor shall provide the required extra materials. If no additional installation is required, the contractor shall forward, to the owner, all extra materials. When forwarding materials obtain a receipt for any materials forwarded.

1.13 WARRANTY

A. All equipment, material and labor provided by the contractor shall be warranted for a minimum period of one year after the date of substantial completion.

PART 2 - PRODUCTS

2.1 Not Applicable.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Obtain equipment shop drawings for the various items that require rough-in.

3.2 INSTALLATIONS

A. Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Coordinate requirements for chases slots, and openings in other building components during the progress of construction, to allow for mechanical installations.
4. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
5. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
6. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.

8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
9. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
10. Install systems, materials, and equipment giving right-of-way priority to the systems required to be installed at a specified slope.
11. Seal all places where piping or ducts pass through walls and floors.

3.3 CUTTING AND PATCHING

A. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.
2. Removal and replacement of defective Work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Remove samples of installed Work as specified for testing.
5. Install equipment and materials in existing structures.

B. Upon written instructions from the Architect, uncover and restore work to provide for Architect/Engineer observation of concealed Work.

C. In areas of the building where new finishes are being provided, the patching required on a surface which is to receive a new finish will be to bring the underlying surface up to the finish required to receive the final finish. This contractor shall coordinate subsurface finish requirements with the finish trade contractor(s).

D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

E. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 CLEANING

A. This contractor shall be required to thoroughly clean all installed equipment, duct work and piping. Cleaning shall be required before substantial completion on any phase of the project. Do not use cleaning materials and agents that are hazardous to health or property or that may damage the finished surfaces.

END OF SECTION 22 00 10

SECTION 22 00 30 – ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment specified under other Divisions or furnished by Owner.

1.2 REFERENCES

A. NEMA WD 1 - General Purpose Wiring Devices

B. NEMA WD 6 - Wiring Device Configurations.

C. ANSI/NFPA 70 - National Electric Code.

1.3 COORDINATION

A. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other Divisions.

1. Should there be a difference between the design and the installed equipment; change orders shall only be paid for the difference in the rough-ins. If the Division 26 Contractor installs any rough-ins prior to requesting and receiving shop drawings for the equipment to be installed, and the equipment is different than designed, the required rework shall be performed at no additional cost to the owner aside from the difference is cost between the design documents and installed equipment.
2. Should there be a need to install rough-ins ahead of equipment review and final shop drawing, the Division 26 Contractor shall submit a Request for Information, outlining the equipment to be fed, and how the schedule is impacted for review by the Engineer, Architect, Owner and Owner’s Representative.

B. Determined connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

D. Sequence electrical connections to coordinate with start-up schedule for equipment.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

A. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.

B. Cord Construction: Oil-resistant thermoset insulated Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.

C. Cord Size: Same as rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 PREPARATION

A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

B. The Contractor shall be responsible to coordinate all electrical which are installed for roof top equipment. Refer to “Coordination” in Section 260010 for additional requirements.

3.2 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.3 ELECTRICAL CONNECTIONS

A. Electrical connections shall meet equipment manufacturer's instructions.

B. Conduit connections to equipment shall use flexible conduit. Liquidtight flexible conduit with watertight connectors shall be used in damp or wet locations.

C. Wiring connections shall use wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Receptacle outlets shall be used where connection with attachment plug is indicated. Where attachment plug is required, equipment shall have a cord and cap.

E. Suitable strain-relief clamps and fittings shall be used for cord connections at outlet boxes and equipment connection boxes.

F. Disconnect switches, controllers, control stations, and control devices shall be located as indicated and per NEC requirements.

G. Verify proper rotation of three phase equipment.

H. Where applicable, power wiring shall be extended through external disconnect switches, local control switches, remote mounted control panels, etc. and connected to terminals in the equipment.

I. Where applicable, wire and conduit shall be extended between control device (start/stop pushbuttons or lighted handle switch) and combination starter/disconnect switches.

J. Coolers and Freezers: freezer and cooler walls, floors and ceilings shall be cut and sealed around conduit openings.

3.4 MISCELLANEOUS CONNECTIONS

A. Fire alarm, security, data, telephone and other low voltage connections shall be installed as required at equipment.

3.5 CONTRACTOR RESPONSIBILITIES (DIVISION 23 CONTRACT)

A. HVAC Control System Panels & Equipment Controls

1. 120 volt – 1 phase.
2. Division 23 Contractor shall provide power connection to control panel from nearest 120/208 volt electrical panel. Power for control panels for equipment being fed from the emergency generator, including, but not limited to boilers, heating pumps, selected air handling and terminal equipment, etc., shall be derived from the nearest 120/208 volt normal/emergency panel.
3. In addition to HVAC control system panels, where terminal equipment, including, but not limited to shut-off VAV boxes are provided with 120V connection, Division 23 Contractor shall provide power connection to the unit as described above.
4. Division 26 Contractor shall assist the Division 23 Contractor in locating the appropriate panel, ensure there is a spare 20A/1P breaker to feed the control panels and label breaker accordingly.
5. All wiring associated with the unit shall be by the Division 23 Contractor per manufacturer requirements.

B. Duct-mounted Smoke Detector

1. Division 26 Contractor shall furnish duct mounted smoke detector, including detector base and appropriately sized sampling tube for duct being installed.
2. Division 23 Contractor shall install sampling tube and detector base in duct. Coordinate exact location with Division 26 Contractor.
3. Division 26 Contractor shall install detector in base, wire and program into fire alarm system.
4. Division 26 Contractor shall provide relay, and wiring to associated HVAC unit from fire alarm system so that unit shuts down and supervisory signal is provided upon detection of smoke. Refer to Division 28 “Fire Alarm and Detection System” and drawings for additional requirements.
5. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

C. Ductless Air Conditioner (AC)

1. 208 volt – 1 phase.
2. 2-pole toggle switch shall be furnished and installed by the Division 26 Contractor adjacent to unit.
3. Division 26 Contractor shall wire through switch and make one power connection to the line side terminals in the unit.
4. Division 26 Contractor shall power the AC unit from the exterior unit. In systems where indoor unit receives separate power feed, provide junction box adjacent to the disconnect at the outdoor unit and run to the indoor unit for connection so that a single breaker controls both units.
5. All other wiring within the unit and between the unit and associated condensing unit shall be by the Division 23 Contractor per manufacturer requirements.

D. Air Cooled Condensing Unit (CU)

1. 208 volt – 1 phase.
2. Division 26 Contractor shall furnish and install a NEMA 3R fused disconnect switch at unit and shall extend power wiring thru switch to unit and shall make one connection to terminals in unit.
3. Where CU is associated with an indoor AC, power wire for AC unit shall come from the exterior unit. In systems where indoor unit receives separate power feed, provide junction box adjacent to the disconnect at the outdoor unit and run to the indoor unit for connection so that a single breaker controls both units.
4. All other wiring within the unit and between the unit and associated indoor unit shall be by the Division 23 Contractor per manufacturer requirements.

E. Indoor Fans – Manually Controlled (EF)

1. 120 volt – 1 phase
2. Wall switch shall be furnished and installed by the Division 26 Contractor.
3. Division 26 Contractor shall install Division 23 Contractor speed control in space being served by fan. Coordinate location in field for balancing.
4. Division 26 Contractor shall make one power connection thru wall switch and speed control where applicable.

F. Roof Fans – Reverse Acting T-Stat or ATC Controlled (EF)

1. 120, 208, 277 volt – 1 phase.
2. Integral disconnect switch provided by the equipment manufacturer.
3. Division 26 Contractor shall install Division 23 Contractor speed control in space being served by fan. Coordinate location in field for balancing.
4. Division 26 Contractor shall make one power connection through speed control where applicable.
5. Any other connections and/ or equipment required shall be provided by Division 23 Contractor.

G. Fan Powered Variable Air Volume Box (FPV)

1. 120, 277 volt - 1 phase.
2. Division 26 Contractor shall furnish and install a toggle switch for 1 phase units and non-fused disconnect switch for 3 phase units adjacent to unit and shall extend power wiring thru switch to unit and shall make one connection to terminals in units.
3. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

H. Kitchen Ventilation System (KVS-1 & KEF-1)

1. 480 volt - 3 phase.
2. A Demand Control Ventilation control panel, complete with VFD drives, interface screen, controls equipment, etc. shall be provided with the KVS housing drives and local disconnect. The Division 26 Contractor shall install the control panel at the hood. Field verify exact location to ensure ADA heights are maintained to the interface.
3. Division 26 Contractor shall make power connection to the VFD control panel and extend power wiring to rooftop make-up air unit fan and rooftop exhaust fan. Division 26 Contractor shall provide interlock wiring between fans and VFD control panel.
4. Division 26 Contractor shall make additional 120V connection to the KVS disconnect for IBT heaters and provide additional control wiring between the KVS and the VFD control panel per manufacturer requirements.
5. Division 23 Contractor shall furnish and install heat sensors. Division 26 Contractor shall interconnect the heat sensor and hood control panel so that unit starts when heat is sensed per IMC.
6. Division 26 Contractor shall provide wiring from VFD control panel to microswitches and provide 120V power. Division 26 Contractor shall provide interconnecting wiring from microswitches to the fire alarm system, gas solenoid and shunt trip breaker(s). Division 26 Contractor shall provide additional relays as required.
7. Division 26 Contractor shall provide 120V power to the control panel.
8. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

I. Kitchen Dishwasher Exhaust Fan (EF)

1. 120 volt – 1 phase.

2. Integral disconnect switch provided by the equipment manufacturer.
3. Division 23 Contractor shall provide all interlock wiring between exhaust fan and dishwasher machine.
4. Division 26 Contractor shall make one power connection to fan through equipment disconnect switch.
5. Any other connections and/or equipment required shall be provided by Division 23 Contractor.

J. Shut-off Air Terminal Unit (SOV)

1. Control power or 120 volt – 1 phase (contractor discretion).
2. Division 23 Contractor shall provide power to unit. Should 120 volt be selected, Division 23 Contractor shall provide power connection to unit from nearest 120/208 volt electrical panel. Power for units connected to air handling equipment connected to the emergency generator shall be derived from the nearest 120/208 volt normal/emergency panel. An attempt shall be made to minimize the quantity of breakers required by feeding multiple units from the same breaker, not exceeding 20 ampere of load on a single circuit.
3. Division 26 Contractor shall assist the Division 23 Contractor in locating the appropriate panel, ensure there is a spare 20A/1P breaker to feed the unit and label breaker accordingly.
4. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

3.6 CONTRACTOR RESPONSIBILITIES (DIVISION 22 CONTRACT)

A. Domestic Water Heater Electric (DWH)

1. 120, 208 volt – 1 phase.
2. Equipment manufacturer shall provide disconnect switch integral to unit.
3. Division 26 Contractor shall provide power wiring to unit disconnect switch and make one power connection.
4. Any other connections and/or equipment required shall be furnished and installed by the Division 22 Contractor.

B. Recirculating Pumps (CP)

1. 120 volt – 1 phase.
2. Thermal overload switch or starter/disconnect switch shall be furnished and installed by the Division 26 Contractor adjacent to the unit. Wire thru switch to pump motor.
3. Any other connections and/or equipment required shall be furnished and installed by the Division 22 Contractor.

C. Electric Water Cooler

1. 120 volt – 1 phase.
2. Division 26 Contractor shall refer to Electric Water Cooler shop drawings and furnish and install a duplex receptacle contained within the enclosure where applicable or provide direct connection where cord and plug is not provided.
3. Any other connections and/or equipment required shall be furnished and installed by the Division 22 Contractor.

3.7 CONTRACTOR RESPONSIBILITIES (GENERAL TRADES CONTRACT(S))

A. Food Service Equipment

1. The food service equipment will be furnished and installed under the Food Service Equipment Contract, but all related electrical work shall be provided by the Division 26 Contractor. Necessary Disconnect switches, starters, thermal switches, and special control devices will be furnished, installed and wired by the Division 26 Contractor. Division 26 Contractor shall install all necessary inter-connecting wiring within the equipment.
2. Division 26 Contractor is required to bring electrical service where required to make final connections. The exact locations for such will be determined by the Food Service Equipment Installer and such information will be furnished to the Division 26 Contractor.
3. Division 26 contractor shall secure roughing-in shop drawings prior to rough-in.
4. Installation of fractional horsepower equipment shall be made by installing a duplex outlet, 3-wire grounding type in wall behind the machine, except where floor outlets are indicated, and making final connection through a 3-wire cap with cord grip. Each machine shall be provided with approved grounding. Flexible feeders from junction boxes shall be provided as required.
5. Interlock wiring for condensing units, evaporative blower units, and lighting in walk-in cooler/freezer units shall be provided by the Division 26 Contractor unless otherwise noted on Food Service Contract drawings and specifications.
6. All work shall be installed in accordance with the standards and requirements of the NSF, DER, and NEC.

B. Powered Furniture

1. Division 26 Contractor shall acquire shop drawings for powered furniture and provide electrical connection per shop drawings. Should shop drawings differ from electrical drawings, contractor shall submit, in writing, changes prior to rough-in.
2. Division 26 Contractor shall provide all wiring, jacks, conduits and boxes for data wiring in furniture. Division 26 Contractor shall coordinate with the Installing Contractor to insure proper placement of jacks.

END OF SECTION 22 00 30

SECTION 22 05 00 - COMMON WORK REQUIREMENTS - PLUMBING 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.

1.2 SUMMARY

A. This Section includes materials and methods that are common to various Plumbing Systems.

1.3 DEFINITIONS

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

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

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

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

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

F. The following are industry abbreviations for rubber materials:

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

1.4 SUBMITTALS

A. Product Data: For the following:

1. Mechanical sleeve seals.
2. Escutcheons.
3. Access Doors.

B. Welding certificates.

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

1.7 COORDINATION

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

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

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

PART 2 - PRODUCTS

2.1 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.

2.2 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 (3.2-mm) maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

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

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

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

F. 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 DIELECTRIC FITTINGS

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

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

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

1. Manufacturers:

    a. Capitol Manufacturing Co.
    b. Epco Sales, Inc.
    c. Hart Industries, International, Inc.
    d. Watts Industries, Inc.; Water Products Div.
    e. Zurn Industries, Inc.; Wilkins Div.

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

1. Manufacturers:

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

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

1. Manufacturers:

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.

c. Pipeline Seal and Insulator, Inc.

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

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

1. Manufacturers:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Pipe wall penetration seals to be of the modular link type. Seals shall consist of a series of interlocking, molded synthetic rubber links, with heavy-duty plastic pressure plates, and corrosion resistant nuts and bolts. Seals to be designed to provide a hydrostatic seal between the pipe and wall penetration. Seals shall be sized and selected per manufacturer recommendations. Mechanical pipe seals shall be fabricated of an EPDM elastomer for general service and a Nitrile/ Buna-N for hydrocarbon/petroleum-based applications. Provide stainless steel hardware as required.

B. Steel wall sleeve: Cast in place concrete wall sleeves to be fabricated from galvanized heavy wall welded or seamless carbon steel pipe. All sleeves to have a 2" wide, full perimeter water stop, welded on both sides.

C. Mechanical pipe seals and wall sleeves shall be manufactured by The Metraflex Company®, or Flexicraft Industries.

2.5 SLEEVES

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

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

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

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

2.6 ROOF PENETRATIONS

A. Provide pre-fabricated roof cub with piping portal for all pipe gas piping penetrations through the roof. Curbs to be manufactured by the Pate Co. or equal.

B. Roof Curbs with Pipe Portals: Provide prefabricated galvanized steel roof curbs fabricated from minimum 16-gauge steel with welded corners. Curbs to be internally reinforced, factory insulated with 1.5” thick 3 lb. Density fiberboard insulation. Where required provide curbs with wood nailers fastened from the underside of the wood nailer.

C. Refer to drawing details for the type of curb required for the specified roofing system. Provide curbs with an integral metal cant, stepped integral metal cant raised the thickness of roof insulation or no integral cant, as required to suit the details. Provide curbs to meet the installed curb height as detailed on the drawings.

D. Pipe portal curb cover furnished with a laminated acrylic coated ABS plastic curb cover with pre-punched holes and molded sealing ring on a collared opening, and an EPDM compression molded cap with stainless steel snap lock clamps. Curbs covers shall be resistant to ozone and ultraviolet rays and shall have a serviceable temperature range of -40 degrees F to positive 250 degrees F. The molded sealing ring on the collared opening and the groove in the rubber cap shall be installed to assure a weather-tight pressure and mechanical seal. The protective rubber caps shall have a serviceable temperature range of -60 degrees F to positive 250 degrees F and shall be resistant to ozone and ultraviolet rays. The conical shaped steps of the nipple shall provide a weatherproof seal around the penetration. The stainless-steel snap lock clamps shall provide added protection to guarantee the seal.

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, Cast-Brass Type: With set screw.

C. Finish: Polished chrome-plated and rough brass.

2.8 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.9 CONCRETE EQUIPMENT BASES

A. Minimum compressive strength: 3500 p.s.i. at 28 days.

B. Minimum cementitious material content: 520 lb/cu. Yd.

2.10 ACCESS DOORS

A. Manufacturers: Subject to review, provide access doors manufactured by Milcor, Inc or equal.

B. Description: Steel access doors and frames for installation in masonry and/or drywall/gypsum board assemblies. Provide fire rated access doors when doors are installed in a fire rated assembly.

C. Frames: minimum 16 gage steel with exposed nominal 1” flange around the perimeter of the unit. Where doors are to be installed in drywall/gypsum board assemblies provide frames with a drywall bead. Doors to be installed in masonry shall be furnished with adjustable metal masonry anchors.

D. Flush Panel Doors: minimum 14 gage steel with concealed spring or piano hinge(s) with a minimum swing of 175 degrees. Finish to be a factory-applied primer, suitable for field painting. Provide flush cylinder lock with key. Key all locks alike.

E. Access door schedule: In addition to access door shown on the drawings provide the following access doors to be installed where directed by the architect or engineer:

1. Ten 16” x 16” to be installed in drywall/ gypsum construction.
2. Ten 16” x 16” to be installed in masonry construction.

2.11 FIRESTOPPING

A. The contractor shall be responsible for providing permanent, UL approved firestopping systems for all penetrations through fire rated floor or fire rated wall assemblies. All firestopping shall meet the requirements of ASTM E-814 and UL 1479.

B. Subject to compliance with project requirements, firestopping materials may be provided by one of the following manufacturers:

1. Specified Technologies Inc. (STI) Somerville, NJ.
2. Tremco, Beechwood, OH.
3. 3M, St. Paul MN.

C. Submit for review the following product data

1. Product data sheets.
2. UL System drawings for each firestopping application
3. Manufacturer’s Certificates of Compliance for their products.

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. Maintain unobstructed passageway of not less than 42” in width and 80” minimum head clearance as required by code.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal. Install piping to permit valve servicing. Install piping at indicated slopes. Install piping free of sags and bends.

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

G. Install piping to allow application of insulation.

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

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

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

K. Permanent sleeves are not required for holes formed by removable sleeves.

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

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

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.

M. Seal annular space between sleeve or opening and pipe or pipe insulation, using sealants appropriate for size, depth, and location of joint.

N. Aboveground and Underground, Exterior-Wall Pipe Penetrations: Provide Mechanical Sleeve Seal and wall sleeve.

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

O. Corrosion Protection: Pipes passing through concrete walls and/or floors and through block walls shall be protected against external corrosion by a protective sheathing or wrapping that will withstand any reaction from wall or floor material.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at all pipe penetrations. Where required seal all pipe penetrations with fire stop materials.

Q. Roof penetrations: provide roof curbs with pipe portals at all locations where gas piping penetrates the roof.

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

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

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

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

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

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

3.3 PIPING CONNECTIONS

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

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

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

B. Install equipment to maintain unobstructed passageway of not less than 42” in width and 80” minimum head clearance as required by code.

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

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

3.5 CONCRETE EQUIPMENT BASES

A. Provide concrete bases for all floor mounted mechanical equipment unless otherwise noted on the contract drawings.

1. Construct concrete bases with a minimum height of 6” and extend bases not less than 6” larger, in all directions, than supported equipment.
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 and according to anchor-bolt manufacturer's written instructions.
6. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project when applicable.

3.6 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors. Clean surfaces that will come into contact with grout.

B. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment.

C. Place grout around anchors. Cure placed grout.

3.7 INSTALLATION OF PIPING UNDER EXISITNG FLOORS

A. Where the drawings indicate new piping is to be installed under existing slab-on-grade construction, the installing contractor will be required to verify the location(s) of any existing pipes, conduits or any other system components, that are required to remain in service, before saw cutting existing slabs.

3.8 ACCESS DOORS

A. Comply with manufacturer's written instructions for installing access doors and frames. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

B. Adjust doors and hardware after installation for proper operation. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 22 05 00

SECTION 22 05 10 - EXCAVATION FOR PLUMBING CONSTRUCTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions and other Division-22 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Excavation, backfill and compaction associated with utility construction including such related features as protection of adjacent utilities and structures, maintenance and protection of traffic, cutting paved surfaces, support of excavation, control of excavated materials, de-watering, piping, bedding, disposal of excavated materials, and all work related to providing excavation, backfill and compaction for all utilities and structures in connection with the plumbing systems.

1.3 QUALITY ASSURANCE

A. Testing Agent: Compaction testing for this Work shall be performed by the contractor's Testing Agency. Where compaction testing is specified, such compaction testing shall be performed by a soils testing agent engaged and paid for by the Contractor and approved by the Architect.

B. Reference Standards:

1. Pennsylvania Department of Transportation:

    a. Regulations Governing Occupancy of Highways by Utilities (67 PA Code, Chapter 459)
    b. Publication 408 Specifications Pennsylvania Test Method, PTM 106 Pennsylvania Test Method, PTM 402
    c. Publication 203, Work Zone Traffic Control

2. American Society for Testing and Materials (ASTM):

    a. ASTM D698 Test Method for Laboratory Compaction characteristics of Soil Using Standard Effort (12,400 ft.-lbf/ft3)
    b. ASTM D2922 Standard Test Method for Density of Soil and Soil - Aggregate in Place by Nuclear Methods (Shallow Depth).

C. Compaction Testing:

1. Compaction shall be by the testing procedure contained in ASTM D2922 based on previously determined compaction curve data as established by ASTM D698.

1.4 SUBMITTALS

A. Certificates: Submit certification attesting that the composition analysis of pipe embedment and select material stone backfill materials meet specification requirements.

1.5 JOB CONDITIONS

A. Permits: Obtain and pay for all permits and inspections required for the work under this Section.

B. Excavation and Rock Removal:

1. Refer to Earthwork for information relative to removal of rock and classification of excavation. All requirements and classification for excavation, rock removal, earthwork, etc. specified under the Earthwork section shall be made a part of this Section.

C. Compaction of Backfill:

1. Excavations shall be backfilled with lifts which are individually compacted.
2. The following compaction densities (based on standard Proctor Curve ASTM D698) shall be achieved:

a. Trench Backfill under asphalt and concrete paving (not including base course materials): 100%.
b. Trench Backfill within Unpaved Areas: 95%.
c. Exterior Side of Structures: 95%.

3. Contractor shall maintain optimum moisture content of backfill materials to attain the required compaction density.

D. Protection of Existing Utilities and Structures:

1. Take all precautions and utilize all facilities required to protect existing utilities and structures. In compliance with Act 172 of the General Assembly of Pennsylvania, advise each Utility at least three (3) working days in advance of intent to excavate, do demolition work and give the location of the job site. Request cooperative steps of the Utility and suggestions for procedures to avoid damage to its lines.
2. Advise each person in physical control of powered equipment or explosives used in excavation or demolition work of the type and location of utility lines at the job site, the Utility assistance to expect, and procedures to follow to prevent damage.
3. Immediately report to the Utility and the Architect any break, leak or other damage to the lines or protective coatings made or discovered during the work and immediately alert the occupants of premises of any emergency created or discovered.
4. Allow free access to Utility personnel at all times for purposes of maintenance, repair and inspection.

1.6 WARRANTY

A. All equipment, material and labor provided under this specification section shall be warranted for a period of one year after project completion.

PART 2 - PRODUCTS

2.1 DETECTABLE WARNING TAPE

A. Acid and alkali resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, including storm water, 6" wide, 4 mils thick, continuously inscribed with a description of the utility with metallic core encased in a protective jacket for corrosion protection, detectable by metal

detector when tape is buried up to 30 inches deep, colored as directed by authorities having jurisdiction on the project or as directed by the Architect.

2.2 PIPE BEDDING OR EMBEDMENT MATERIAL

A. PennDOT No. 2A coarse aggregate, Table C, Section 703.2, Publication 408 Specifications or PennDOT 2RC.

2.3 SLAB OR BASE MATERIAL

A. Concrete Slab or Precast Base:

1. PennDOT No. 2A coarse aggregate, Table C, Section 703.2, Publication 408 Specifications.

2.4 BACKFILL MATERIAL FOR UTILITIES

A. All Concrete and Asphalt Paving:

1. PennDOT No. 2A coarse aggregate, Table C, Section 703.2, Publication 408 Specifications.

B. Unpaved Areas:

1. PennDOT No. 2A coarse aggregate, Table C, Section 703.2, Publication 408 Specifications.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Identify required lines, levels, contours and datum.

B. Notify Architect of unexpected subsurface conditions and discontinue work in area until notified to resume work.

C. Maintain and protect existing utilities identified by utility users within the Work area.

D. Verify that structure walls are braced to support surcharge forces imposed by backfilling operations.

3.2 PROTECTION OF ADJACENT WORK

A. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.

B. Grade excavation top perimeter to prevent surface water runoff into excavation or to adjacent properties.

3.3 MAINTENANCE AND PROTECTION OF TRAFFIC

A. Coordinate the work to ensure the least inconvenience to traffic and maintain traffic in one or more unobstructed lanes unless closing the roadway is authorized.

B. Maintain access to all streets and private drives.

C. Provide and maintain signs, flashing warning lights, barricades, markers, and other protective devices as required to conform with construction operations and to keep traffic flowing with minimum restrictions.

D. Comply with State and local Municipal codes, permits and regulations and pay for all permits and inspections that are required for the installation.

3.4 CUTTING PAVED SURFACES

A. Where installation of pipelines, structures, and appurtenances necessitate breaking a paved surface, make cuts in a neat uniform fashion forming straight lines parallel with the edge of the excavation. Cut offsets at right angles to the edge of the excavation.

B. Protect edges of cut pavement during excavation to prevent raveling or breaking; square edges prior to pavement replacement.

C. The requirement for neat line cuts, in other than state highways, may be waived if the final paving restoration indicates overlay beyond the width of the excavation.

3.5 EXCAVATION

A. Depth of Excavation:

1. Pipelines: Excavate trenches to the depth and grade shown on the profile drawings for the invert of the pipe plus that excavation necessary for placement of pipe bedding material.
2. Where unsuitable bearing material including shattered rock due to drilling or other operations is encountered in the bottom of the excavation, discontinue excavation until the unsuitable material is observed by the Architect or the Owner's representative.
3. Where contractor, by error or intent, excavates beyond the minimum required depth, backfill the excavation to the required depth with pipe bedding/embedment or slab/base material as appropriate without any change in the Contract Price.

B. Width of Excavation:

1. Pipelines: Excavate trenches, including laterals, to a width necessary for placement and jointing of the pipe, and for placing and compacting pipe embedment under, around and over the pipe. Shape trench walls completely vertical from trench bottom to at least two (2) feet above the top of the pipe. For pressure pipeline fittings, excavate trenches to a width that will permit placement of concrete thrust blocks. Provide earth surfaces for thrust blocks that are perpendicular to the direction of thrust and are free of loose or soft material.
2. Structures: Excavate to the minimum distance necessary for placement/installation of the footings, concrete slab, walls or prefabricated structures and to permit proper backfill procedures to be performed.

C. Length of Open Trench:

1. Do not advance trenching operations more than 200' ahead of completed pipeline.

3.6 SUPPORT OF EXCAVATION

A. Support excavations with sheeting, shoring, and bracing or in the case of pipeline construction, a "trench box" as required to comply with Federal, State, and local laws and codes.

B. Install adequate excavation supports to prevent ground movement or settlement to adjacent structures, pipelines or utilities. Damage due to settlement because of failure to provide support or through negligence or fault of contractor in any other manner, shall be repaired at contractor's expense.

C. Withdraw shoring, bracing, and sheeting as backfilling proceeds unless otherwise directed by the Architect.

D. The neglect, failure or refusal of the Architect to order the use of bracing or sheeting, or a better quality, grade, or section, or larger sizes of steel or timber, or to order sheeting, bracing, struts, or shoring to be left in place, or the giving or failure to give orders or directions as to the manner or methods of placing or driving sheetings, bracing, jacks, wales, stringers, etc., shall not in any way or to any extent relieve Contractor of any responsibility concerning the condition of excavation or of any of his obligations under the Contract, nor shall any delay, whether caused by any action or want of action on the part of Contractor, or by any act of Owner and Architect or their agents, or employees, resulting in the keeping of an excavation open longer than would otherwise have been necessary, relieve contractor from the necessity of properly and adequately protecting the excavation from caving or slipping, nor from any of their obligations under the Contract relating to injury of persons or property, nor entitle them to any claim for extra compensation.

3.7 CONTROL OF EXCAVATED MATERIAL

A. Keep the ground surface, within a minimum of 2' of the sides of the excavation free of excavated material.

B. Provide temporary barricades to prevent excavated material from encroaching on private property, walks, gutters, and storm drains.

C. Maintain accessibility to all fire hydrants, valve pit covers, valve boxes, curb boxes, fire and police call boxes, and other utility controls at all times. Keep gutters clear or provide other satisfactory facilities for street drainage. Do not obstruct natural water courses. Where necessary, provide temporary channels to allow the flow of water either along or across the site of the work.

D. In areas where excavations parallel or cross streams, ensure that no material slides, is washed, or dumped into the stream course.

3.8 DEWATERING

A. Keep excavations dry and free of water. Dispose of precipitation and subsurface water clear of the work.

B. Maintain pipe trenches dry until pipe has been jointed, inspected, and backfilled, and concrete work has been completed. Prevent trench water from entering pipelines under construction.

C. Intercept and divert surface drainage away from excavations. Design surface drainage systems so that they do not cause erosion on or off the site, or cause unwanted flow of water.

D. Comply with Federal and State requirements for dewatering to any watercourse, prevention of stream degradation, and erosion and sediment control.

3.9 PIPE LAYING

A. Provide required pipe bedding placed in accordance with the Drawings and Specifications. A minimum bedding of 6" shall be provided.

B. Shape recesses for the joints or bell of the pipe by hand. Assure that the pipe is supported on the lower quadrant for the entire length of the barrel.

C. Lay pipe as specified in the appropriate Section of these Specifications for pipeline construction.

3.10 BACKFILLING EXCAVATIONS

A. Pipeline Trench:

1. After pipe installation and inspection, provide material to complete the pipe embedment in accordance with the Drawings and Specifications.
2. Unless otherwise shown on the Drawings, the following bedding or embedment requirements using the material indicated:

    a. Storm Sewers: Pipe embedment to 12" above the crown of the pipe.
    b. Potable Water: Pipe embedment to one-half (½) the outside diameter of the pipe.

3. The material shall be hand placed and carefully compacted with hand-operated mechanical tampers in layers of suitable thickness to provide specified compaction around and under the haunches of the pipe. Backfill and compact the remainder of the trench with specified backfill material in accordance with the Drawings and any relevant permit conditions. Employ a placement method so not to disturb or damage the utility line in the trench. Use of a Hydra-hammer or jumping-jack type compaction device is not permitted. A vibratory plate type compaction device is acceptable. Any settlement which occurs because of consolidation of the backfill during the construction period or during the one (1) year maintenance period shall be completely corrected by contractor at his expense.
4. Provide warning tape approximately 12" below finished grades and above all piping.

B. Lift Thickness Limitations:

1. Lift thicknesses shall be limited to four (4) inches for pipe embedment, eight (8) inches maximum for pipeline trenches within paved areas and twelve (12) inches maximum for pipeline trenches in non-paved areas and for structure excavations. Lift thicknesses shall also comply with requirements imposed by any State Highway Occupancy Permit. In no case shall maximum lift thickness placed exceed the maximum limits specified by the manufacturer's recommendations for the compaction equipment to be utilized. Compaction equipment shall not be used over the pipe until sufficient backfill has been placed to ensure that such equipment will not damage or disturb the pipe.
2. Lift thickness limitations specified for State highways, shoulders, or embankments govern over the compaction equipment manufacturer's recommendations.

C. Unsuitable Backfill Material:

1. Where the Architect determines backfill material to be unsuitable and rejects all or part thereof due to conditions prevailing at the time of construction, remove the unsuitable material and replace with suitable backfill material. Unsuitable material shall be legally disposed of, off-site by the contractor.

3.11 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Contractor shall obtain and pay for a testing laboratory to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

1. Perform field density tests in accordance with ASTM D 1556 (sand cone method) or ASTM D 2167 (rubber balloon method), as applicable.

a. Field density tests may also be performed by the nuclear method in accordance with ASTM D 2922, providing that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. In conjunction with each density calibration check, check the calibration curves furnished with the moisture gages in accordance with ASTM D 3017.
b. If field tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Architect.

2. Perform one test at each structure and one test for each 150 lineal feet of pipe or fractions thereof per foot of backfill.
3. If in opinion of Architect, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction and testing until specified density is obtained.

3.12 DISPOSAL OF EXCAVATED MATERIAL

A. Excavated material remaining after completion of backfilling shall remain the property of contractor, removed from the construction area, and disposed of legally, off-site. However, in the event the excavated material can be used in filling and rough grading on the site as determined by the Architect, it shall remain on the site and be used for grading and filling.

END OF SECTION 22 05 10

SECTION 22 05 30 - METERS AND GAUGES FOR PLUMBING SYSTEMS

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 Thermometers, Gauges and Test plugs.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide fully adjustable angle thermometers by one of the following:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
5. Miljoco Corporation.

B. Case: Cast aluminum with dark blue epoxy coating, 9 inches long.

C. Window: Clear acrylic for temperatures up to 300 deg. F; glass for higher temperatures.

D. Tube: blue reading, organic filled.

E. Stem: brass for thermowell installation and of length to suit installation.

F. Accuracy: Plus or minus 1 scale division.

2.2 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.

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

2.3 PRESSURE GAUGES

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

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
5. Miljoco Corporation.

B. Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.

1. Case: Liquid-filled type, fiberglass reinforced polypropylene, 4-1/2-inch diameter, solid front, blow out back.
2. Pressure-Element Assembly: Bronze Bourdon tube.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet.
4. Movement: Stainless steel rotary type with stainless steel bushings.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Acrylic plastic.
8. Accuracy: Plus or minus .5 percent range.
9. Vacuum-Pressure Range: 30-in. Hg of vacuum to 150 psig of pressure.
10. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gauge Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type valve.

2.4 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements provide test plug (PT Plug) products by one of the following:

1. Flow Design, Inc.
2. Peterson Equipment Co., Inc.
3. Sisco Manufacturing Co.
4. Trerice, H. O. Co.
5. Watts Industries, Inc.; Water Products Div.

B. Description: Ports are to be suitable to accept thermometer stem or pressure gauge adapter and shall have dual EPDM internal seals, threaded brass cap with metal retainer strap. Ports are to be adequate length and suitable for installation in insulated or non-insulated piping.

C. Construction: Brass body with dual EPDM seals.

D. Minimum Pressure and Temperature Rating: 1000 psig at 270 deg F.

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

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install thermometers where indicated on the drawings, see plans and detail drawings.

B. Provide the following temperature ranges for thermometers:

1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.

3.2 GAUGE APPLICATIONS

A. Install pressure gauges at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.

C. Install direct-mounting pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

D. Install shut-off needle-valve and snubber fitting in piping for each pressure gauge and thermometer.

E. Install test plugs in tees in piping.

F. Install connection fittings for attachment to portable indicators in accessible locations.

G. Adjust faces of thermometers and gauges to proper angle for best visibility.

END OF SECTION 22 05 30

SECTION 22 05 40 – GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

B. ASME Compliance:

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

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

D. The installation and materials shall comply with the requirements of the 2015 International Plumbing Code and any applicable local code amendments. Verify code with requirements with the local code officials.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

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

C. Valves in Insulated Piping: With stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.

D. Valve-End Connections:

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

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

2.2 BRASS BALL VALVES

A. A. Two-piece full-port, Brass Ball Valves with Brass Trim:

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

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Stockham.
e. Jomar Valve.

2. Description:

a. Standard: MSS SP-110, MSS SP-145
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.

2.3 BRONZE BALL VALVES

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

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

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110, MSS SP-145.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).

d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.

2.4 BUTTERFLY VALVES

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

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

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nickel-plated or -coated ductile iron.

B. Grooved Copper Butterfly: DN65-DN150, 300 psi max pressure rati4ng with copper tubing sized grooved ends. Cast bronze body to CDA-836 (85-5-5-5). Elastomer encapsulated ductile iron disc, ASTM A-536, Grade 65-45-12, with integrally cast stem.

2.5 BRONZE SWING CHECK VALVES

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

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

a. Crane Co.; Crane Valve Group
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Jomar Valve.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.

f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

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

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

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

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

E. Install check valves for proper direction of flow.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

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

1. Shutoff Service: Ball or butterfly valves.
2. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided check valves.

END OF SECTION 22 05 40

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.2 SUBMITTALS

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

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

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

D. Valve-numbering scheme.

E. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch or stainless steel, 0.025-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
5. Fasteners: Stainless steel rivets or self-tapping screws.
6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, with predrilled holes for attachment hardware.
2. Letter and Background Color: As indicated for specific application under Part 3.
3. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
5. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, with predrilled holes for attachment hardware.

B. Letter and Background Color: As indicated for specific application under Part 3.

C. Maximum Temperature: Able to withstand temperatures of up to 160 deg F (71 deg C).

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

E. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances of up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

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

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

H. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E.

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

2.3 WARNING TAPE

A. Material: Vinyl.

B. Minimum Thickness: 0.005 inch.

C. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

D. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

E. Maximum Temperature: 160 deg F.

F. Minimum Width: 4 inches.

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

B. Letter and Background Color: As indicated for specific application under Part 3.

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

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

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.5 STENCILS

A. Stencils for Piping:

1. Lettering Size: Size letters in accordance with ASME A13.1 for piping.
2. Stencil Material: Aluminum, brass, or fiberboard.
3. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel or acrylic enamel in colors in accordance with ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
5. Letter and Background Color: As indicated for specific application under Part 3.

2.6 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.04-inch or stainless steel, 0.024-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain or S-hook.

B. Letter and Background Color: As indicated for specific application under Part 3.

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

1. Include valve-tag schedule in operation and maintenance data.

2.7 WARNING TAGS

A. Description: Preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION, GENERAL REQUIREMENTS

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

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

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

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Sign and Label Colors.

1. White letters on an ANSI Z535.1 safety-green background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where are-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E.

3.4 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Stenciled Pipe Label Option: Stenciled labels showing service and flow direction may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1 with painted, color-coded bands or rectangles on each piping system.

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

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

1. Within 3 ft. (1 m) of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. (1 m) of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F (52 deg C) or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Pipe-Label Color Schedule:

1. Low-Pressure Compressed-Air Piping: White letters on an ANSI Z535.1 safety-blue background.
2. Vacuum Piping: White letters on an ANSI Z535.1 Safety blue background.
3. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
4. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background.
5. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
6. Sanitary Waste and Storm Drainage Piping: White letters on a black background.
7. atural or LP Gas Piping: Black letters on yellow background.
8. Acid Waste Drainage Piping: Black letters on yellow background.

3.6 INSTALLATION OF VALVE TAGS

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

B. The location of all valves shall be indicated by locator tags on the ceiling tile. Provide equipment locator tags in a color suitable to the owner. Tags to be push tack type with 7/8” diameter head as manufactured by Marketing Services Inc. or equal.

C. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:

a. Domestic Cold Water: 1-1/2 inches round.
b. Domestic Hot Water: 1-1/2 inches round.
c. Domestic Hot-Water Return: 1-1/2 inches round.
d. Low-Pressure Compressed Air: 1-1/2 inches round.
e. Natural Gas or LP Gas Piping: 1-1/2 inches round.

2. Valve-Tag Colors:

a. Natural.

3.7 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.

B. Attach warning tags, with proper message, to equipment and other items where indicated on drawings and schedules.

END OF SECTION 22 05 53

SECTION 22 05 93 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The firm responsible for TAB work on this project will be under contract with and has been hired directly by the owner.

B. Work under this section includes, but is not limited to, Testing, Adjusting and Balancing (TAB) of the following domestic water systems and pluming equipment:

1. Domestic hot-water in-line circulation pumps.
2. Domestic hot-water circulation system.
3. Domestic water heaters.
4. Testing, adjusting, and balancing of existing plumbing systems and equipment.
5. Pipe-leakage test verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.5 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine approved submittals for plumbing systems and equipment.

D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.

E. Examine equipment performance data, including pump curves.

1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.

F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.

J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

K. Examine system pumps to ensure absence of entrained air in the suction piping.

L. Examine operating safety interlocks and controls on plumbing equipment.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Domestic Water System:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
b. Water heaters are installed and functioning.
c. Piping is complete and all points of outlet are installed.
d. Systems are flushed, filled, and air purged.
e. Strainers are clean.
f. Control valves are functioning in accordance with the sequence of operation.
g. Shutoff and balance valves are 100 percent open.
h. Hot-water circulating pumps are operational and proper rotation is verified.
i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 220716 "Plumbing Equipment Insulation" and Section 220719 "Plumbing Piping Insulation."

C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:

1. Domestic water in-line pumps.
2. Domestic water heaters.

3.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:

1. Check expansion tank for proper setting.
2. Check water heater for proper discharge temperature setting.
3. Check remotest point of outlet for adequate pressure.
4. Check flow-control valves for proper position.
5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
6. Verify that motor controllers are equipped with properly sized thermal protection.
7. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

G. Check settings and operation of each safety valve. Record settings.

3.6 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

A. Balance system with manual or automatic balancing valves by setting at design flow.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

B. Adjust pump to deliver total design flow.

1. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.

2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
3. Mark final settings and verify that all memory stops have been set.
4. Verify final system conditions as follows:

a. Re-measure and confirm that total flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.

c. Mark final settings.

3.7 PROCEDURES FOR WATER HEATERS

A. Electric Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Measure and record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/h of heating output.
6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

3.8 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record flows, temperatures, and pressures of each piece of equipment. Compare the values to design or nameplate information, where information is available.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the condition of filters.
4. Check bearings and other lubricated parts for proper lubrication.
5. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:

1. New filters are installed.
2. Bearings and other parts are properly lubricated.
3. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated system flows of the renovated work to the measured flows, and determine the new pump speed.
2. Verify that the indicated system flows of the renovated work result in velocities and pump speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the system flow rates by more than ten percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 10 percent or less, equipment adjustments are not required.

3.9 TOLERANCES

A. Set plumbing system's flow rates within the following tolerances:

1. Domestic Water Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm , within 10 percent.
2. Compressed-Air Flow Rate: Plus or minus 10 percent. If design value is less than 10 Scfm, within 10 percent.
3. Vacuum Flow Rate: Plus, or minus 5 percent.

3.10 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.

3.11 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:

    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:

1. Flow rates.
2. Pipe and valve sizes and locations.
3. Balancing stations.
4. Position of balancing devices.

E. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Model number and unit size.
d. Manufacturer's serial number.
e. Output capacity in Btu/h.
f. Number of stages.
g. Connected volts, phase, and hertz.
h. Rated amperage.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. High-temperature-limit setting in deg F.
e. Operating set point in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water-pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump speed.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.

d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

G. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.12 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Architect, Owner, Construction Manager, Commissioning Authority.

B. Architect, Owner, Construction Manager, Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 20 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue other Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 22 05 93

SECTION 22 07 00 - PLUMBING SYSTEM 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 insulation materials and accessories for insulating Plumbing piping and equipment.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields. Coordinate clearance requirements with piping Installer for insulation application.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Mineral-Fiber Plumbing Pipe Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1. Products: Subject to compliance with requirements, provide Johns Manville Micro-Loc insulation or equal products manufactured by one of the following:

a. Knauf Insulation.
b. Owens Corning Fiberglas 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 jacket.
3. Provide High-impact-resistant, UV-resistant PVC jacketed fitting covers complying with ASTM D 1784, Class 16354-C; Flame spread 25 or less; Smoke development 50 or less.

B. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

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

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

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

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

2.2 FIELD-APPLIED JACKETS

A. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming.

B. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

C. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane, consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

D. Self-Adhesive Indoor/Outdoor Jacket (Non-Asphaltic): Vapor barrier and waterproofing jacket for installation over insulation located aboveground outdoors or indoors. Specialized jacket with five layers of laminated aluminum and polyester film with low-temperature acrylic pressure-sensitive adhesive. Outer aluminum surface is coated with UV-resistant coating for protection from environmental contaminants.

2.3 CEMENTS, ADHESIVES AND MASTICS

A. Provide all required types of cements, adhesives, mastics and other accessories required to install all insulation materials and systems per the Manufacturer’s Installation Requirements. Prepare surfaces as required by the insulation manufacturers. Install cements, adhesives and mastics per manufacturer’s recommendations.

PART 3 - EXECUTION

3.1 GENERAL APPLICATION REQUIREMENTS

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

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

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

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

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

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

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

H. Keep insulation materials dry during application and finishing.

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

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

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

L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.

1. Apply insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches (300 mm) from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

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

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

O. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Circumferential Joints: Cover with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches (100 mm) o.c.
3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches (40 mm). Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.

    a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.

4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.

P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.

1. Seal penetrations with vapor-retarder mastic.
2. Apply insulation for exterior applications tightly joined to interior insulation ends.
3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal metal jacket to roof flashing with vapor-retarder mastic.

Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

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

S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.

1. Firestopping and fire-resistive joint sealers are specified in other Division 22 Sections.

T. Floor Penetrations: Apply insulation continuously through floor assembly.

1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.2 MINERAL-FIBER INSULATION APPLICATION

A. Insulation Installation on Straight Pipes and Tubes per manufacturer's instructions. Where vapor barriers are required, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c. 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 Fittings, Elbows, Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.3 INSTALLATION OF FIELD-APPLIED JACKETS

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

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

C. Where metal jackets are indicated, install with 2-inch (50-mm) 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 (300 mm) o.c. and at end joints.

3.4 FLEXIBLE ELASTOMERIC INSULATION APPLICATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Apply Insulation on Pipe Fittings, Elbows, Valves and Pipe Specialties.

3.5 INSULATION APPLICATION SCHEDULE, GENERAL

A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.6 INTERIOR INSULATION APPLICATION SCHEDULE

A. Service: Domestic hot and re-circulated hot water.

1. Operating Temperature: 60 to 140 deg F.
2. Insulation Material: 1 ½" Mineral fiber.

B. Service: Domestic cold water.

1. Operating Temperature: 35 to 60 deg F.
2. Insulation Material: 1” thick Mineral fiber with vapor barrier.

C. Service: Rainwater conductors and roof drain bodies.

1. Insulation Material: 1” Mineral fiber with vapor barrier.

D. Service: Condensate drain piping.

1. Insulation Material: ¾” Flexible elastomeric.

E. Service: Sanitary drain piping and accessories, associated with condensate drains, where indicated on the drawings.

1. Insulation Material: ¾” Flexible elastomeric.

END OF SECTION 22 07 00

SECTION 22 11 10 - 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 for underground, under slab and above ground installations including accessories.

1.3 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.
2. Piping materials.

B. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

C. System purging and disinfecting activities report.

1.4 QUALITY ASSURANCE

A. The installation shall comply with the requirements of the International Plumbing Code (IPC) and any applicable local code amendments. Verify the code with requirements with the local code official(s) before beginning the work.

B. All domestic water piping and fittings are required to bear the identification of the manufacturer as required in Chapter 3; paragraph 303.1 of the IPC.

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

1.5 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt service to any portion of the existing occupied facilities until receiving permission. If interruption of the existing service is required, coordinate the work with the Owner and, if necessary, perform the work at a time, other than normal working hours, which is suitable to the owner.

1.6 COORDINATION

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 COPPER TUBE AND FITTINGS

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

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

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

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

C. Grooved Joint Copper Piping Systems: Provide grooved copper products manufactured by Victaulic. All grooved copper system components are to be supplied by the same manufacturer.

1. Copper Tube: ASTM B 88, Type L roll grooved in accordance with the manufacturer's standards and copper tube dimensions.
2. Couplings for grooved piping to consist of ductile iron cast housings with synthetic rubber gasket of a pressure responsive design with plated nuts and bolts to secure the unit. Couplings shall be manufactured to connect to copper tubing and fittings without flaring.

    a. Coupling housings: ductile iron (ASTM A-536, grade 65-45-12) coated with copper colored alkyd enamel.
    b. Coupling Gaskets: gasket to be Grade EHP EPDM compound with red color code design for operating temperatures from minus 30 degrees F to plus 250 degrees F.
    c. Victaulic Style 607 installation ready coupling for direct stab installation with filed disassembly.

3. Fittings: manufactured to copper tube sizes with grooves designed to accept grooved couplings. Fittings shall be wrought copper conforming to ASTM B-75 alloy C12200 or ASTM B-152 alloy C11000 and ANSI B16.22.

D. Press-Fit Joint Copper Piping Systems: Provide Press-fit copper pipe products manufactured by Viega, Elkhart Products or NIBCO, Inc

1. Hard Copper Tube: ASTM B88.
2. Copper fittings: ASME B16.18, ASME B16.22 or ASME B16.26.
3. Press Fitting: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect™) feature design (leakage path). In ProPress ½" to 4" dimensions the Smart Connect Feature assures leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.4 PIPING JOINING MATERIALS

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

2.5 FLEXIBLE CONNECTORS

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

1. Hyspan Precision Products, Inc.
2. Metraflex, Inc.
3. Universal Metal Hose; a Hyspan company.

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

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

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

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

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

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

D. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105.

E. Install shutoff valve, drain valve, pressure gage, inside the building at each domestic water service entrance.

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

G. When required, rough-in domestic water piping for water-meter installation according to utility company's requirements.

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas. Install exposed piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

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

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

K. Install piping free of sags and bends.

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

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

N. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump.

O. Install thermometers on inlet and outlet piping from each water heater.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

B. 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.

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

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

E. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

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

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

3.3 VALVE INSTALLATION

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

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

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

C. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow.

3.4 DIELECTRIC FITTING INSTALLATION

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

3.5 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.

3.6 WATER METER INSTALLATION

A. Where required, rough-in domestic water piping for water meter installation, and install water meters according to utility company's requirements. Install water meters according to AWWA M6, utility company's requirements.

3.7 PIPE HANGER AND SUPPORT INSTALLATION

A. Support all domestic water piping in accordance with the International Plumbing Code or local code requirements.

B. Hangers shall be of materials that will not support galvanic action. Support piping with adjustable clevis hangers for all horizontal piping. Provide a 12” long 18 gage protective saddle for all clevis hangers that support insulated piping. Support each system independently of other piping systems, allowing for expansion of the pipe.

C. Install hangers for copper tubing with the following spacing:

1. NPS 1-1/4” and smaller: 6 feet maximum horizontal.
2. NPS 1-1/2” and larger: 10 feet maximum horizontal.
3. Install supports for vertical pipe at a maximum spacing of 10 feet.

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to equipment and machines to allow service and maintenance.

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

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

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

3.9 ESCUTCHEON INSTALLATION

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

3.10 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls. Sleeves are not required for core-drilled holes.

B. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated. Install sleeves in new partitions, slabs, and walls as they are built.

C. 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. Provide fireproofing where required.

D. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using wall penetration systems.

E. Install sleeve materials according to the following applications:

1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe. Extend sleeves 2 inches above finished floor level.
3. Sleeves for Piping Passing through Gypsum-Board Partitions:

    a. Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations.

3.11 IDENTIFICATION

A. Identify system components. Comply with requirements indicated in Specification Section 220553.

3.12 FIELD QUALITY CONTROL

A. Test systems according to procedures of authorities having jurisdiction or, in absence of such procedures, testing shall be per the requirements on the International Plumbing Code Section 312, Test and Inspections.

B. Piping Inspections: coordinate all inspection requirements with the Authorities Having Jurisdiction. Do not enclose, cover, or put piping into operation until it has been inspected and approved.

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

D. Prepare test and inspection reports.

3.13 ADJUSTING

A. Perform the following adjustments before operation:

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

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

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

3.14 DISINFECTION OF POTABLE WATER SYSTEM(S)

A. All domestic water piping shall be purged and disinfected prior to utilization. The method to be followed shall be that required by the International Plumbing Code, Section 610, or the requirements of the local authorities.

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

3.15 PIPING SCHEDULE

A. Under-building-slab, domestic water, building service piping, NPS 3 (DN 80) and smaller, shall be the following:

1. Soft copper tube, ASTM B 88, Type L (ASTM B 88M, Type B)]; wrought-copper solder-joint fittings; and brazed or copper pressure-seal fittings and joints.

B. Exterior Underground, Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) shall be the following:

1. Mechanical-joint, ductile-iron pipe; mechanical-joint fittings; and mechanical restrained joints.

C. Aboveground domestic water piping, shall be the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) copper solder-joint fittings; and soldered, press-fit or grooved joints.

3.16 VALVE SCHEDULE

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

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

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

END OF SECTION 22 11 10

SECTION 22 11 20 - 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:

1) Vacuum breakers.
2) Balancing valves.
3) Temperature-actuated, water mixing valves.
4) Strainers for domestic water piping.
5) Outlet boxes.
6) Hose bibbs.
7) Wall hydrants.
8) Roof hydrants.
9) Drain valves.
10) Water-hammer arresters.
11) Trap-seal primer device.
12) Trap-seal primer systems.
13) Flexible connectors.

1.3 SUBMITTALS

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

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

1.4 QUALITY ASSURANCE

A. The installation and manufacture of all products shall conform to the requirements of the following:

1. International Plumbing Code and any local code amendments. Verify the code requirements with the local code official(s) before beginning the work.
2. Lead Free Law as adapted effective January, 2014.
3. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

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

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

   a. Ames Co.
   b. Cash Acme.
   c. Conbraco Industries, Inc.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.

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

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. Watts Industries, Inc.; Water Products Div.
   d. Zurn Plumbing Products Group; Wilkins Div.

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

2.2 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

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

   a. Bell & Gossett Model CS Plus
   b. Armstrong Pump Model CVB
   c. Flow Design Inc. Model UA
   d. Flo Pac Model MB/MBF/MBG
   e. Jomar Valve

2. Valves: venturi type bronze body, chrome plated ball, EPDM seals. Provide pressure & temperature test ports across valve measurement area. Ports to be fitted with dual durometer EPDM cores, brass cap & O-ring seal. Valves to have drain/purge port. Provide valve with memory stop, memory lock and calibrated position indicator. Valves to be rated at 200 PSIG at 2500 F and be 100% positive shut-off. Accuracy to be +/- 3%.

2.3 MIXING VALVES

A. DIGITAL WATER MIXING VALVE ASSEMBLIES

1. Manufacturer: Subject to compliance with requirements, provide a water mixing assembly manufactured by Powers/Watts. Products meeting the requirements and manufactured by the following will be considered:

   a. Leonard Valve Company.
   b. Armstrong International.
   c. Lawler Manufacturing Co., Inc.

2. Description: Factory assembled and tested, Lead Free digital water temperature control and monitoring water-mixing-valve assembly with duty as indicated on the drawings. Digital Mixing Valves to comply with ASSE 1017. Include integral check stops on hot- and cold-water inlets.
3. Controller: 3.5” full color touchscreen interface configurable on location to control water temperature to +/- 2 deg F and resist “temperature creep” during no or low demand. Controller shall be password protected and adjustable outlet range of 60-180 deg F with high and low alerts. Controller shall digitally control and monitor mixed outlet temperature and shall integrate with building automation systems through BACnet and Modbus protocols and feature local and remote temperature alarms. System shall be capable of sending system alerts by text and/or email and prioritizing alerts based on user input levels. Control shall be equipped with secure WI-FI protocols WPA2-PSK and WPA2-PEAP-MSCHAPv2.
4. System shall feature a user set, high temperature sanitation mode for thermal disinfection and programmable temperature set back feature. System shall fail full cold open and in event loss of cold water, system shall close hot water supply.
5. Power: 120-1-60.
6. Mixing Valve Finish: rough bronze.

B. Individual-Fixture, Water Tempering Valves:

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

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

2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.

2.4 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. Screen: Stainless steel with round perforations, unless otherwise indicated.

4. Perforation Size:

   a. Strainers NPS 2 and Smaller: 0.033 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
   c. Strainers NPS 5 and Larger: 0.125 inch.

5. Drain: Factory-installed, hose-end drain valve.

2.5 OUTLET BOXES

A. Clothes Washer Outlet Boxes WOB-1:

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

   a. Guy Gray Manufacturing Co., Inc. or equal.

2. Material and Finish: Epoxy-painted-steel or enameled-steel box and faceplate.
3. Mounting: Recessed. Provide fire-rated construction where installed within fire-rated walls.
4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
7. Accessory: Water hammer arresters.

B. Icemaker Outlet Boxes IMB1:

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

   a. Guy Gray Manufacturing Co., Inc. or equal.

2. Mounting: Recessed.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Accessory: Water hammer arrestor.
6. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.6 HOSE BIBBS

A. Hose Bibbs HB:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Pressure Rating: 125 psig.
5. Vacuum Breaker: Integral.
6. Finish for Equipment Rooms: Rough bronze.
7. Finish for Service Areas: Chrome plated.
8. Finish for Finished Rooms: Chrome plated.
9. Operation: operating key.
10. Include operating key with each operating-key hose bibb.
11. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.7 WALL HYDRANTS

A. A. Non-freeze Wall Hydrants WH-1:

1. Manufacturers: Zurn Model Z1320-C or equal.
2. Provide anti-siphon, automatic draining non-freeze wall hydrant with integral backflow preventer.
3. Operation: Loose key.
4. Provide length required to match wall thickness.
5. Nozzle and Wall-Plate Finish: Chrome plated cast bronze.
6. Operating Keys(s): Two with each wall hydrant.

B. Interior Hot & Cold Water Wall Hydrants WH-2:

1. Manufacturers: Acorn model 8156 or equal.
2. Provide Acorn Recessed Hose Box model 8156 with Wall Flange.
3. Box shall be fabricated with 18 gage, type 304 stainless steel, with a satin finished exterior. Flange shall be 16 gage stainless steel and be polished to a satin finish. Door shall be 16 gauge with satin finish and removable hinge and cylinder lock
4. Valve shall be cartridge-operated type with vandal-resistant lock shield, removable loose key wheel handle and screwdriver operated stops.
5. Provide hydrant with vacuum breaker.

2.8 ROOF HYDRANTS

A. Non-freeze, Draining-Type Roof Hydrants RH-1:

1. Manufacturers: Woodford Manufacturing Company; a division of WCM Industries, Inc Model SRH-MS or equal.
2. Standard: ASSE 1052 and 1057, ASME A112.21.3M.
3. Type: Non-freeze, exposed-outlet roof hydrant.
4. Operation: Lever Lock with plunger.
5. Casing and Operating Rod: cast iron underdeck flange with EDPM boot cover and 35 ½” operating rod.
6. Casing: 1 ¼”.
7. Inlet: NPS 3/4 (DN 20).
8. Outlet: Garden-hose thread complying with ASME B1.20.7.
9. Drain: Designed with hole to drain to indirect waste inlet when shut off.
10. Vacuum Breaker:

    a. Non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters

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

    a. AMTROL, Inc.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

e. Tyler Pipe; Wade Div.
f. Watts Drainage Products Inc.
g. Zurn Plumbing Products Group; Specification Drainage Operation.

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

2.10 TRAP-SEAL PRIMER VALVES

A. Trap-Seal Primer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products conforming to ASSE 1018 manufactured by one of the following:

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

2. Body: Bronze.
3. Inlet and Outlet Connections: NPS 1/2 threaded or solder joint.
4. Gravity Drain Outlet Connection: NPS ½ threaded or solder joint.
5. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.11 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, provide products conforming to ASSE 1044 and manufactured by Precision Plumbing Products Inc. or equal.
2. Piping: NPS 3/4, ASTM B 88, Type L copper, water tubing.
3. Cabinet: Surface-mounting steel box with stainless-steel cover.
4. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
5. Vacuum Breaker: ASSE 1001.

2.12 FLEXIBLE CONNECTORS

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

1) Working-Pressure Rating: Minimum 200 psig.
2) End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3) End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

B. Stainless Steel-Hose Flexible Connectors: Corrugated-stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.

1) Working-Pressure Rating: Minimum 200 psig.
2) End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.

3) End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet. Install thermometers and water regulators if specified. Install cabinet-type units recessed in or surface mounted on wall as specified.

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

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

D. Install outlet boxes recessed in wall.

E. Install non-freeze, nondraining-type post hydrants set in concrete or pavement.

F. Connect drain piping from roof hydrant and route to nearest indirect waste termination.

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

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

I. 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.

J. 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 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each vacuum breaker, reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

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

3.3 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. Adjust each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check, backflow-prevention assembly an double-check, detector-assembly backflow preventer in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

END OF SECTION 22 11 20

SECTION 22 11 30 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes all bronze and bronze fitted in-line pumps used in domestic water systems.

1.3 SUBMITTALS

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

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

1.4 QUALITY ASSURANCE

A. The installation shall comply with the requirements of the 2009 International Plumbing Code and any applicable local code amendments. Verify the code with requirements with the local code officials before beginning the work.

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

B. Protect bearings and couplings against damage.

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

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL PUMPS

A. Subject to compliance with requirements, provide pumps manufactured by one of the following:

1. Armstrong Pumps Inc.
2. Bell & Gossett Domestic Pump; ITT Corporation.
3. PACO.
4. TACO Incorporated.

B. Description: Factory-assembled and -tested, in-line, single-stage all bronze centrifugal pumps. Pumps to be suitable for operation at 225 degrees F and a working pressure of 175 psig.

C. Pump Construction:

1. Casing: all bronze.
2. Impeller: cast bronze, statically and dynamically balanced, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
4. Coupling: Flexible.
5. Seal: internal flush mechanical seal, stainless-steel spring, ceramic seat, and Buna bellows and gasket.
6. Bearings: permanently lubricated.
7. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

D. Motor: Single speed, with permanently lubricated ball bearings; and mounted to pump casing. Motors to be non-over loading.

E. Pump capacities and operating characteristics are noted on the drawings.

2.2 CONTROLS

A. Provide programmable seven-day electronic time clock with manual override.

1. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
2. Operation of Pump: On or off.
3. Transformer: Provide if required.
4. Power Requirement: 24-V ac or 120-V ac.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PUMP INSTALLATION

A. Install in-line centrifugal pumps according to the manufacturer’s instructions.

B. Install continuous-thread hanger rods of size required to support pump weight.

C. Install thermostats in hot-water return piping.

D. Install timers including all control wiring.

E. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 CONNECTIONS

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

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

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

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the pumps.
2. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping.
3. Install pressure gauge at suction of each pump and pressure gauge at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps.

D. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.4 IDENTIFICATION

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

3.5 STARTUP SERVICE

A. Perform startup service:

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

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

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

3.6 ADJUSTING

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

B. Adjust initial temperature set points.

END OF SECTION 22 11 30

SECTION 22 13 11 - 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 soil, waste, and vent piping inside the building.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

B. The installation shall comply with the requirements of the International Plumbing Code (I.P.C.) and any applicable local code amendments. Verify the code with requirements with the local code officials before beginning the work.

C. All sanitary piping and fittings are required to bear the identification of the manufacturer as required in Chapter 3; 303.1 of the IPC. PVC pipe and fittings shall be third party certified per the requirements of the I.P.C.

D. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and shall be Third Party Tested per the requirements of the I.P.C.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Hub and Spigot Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A 74. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute® and listed by NSF® International. Pipe and fittings to be Service (SV) class.

B. Provide joints using a compression gasket manufactured from an elastomer meeting the requirements of ASTM C 564 or lead and oakum.

C. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and applicable code requirements.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Hubless Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A 888 and CISPI Standard 301. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute ® and listed by NSF® International.

B. Hubless Couplings shall conform to ASTM C 1540 for heavy duty couplings. Gaskets shall conform to ASTM C 564.

C. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and applicable code requirements. Couplings shall be installed in accordance with the manufacturer's band tightening sequence and torque recommendations. Tighten bands with a properly calibrated torque limiting device.

2.4 COPPER TUBE AND FITTINGS

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

1. Copper Drainage Fittings: cast copper or wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), 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. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

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

2.5 PVC PIPE AND FITTINGS

A. Pipe and fittings shall be manufactured from virgin rigid PVC (polyvinyl chloride) vinyl compounds with a Cell Class of 12454 as identified in ASTM D 1784.

B. PVC Schedule 40 pipe shall be Iron Pipe Size (IPS) conforming to ASTM D 1785 and ASTM D 2665. PVC DWV fittings shall conform to ASTM D 2665. Pipe and fittings shall be manufactured as a system and be the product of one manufacturer. All pipe and fittings shall be manufactured in the United States. All systems shall utilize a separate waste and vent system. Pipe and fittings shall conform to NSF International Standard 14.

C. Adhesive Primer: ASTM F 656.

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

D. Solvent Cement: ASTM D 2564.

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

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, condensate drain, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:

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

C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger shall be:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

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

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel rigid, couplings; and hubless-coupling joints.

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

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

F. Underground, soil, waste, and vent piping shall be:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Refer to the contract drawings which indicate areas where the installation of PVC pipe is prohibited. Kitchen equipment discharge and mechanical room services.

3.2 EXCAVATION AND BACKFILL

A. Provide all excavation and backfill required for underground piping installations. Perform excavation and backfill work conforming to the requirements of Section 306, Trenching, Excavation and Backfill, of the International Plumbing Code.

3.3 PIPING INSTALLATION

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

B. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

C. 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."

D. Underground PVC piping: Installation shall comply with the latest installation instructions published by the manufacturer and shall conform to all applicable plumbing code requirements. Buried pipe shall be installed in accordance with ASTM D 2321 and ASTM F 1668. Solvent cement joints shall be made in a two step process with primer conforming to ASTM F 656 and solvent cement conforming to ASTM D 2564. The system shall be protected from chemical agents, fire stopping materials, thread sealant, plasticized vinyl products, or other aggressive chemical agents not compatible with PVC compounds. Systems shall be hydrostatically tested after installation.

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: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 1 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.

H. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

I. Where existing below slab sanitary laterals are connected to a new below slab branch or main pipe extension, the Contractor shall investigate and verify the existing piping condition and ensure functionality prior to connection. The Contractor shall utilize ground penetrating radar to locate existing below slab piping and investigate by using pipeline inspection gauge (PIG) or “push camera” and provide video recording for review.

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

K. Install radon pipe in locations detailed on the contract drawings.

3.4 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

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.

3.5 VALVE INSTALLATION

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

1. Install full-port ball valve for piping NPS 2 (DN 50) and smaller.
2. Install butterfly valve for piping NPS 2-1/2 (DN 65) and larger.

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

C. Backwater Valves: Install backwater valves where indicated.

3.6 HANGER AND SUPPORT INSTALLATION

A. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. All sizes: 60 inches.
2. Hangers spacing may be increased to 10’-0” when 10-foot lengths of pipe are used.

B. Install supports for vertical cast-iron soil piping every 15 feet and at all floors.

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

1. NPS 1-1/4: 72 inches.
2. NPS 1-1/2 and larger: 120 inches.

D. Install supports for vertical copper tubing every 10 feet and at all floors.

3.7 CONNECTIONS

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

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

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

3.8 FIELD QUALITY CONTROL

A. Test systems according to procedures of authorities having jurisdiction or, in absence of such procedures, testing shall be per the requirements on the International Plumbing Code Section 312, Test and Inspections.

B. Piping Inspections: coordinate all inspection requirements with the Authorities Having Jurisdiction. Do not enclose, cover, or put piping into operation until it has been inspected and approved.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 13 11

SECTION 22 13 20 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes sanitary drainage piping specialties.

1.3 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals. Provide wiring diagrams for power, signal, and control wiring, where applicable.

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

1.4 QUALITY ASSURANCE

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

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.

1.5 COORDINATION

A. Coordinate size and location of concrete bases where applicable. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Cast-Iron Backwater Valves:

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

    a. Josam Company; Josam Div.
    b. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.

c. Tyler Pipe; Wade Div.
d. Watts Drainage Products Inc.
e. Zurn Plumbing Products Group; Specification Drainage Operation.

2.2 CLEANOUTS

A. Provide cleanouts and all required accessories manufactured by one of the following:

1. Josam Company.
2. Smith, Jay R. Mfg. Co.
3. Tyler Pipe; Wade Div.
4. Watts Drainage Products Inc.
5. Zurn Plumbing Products Group.

B. Brass cleanout plugs shall conform to ASTM A74, ASME A112.3.1 or ASME A112.36.2N.

C. Cleanout locations and details are indicated on the drawings and noted in Part 3.

2.3 FLOOR DRAINS

A. Provide cast-iron and/or stainless-steel floor drains per the model numbers indicated on the drawings included all required accessories. Provide drains manufactured by one of the following:

1. Josam Company; Josam Div.
2. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
3. Tyler Pipe; Wade Div.
4. Watts Drainage Products Inc.
5. Zurn Plumbing Products Group.

B. Floor drains shall conform to the requirements of Section 412 of the International Plumbing Code.

C. Floor drains to have removable strainers and constructed so the drain can be cleaned.

2.4 DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Barrier-Type Trap Seal Devices:

1. Description: Elastomeric, normally closed seal to prevent evaporation and protect against sewer gases from entering habitable spaces. Inlet and outlet shall match connected piping and assembly shall conform to ASSE 1072.

D. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

E. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counter flashing.

2.5 SOLIDS INTERCEPTORS

A. Interceptors are shown on the drawings. Provide the applicable model and all required accessories manufactured by one of the following:

1. Josam Company; Josam Div.
2. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
3. Tyler Pipe; Wade Div.
4. Watts Drainage Products Inc.
5. Zurn Plumbing Products Group.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping where indicated on the drawings. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts in piping located 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. If cleanout is more than 2-inches from wall surface, provide pipe extension to wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
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 fixture air-admittance valves on fixture drain piping.

G. Install stack air-admittance valves at top of stack vent and vent stack piping.

H. Install air-admittance-valve wall boxes recessed in wall.

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

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

K. Install through-penetration firestop assemblies at floor penetrations.

L. Install deep-seal traps on floor drains and other waste outlets, if indicated.

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

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

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

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

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

Q. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

R. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

S. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

T. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

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

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

3.2 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. 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. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 20

SECTION 22 13 23 - SANITARY WASTE INTERCEPTORS

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. Grease interceptors.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. PP: Polypropylene.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of interceptor. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

B. Shop Drawings: For each type and size of precast-concrete interceptor indicated.

1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Piping connections. Include size, location, and elevation of each.
2. Interface with underground structures and utility services.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste interceptors to include in emergency, operation, and maintenance manuals.

1.7 FIELD CONDITIONS

A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:

1. Notify Architect and Owner no fewer than seven days in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer services without Architect's written permission.

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS

A. Cast-Iron or Steel Grease Interceptors:

1. JR Smith Manufacturing or Zurn industries.
2. Standard: PDI G101 and ASME A112.14.3, for intercepting and retaining FOG from food preparation or -processing wastewater.
3. PDI Seal: Required.
4. Body Material: Cast iron or steel.
5. Interior Lining: Corrosion-resistant enamel.
6. Exterior Coating: Corrosion-resistant enamel.
7. Body Dimensions: 35”X20.75”X24.25”.
8. Body Extension: Required, verify dimension required in field.
9. Capacities and Characteristics:

a. Number of Compartments: Two.
b. Flow Rate: 50 GPM.
c. Retention Capacity: 100 lb.
d. Inlet and Outlet Pipe Size: 4” NPS.
e. Vent Pipe Size: Not required.
f. Mounting: Recessed, flush with floor.
g. Flow-Control Fitting: Not required.
h. Operation: Manual cleaning.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION

A. Equipment Mounting:

B. Set interceptors level and plumb.

C. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
2. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
3. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in Section 221311 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.4 IDENTIFICATION

A. Identification materials and installation are specified in Section 312000 "Earth Moving."

1. Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
2. Use warning tapes or detectable warning tape over ferrous piping.
3. Use detectable warning tape over nonferrous piping and over edges of underground structures.

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

1. Grease interceptors.

3.5 PROTECTION

A. Protect sanitary waste interceptors from damage during construction period.

B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 22 13 23

SECTION 22 14 11 - 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 storm drainage piping and accessories located inside the building.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

B. The installation shall comply with the requirements of the International Plumbing Code (I.P.C.) and any applicable local code amendments. Verify the code with requirements with the local code officials before beginning the work.

C. All storm drainage piping and fittings are required to bear the identification of the manufacturer as required in Chapter 3; 303.1 of the IPC. PVC pipe and fittings shall be third party certified per the requirements of the I.P.C.

D. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and shall be Third Party Tested per the requirements of the I.P.C.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Identification: Each length of pipe and each pie fitting, trap, fixture material and device utilized in a plumbing system shall bear the identification of the manufacturer.

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

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Hub and Spigot Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A 74. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute® and listed by NSF® International. Pipe and fittings to be Service (SV) class.

B. Joints can be made using a compression gasket manufactured from an elastomer meeting the requirements of ASTM C 564 or lead and oakum.

C. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and applicable code requirements.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Hubless Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A 888 and CISPI Standard 301. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute ® and listed by NSF® International.

B. Hubless Couplings shall conform to ASTM C 1540 for heavy duty couplings. Gaskets shall conform to ASTM C 564.

C. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and applicable code requirements. Couplings shall be installed in accordance with the manufacturer's band tightening sequence and torque recommendations. Tighten bands with a properly calibrated torque limiting device.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

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

C. Adhesive Primer: ASTM F 656: Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564: Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 SPECIAL PIPE FITTINGS

A. Flexible, Non-pressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

   a. Dallas Specialty & Mfg. Co.
   b. Fernco, Inc.
   c. Logan Clay Products Company (The).
   d. Mission Rubber Co.

2. Sleeve Materials:

   a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.

2.6 ROOF DRAINS

A. Provide ABS roof drains per model numbers indicated on the drawings. Provide the applicable model drain and all required accessories including the proper height extension, under deck clamp and sump receiver (except on poured-in –place decks) manufactured by one of the following:

1. Josam Company; Josam Div.
2. Jay R. Smith Mfg. Co.
3. Tyler Pipe; Wade Div.
4. Watts Drainage Products Inc.
5. Zurn Plumbing Products Group.

B. Strainers shall have an available inlet area, above the roof level, of not less than 1.5 times the area of the conductor to which the drain is connected.

2.7 CLEANOUTS

A. Provide cleanouts and all required accessories manufactured by one of the following:

1. Josam Company.
2. Smith, Jay R. Mfg. Co.
3. Tyler Pipe; Wade Div.
4. Watts Drainage Products Inc.
5. Zurn Plumbing Products Group.

B. Brass cleanout plugs shall conform to ASTM A74, ASME A112.3.1 or ASME A112.36.2N.

C. Cleanout locations and details are indicated on the drawings and noted in Part 3.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

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

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.
3. PVC pipe and socket fittings with solvent cemented joints in exterior canopies.

B. Aboveground, storm drainage piping NPS 8 and larger shall be:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

C. Underground storm drainage piping shall be:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. PVC pipe and socket fittings with solvent cemented joints.

3.2 EXCAVATION AND BACKFILL

A. Provide all excavation and backfill required for underground piping installations. Perform excavation and backfill work conforming to the requirements of Section 306, Trenching, Excavation and Backfill, of the 2015 International Plumbing Code.

3.3 ROOF DRAIN INSTALLATION

A. Roof drains shall be furnished to the Roofing Contractor for installation.

3.4 PIPING INSTALLATION

A. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas. Where piping is to be exposed, install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

B. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

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

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

D. Install underground PVC piping according to ASTM D 2321.

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. Minimum 1 percent downward in direction of flow.

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

I. Where existing below slab storm or RWC laterals are connected to a new below slab branch or main pipe extension, the Contractor shall investigate and verify the existing piping condition and ensure functionality prior to connection. The Contractor shall utilize ground penetrating radar to locate existing below slab piping and investigate by using pipeline inspection gauge (PIG) or “push camera” and provide video recording for review.

3.5 JOINT CONSTRUCTION

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

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

C. PVC Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.6 CLEANOUTS

A. Install cleanouts in piping, where indicated on the drawings and according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate cleanouts at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

3.7 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports:

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

a. MSS Type 1, adjustable, steel clevis hangers.

B. Install hangers for cast-iron soil piping with the following maximum horizontal spacing:

1. All sizes: 60 inches.
2. Hanger spacing for 10-foot pipe lengths, without fittings, may be increased to 10 feet.

C. Install supports for vertical cast-iron soil piping every 15 feet and at all floors.

3.8 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.

3.9 FIELD QUALITY CONTROL

A. Test systems according to procedures of authorities having jurisdiction or, in absence of such procedures, testing shall be per the requirements on the International Plumbing Code Section 312, Test and Inspections.

B. Piping Inspections: coordinate all inspection requirements with the Authorities Having Jurisdiction. Do not enclose, cover, or put piping into operation until it has been inspected and approved.

3.10 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 14 11

SECTION 22 16 20 – NATURAL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes natural gas piping, valves and accessories.

1.3 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping materials and specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.

B. Welding certificates.

C. Operation and Maintenance Data: For gas valves and other accessories.

1.4 QUALITY ASSURANCE

A. The installation shall conform to the requirements of the current International Fuel Gas Code and the requirements of the local utility company. Verify the code with requirements with the local utility before beginning the work.

B. Refer to the International Fuel Gas Code, Section 107, for the requirements of Inspections and Testing. Coordinate requirements with the applicable code officials and the utility company representatives.

C. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

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

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

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

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to any portion of the existing occupied facilities until receiving permission. If interruption of the existing service is required, coordinate the work with the Owner and, if necessary, perform the work at a time, other than normal working hours, which is suitable to the owner.

1.7 COORDINATION

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

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces.

C. Coordinate and schedule the main gas service installation with the local utility supplier. Prepare any permits and\or applications that may be required by the utility.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40.

1. Malleable-Iron Threaded Fittings: ASME B1.20.1.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding."
3. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. PE Pipe: ASTM D 2513.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE pipe shall be marked “GAS” and “ASTM D 2513.”

C. Press-Fit Joint Piping Systems: Provide MegaPressG products manufactured by Viega LLC.

1. Carbon steel ASTM A53 and A106 Schedule 40.
2. Cold Press Mechanical joint fittings: ASTM A420, ASTM B16.3 and performance criteria AMSI LC-4/CSA 6. 32.
3. Fittings:

a. Cold Press Mechanical Joint Fitting shall conform to material requirements of ASTM A420 or ASME B16.3 and performance criteria ANSI LC-4/CSA 6.32.

b. Sealing elements for press fittings shall be HNBR. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer.
c. Press ends shall have SC (Smart Connect™) technology design (leakage path). MegaPressG fittings with Smart Connect technology assure leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.

4. Verify pipe and fittings with applicable codes.
5. Piping and fittings shall comply with ANSI LC-4/CSA 6.32 and the latest edition of NFPA-54.
6. Fittings shall comply to the requirements of ASTM F3226.

D. Valves: Valves shall conform to the performance criteria ANSI LC-4/CSA 6.32.

1. Metallic Valves shall comply with ASME B16.33.

2.2 Cathodic Protection

A. Provide a complete electrically isolated, cathodic protection system for entire length of underground gas line, including all components, suitable for temperatures and pressures involved.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Flexible Metal Connectors: Comply with ANSI Z21.75, UL 536.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches (1830 mm).

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

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

2.5 MANUAL GAS SHUTOFF VALVES

A. Shut off valves are to conform to the requirements of the International Fuel Gas Code and the following standards, depending on gas pressure and application:

1. ANSI Z21.15.
2. ASME B16.44
3. ASME B16.33

B. General Requirements for Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig (862 kPa).
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.33.

1. CWP Rating: 125 psig (862 kPa).
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated bronze.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Threaded-body packnut design with adjustable-stem packing.
6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. CWP Rating: 600 psig (4140 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 MOTORIZED GAS VALVES

A. Automatic Gas Valves: Comply with ANSI Z21.21.

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

    a. ASCO Power Technologies, LP; Division of Emerson.
    b. Eaton Corporation; Controls Div.
    c. Eclipse Combustion, Inc.
    d. Honeywell International Inc.

2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. Normally closed.
6. Visual position indicator.

B. Electrically Operated Valves: Comply with UL 429.

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

    a. ASCO Power Technologies, LP; Division of Emerson.
    b. Eclipse Combustion, Inc.
    c. Goyen Valve Corp.; Tyco Environmental Systems.
    d. Magnatrol Valve Corporation.
    e. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
    f. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

2. Pilot operated.
3. Body: Brass or aluminum.
4. Seats and Disc: Nitrile rubber.
5. Springs and Valve Trim: Stainless steel.
6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
7. NEMA ICS 6, Type 4, coil enclosure.
8. Normally closed.
9. Visual position indicator.

2.7 PRESSURE REGULATORS

A. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Overpressure Protection Device: Factory mounted on pressure regulator.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 5 psig.

B. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Body and Diaphragm Case: die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
8. Maximum Inlet Pressure: 5 psig.

2.8 DIELECTRIC FITTINGS

A. Dielectric Unions:

1. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
2. Combination fitting of copper alloy and ferrous materials.
3. Insulating materials suitable for natural gas.
4. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.9 LABELING AND IDENTIFYING

A. Provide pipe identification for all gas piping installed within the building. The identification markers shall have a yellow label with the word “GAS” marked in black letters. Spacing shall be per the requirements of the International Fuel Gas Code. Where there are two or more meters the piping for each system shall be labeled so that the piping system supplied by each meter is identifiable.

B. Below Grade Gas Piping: Provide warning tape per the following:

1. Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 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.

3.2 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 5 PSIG

A. Aboveground branch piping shall be:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

B. Underground, below building, 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.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

D. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.3 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Two-piece, full-port, bronze ball valves with bronze trim.

3.4 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.5 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

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

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

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

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

G. All piping to be installed a minimum of 4” above grade. Where gas piping is located on a roof surface, the pipe is shall be a minimum of 4’ above the surface and properly supported.

H. Install pressure gage upstream and downstream from each service regulator.

3.6 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 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. 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. Locate valves for easy access.

F. Install natural-gas piping with a slope conforming to the requirements of the International Fuel Gas Code. Install piping free of sags and bends. Install fittings for changes in direction and branch connections.

G. Install escutcheons at penetrations of interior walls, ceilings, and floors.

H. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials.

I. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

    1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

J. Extend relief vent connections to service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap. Where regulators or other devices requiring a vent connection are located on the outdoors, provide vent cap on the relief vent connection.

K. 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.

L. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

M. Connect branch piping from top or side of horizontal piping.

N. 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.

O. Do not use natural-gas piping as grounding electrode.

P. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

Q. Install pressure gage upstream and downstream from each line regulator.

3.7 VALVE INSTALLATION

A. Install a manual gas shutoff valve, in an accessible location, at the gas connection to all gas fired equipment and/or gas fueled appliances. Shutoff valves to be installed per the following requirements:

1. The valve is to be located within the same room as the equipment.
2. The valve is to be located within 6'-0" of the equipment.
3. The valve shall be installed upstream of the union, connector or disconnect device.

B. Shutoff valves connected to emergency generators and other gaseous fueled equipment are to be installed per NFPA 37.

3.8 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

B. 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.

C. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.9 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports shall conform to the requirements of MSS SP-58.

B. Support vertical piping at base and at each floor with a maximum spacing of 120".

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS ¾ and NPS 1: Maximum span, 96 inches.
2. NPS 1-1/4 and larger: Maximum span, 120 inches.

3.10 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.11 LABELING AND IDENTIFYING

A. Provide Identification and Labeling of all gas piping systems and components as required by the International Fuel Gas Code.

B. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below sub-grade under pavements and slabs.

3.12 PAINTING

A. Paint all exposed, exterior steel piping, valves, service regulators, service meters and meter bars, valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.
2. Prime Coat: Alkyd anticorrosive metal primer.
3. Intermediate Coat: Exterior alkyd enamel matching topcoat.
4. Topcoat: Exterior alkyd enamel semigloss.
5. Color: Gray.

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

3.13 FIELD QUALITY CONTROL

A. Perform all required tests and inspections. Refer to Section 406 of the International Fuel Gas Code for requirements.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.14 DEMONSTRATION

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

END OF SECTION 22 16 20

SECTION 22 33 09 – TANKLESS 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. Section includes Tankless Electric Domestic Water Heaters and accessories.

1.3 SUBMITTALS

A. Product Data: For each domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Provide wiring diagrams for power, signal, and control wiring.

C. Domestic Water Heater Labeling: All Tankless Electric Domestic Water Heaters shall be third party certified per the requirements of the International Plumbing Code.

D. Warranty: Provide Manufacturer’s warranty.

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

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain all Tankless Electric Domestic Water Heaters through one source and from a single manufacturer, regularly engaged in production of the required components.

B. Electrical Components are to be UL Listed and labeled.

1.5 WARRANTY

A. Warranty: Manufacturer shall provide a warranty to replace the Electric Heating Element at any time up to one year past the date of substantial completion.

PART 2 - PRODUCTS

2.1 TANKLESS ELECTRIC DOMESTIC-WATER HEATERS

A. Manufacturers: Subject to compliance with requirements, provide Tankless Electric Domestic Water Heaters manufactured by Bradford White. Subject to review, equipment meeting the full requirements of

the specifications and any project installation limitations and manufactured by the following will be considered:

1. Bosch.
2. Rheem.
3. A. O. Smith

B. Tankless heater(s) to provide the recovery rate as indicated on the contract drawings at the indicated KW and voltage. Heater to have baked-on enamel steel cover.

C. Provide integral flow restrictor and high temperature safety limit switch.

D. Electric heating element shall be a replaceable cartridge insert type. Provide a replaceable filter in cold water inlet connector. The heating element shall be iron free, nickel-chrome material.

E. Heater shall be provided compression nuts and sleeves or NPT fittings to eliminate need for soldering. Maximum operating pressure of the heater is 150 psi.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Install Tankless Electric Domestic Water Heaters per the manufacturer's installation instructions maintaining recommended clearances on all sides of the unit. Install unit(s) so controls and devices that require servicing are accessible.

B. Install shut-off valves at the heater cold and hot water connections.

C. Fill water heaters with water prior to energizing.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections as recommended by the manufacturer.

B. Leak Test: After installation fill system and test for leaks. Repair leaks and retest until no leaks exist

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare final test and inspection reports.

3.3 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain tankless electric domestic-water heaters.

END OF SECTION 22 33 09

SECTION 22 40 00 – PLUMBING FIXTURES

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 conventional plumbing fixtures and related components.

1.3 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow control rates.

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

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

D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

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

1.5 WARRANTY

A. All equipment, material and labor provided under this specification section shall be warranted for a period of one year after project completion.

1.6 EXTRA MATERIALS

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

1. Faucet Washers and O Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Sloan Valve Company.
2. Zurn Plumbing Products Group
3. American Standard
4. Kohler Co.

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

1. Sloan Valve Company.
2. Zurn Plumbing Products Group.
3. Kohler Co.
4. American Standard

C. Shower Systems and Valves: Subject to compliance with requirements, provide products by one of the following:

1. Aquarius Bathware
2. Powers; a Watts Industries Co.
3. Comfort Designs.

D. Water Coolers: Subject to compliance with requirements, provide products by one of the following:

1. Acorn Engineering Company.
2. Oasis
3. Halsey Taylor.

E. Flushometers: Subject to compliance with requirements, provide products by one of the following:

1. Sloan Valve Company.
2. Zurn Plumbing Products Group; Commercial Brass Operation.

F. Toilet seats: Subject to compliance with requirements, provide products by one of the following:

1. Bemis Manufacturing Company.
2. Church Seats.
3. Eljer.
4. Kohler Co.
5. Olsonite Corp.

G. Fixture Supports: Subject to compliance with requirements, provide products by one of the following:

1. Josam Company
2. Smith, Jay R. Mfg. Co.

3. Tyler Pipe; Wade Div.
4. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
5. Zurn Plumbing Products Group; Specification Drainage Operation.

H. Faucets: Subject to compliance with requirements, provide products by one of the following:

1. T & S Brass and Bronze Works, Inc.
2. Delta Faucet Company.

I. Commercial Sinks: Subject to compliance with requirements, provide products by one of the following:

1. Acorn Engineering Company.
2. Advance Tabco
3. Elkay Manufacturing Co.
4. Just Manufacturing Company.
5. Eagle Group.

J. Protective Shielding Pipe Covers: Subject to compliance with requirements, provide products by one of the following:

1. TRUEBRO, Inc.
2. McGuire Manufacturing Co., Inc.
3. Plumberex Specialty Products Inc.

2.2 FIXTURES

A. F1 - Water Closet:

1. Sloan tank water closet system: WETS-8009.8110, elongated vitreous china bowl, 1.28 gallon per flush, pressure assist, floor mounted. Color shall be white.
2. Seat: White open front solid plastic.
3. Supply: Chrome angle supplies with loose key stop.

B. F2 - Water Closet - (ADA):

1. Sloan complete water closet system: WETS-2450.1001, elongated vitreous china bowl, 1.28 gallon per flush, siphon jet, wall mounted. Color shall be white.
2. Seat: White open front solid plastic.
3. Flush Valve: Sloan 111 Royal; 1.28 gpf: manual operated.
4. Hanger: J. R. Smith.

C. F3 - Lavatory:

1. Sloan wall hung lavatory model SS-3003; white vitreous china; self-draining deck; with contoured back and side splash shields; faucet ledge.
2. Faucet: T&S Brass commercial chrome ADA metering; model B-0831-VF05; 4” center-set, manual control metering faucet with escutcheon plate, 0.5 gpm max laminar flow discharge @ .25 or .20 gpc, ASSE 1070 mixing valve and integral checks.
3. Drain: chrome grid drain; chrome tailpiece and P-trap.
4. Supplies: chrome angle supplies with loose key stops.
5. Lav Guard: Truebro Lav Guard molded insulation kit.
6. Carrier: J. R. Smith.

D. F4 - Lavatory - (ADA):

1. Sloan undermount lavatory model SS-3001; white vitreous china; with front overflow.
2. Faucet: T&S Brass Model B-2711-VF05 chrome ADA single lever; 4" center-set, manual control single lever faucet with escutcheon plate, 0.5 gpm max laminar flow discharge @ .5 or .20 gpc, ASSE 1070 mixing valve and integral checks.
3. Drain: chrome grid drain; chrome tailpiece and P-trap.
4. Supplies: chrome angle supplies with loose key stops.
5. Lav Guard: Truebro Lav Guard insulation kit.

E. F5 – Tub / Shower

1. Aquarius Bathware AcrylX model G 3260 TS 3P; 60"x32.5"x74" white enclosure designed for three-piece installation, horizontal and vertical grab bars, premium curtain, curtain rod, molded soap dish and chrome strainer drain.
2. Powers ASSE 1016 thermostatic / pressure mixing valve model E707 with check-stops and lever handle, deluxe shower head, ½" diverter tub spout.

F. F6 - Sink:

1. Elkay single bowl model LRAD221955 type 304#18 stainless steel. 22"x19.5"x5 ½" deep. Three faucet holes and rear offset drain. The Plumbing contractor shall make final connections and provide all required valves, drain, fittings, traps etc.
2. Faucet; T&S Brass model B-1142-04; 8" gooseneck with wrist blade handles, 1.5 gpm.
3. Supplies: Chrome ¼ turn angle supplies – FIP x slip-joint with check stops and loose key handle.
4. Drain; LKAD35 offset tailpiece and strainer basket.

G. F7 - Sink:

1. Elkay single bowl model LRAD221955 type 304#18 stainless steel. 22"x19.5"x5 ½" deep. Three faucet holes and rear offset drain. The Plumbing contractor shall make final connections and provide all required valves, drain, fittings, traps etc.
2. Faucet; T&S Brass model B-1142-04; 8" gooseneck with wrist blade handles, 1.5 gpm.
3. Supplies: Chrome ¼ turn angle supplies – FIP x slip-joint with check stops and loose key handle.
4. Drain; LKAD35 offset tailpiece and strainer basket.

H. F8 - Sink:

1. Elkay single bowl model LRAD221955 type 304#18 stainless steel. 22"x19.5"x5 ½" deep. Three faucet holes and rear offset drain. The Plumbing contractor shall make final connections and provide all required valves, drain, fittings, traps etc.
2. Faucet; T&S Brass kitchen 8" gooseneck faucet with side pullout spray model B-1174, and deck plate, 2.2 gpm.
3. Supplies: Chrome ¼ turn angle supplies – FIP x slip-joint with check stops and loose key handle.
4. Drain; LKAD35 offset tailpiece and strainer basket.

I. F10 – ADA Shower:

1. Comfort Designs model XST 3838 TR 4P .75 white sanitary grade AcyLX surface shower stall designed for on slab installation, horizontal and vertical grab bars, premium curtain, curtain rod, factory installed padded fold-up seat and integral front trench drain.
2. Powers ASSE 1016 thermostatic / pressure mixing valve model E707 with check-stops and lever handle.
3. Powers e707 Hydroguard T/P Mixing valve with deluxe shower head and deluxe chrome ADA hand held shower system with 30" slide bar.; 2.0 gpm.
4. Powers model 141-600B diverter valve with lever handle.
5. ADA compliant collapsible threshold.

J. F11 - EWC with bottle filler:

1. Elkay Modular model HTHB-HAC8SS-WF barrier free bottle filling station, push button activated; rated for 8 gallons per hour at 50 deg F.; water filter system. Stainless steel finish.
2. Supply: provide isolation valve in an accessible location on the supply pipe.
3. Drain: provide chrome p-trap.
4. Voltage; 120-1-60.

K. F12 - Water Closet - (ADA): (Alternate Bid)

1. Sloan complete water closet system: WETS-2720.1001-STG, elongated vitreous china bowl, 1.28 gallon per flush, siphon jet, floor mounted. Color shall be white.
2. Seat: White open front solid plastic.
3. Flush Valve: Sloan 111 Royal; 1.28 gpf: manual operated.
4. Provide new floor seal.

L. F13 - Water Closet: (Alternate Bid)

1. Sloan complete water closet system: WETS-2700.1001-STG, elongated vitreous china bowl, 1.28 gallon per flush, siphon jet, floor mounted. Color shall be white.
2. Seat: White open front solid plastic.
3. Flush Valve: Sloan 111 Royal; 1.28 gpf: manual operated.
4. Provide new floor seal.

M. F14 - Water Closet - (ADA): (Alternate Bid)

1. Sloan complete water closet system: WETS-2450.1001, elongated vitreous china bowl, 1.28 gallon per flush, siphon jet, wall mounted. Color shall be white.
2. Seat: White open front solid plastic.
3. Flush Valve: Sloan 111 Royal; 1.28 gpf: manual operated.
4. Hanger: Existing to remain.

N. F15 - Water Closet: (Alternate Bid)

1. Sloan complete water closet system: WETS-2450.1001, elongated vitreous china bowl, 1.28 gallon per flush, siphon jet, wall mounted. Color shall be white.
2. Seat: White open front solid plastic.
3. Flush Valve: Sloan 111 Royal; 1.28 gpf: manual operated.
4. Hanger: Existing to remain.

O. F16 - Lavatory: (Alternate Bid)

1. Sloan wall hung lavatory model SS-3003; white vitreous china; self-draining deck; with contoured back and side splash shields; faucet ledge.
2. Faucet: T&S Brass Model B-2711-VF05 chrome ADA single lever; 4” center-set, manual control single lever faucet with escutcheon plate, 0.5 gpm max laminar flow discharge @ .5 or .20 gpc, ASSE 1070 mixing valve and integral checks.
3. Drain: chrome grid drain; chrome tailpiece and P-trap.
4. Supplies: chrome angle supplies with loose key stops.
5. Lav Guard: Truebro Lav Guard molded insulation kit.
6. Carrier: Existing to remain.

P. F17 – Wheelchair Lavatory: (Alternate Bid)

1. American Standard wall hung lavatory 9141.011; white vitreous china; Wheelchair users lav for concealed arm support.
2. Faucet: T&S Brass Model B-2711-VF05 chrome ADA single lever; 4" center-set, manual control single lever faucet with escutcheon plate, 0.5 gpm max laminar flow discharge @ .5 or .20 gpc, ASSE 1070 mixing valve and integral checks.
3. Drain: chrome grid drain; chrome tailpiece and P-trap.
4. Supplies: chrome angle supplies with loose key stops.
5. Lav Guard: Truebro Lav Guard molded insulation kit.
6. Carrier: Existing to remain.

Q. F18 - Lavatory - (ADA): (Alternate Bid)

1. Sloan undermount lavatory model SS-3001; white vitreous china; with front overflow.
2. Faucet: T&S Brass Model B-2711-VF05 chrome ADA single lever; 4" center-set, manual control single lever faucet with escutcheon plate, 0.5 gpm max laminar flow discharge @ .5 or .20 gpc, ASSE 1070 mixing valve and integral checks.
3. Drain: chrome grid drain; chrome tailpiece and P-trap.
4. Supplies: chrome angle supplies with loose key stops.
5. Lav Guard: Truebro Lav Guard insulation kit.

R. F19 - Urinal: (Alternate Bid)

1. Sloan Urinal and Flushometer Combo: WEUS-1000.1201, washdown vitreous china bowl, 0.125 gallon per flush, wall mounted. Color shall be white.
2. Flush Valve: Sloan Solis 8186; 0.125 gpf: battery sensor operated.
3. Hanger: Existing to remain.

S. F20 - Water Closet (Alternate Bid):

1. Sloan tank water closet system: WETS-8009.8110, elongated vitreous china bowl, 1.28 gallon per flush, pressure assist, floor mounted. Color shall be white.
2. Seat: White open front solid plastic.
3. Supply: Chrome angle supplies with loose key stop.

T. F21 – Sink (Alternate Bid):

1. Elkay single bowl model BPSR15 type 304#20 stainless steel. 15"x15"x6" deep. Two faucet holes and rear offset drain. The Plumbing contractor shall make final connections and provide all required valves, drain, fittings, traps etc.
2. Faucet; T&S Brass model B-0892; 4" gooseneck with wrist blade handles, 1.5 gpm.
3. Supplies: Chrome ¼ turn angle supplies – FIP x slip-joint with check stops and loose key handle.
4. Drain; LK36 offset tailpiece and strainer basket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. 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.

C. Use carrier supports with waste fitting and seal for back outlet fixtures.

D. Use carrier supports without waste fitting for fixtures with tubular waste piping.

E. Use chair type carrier supports with rectangular steel uprights for accessible fixtures.

F. Install back outlet, wall mounting fixtures onto waste fitting seals and attach to supports.

G. Install floor mounting fixtures on closet flanges or other attachments to piping or building substrate.

H. Install wall mounting fixtures with tubular waste piping attached to supports.

I. Install floor mounting, back outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

J. Install counter mounting fixtures in and attached to casework.

K. Install fixtures level and plumb according to roughing in drawings.

L. 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 if supply stops are not specified with fixture. Valves are specified in Division 22 Section "Valves."

M. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

N. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

O. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

P. Install toilet seats on water closets.

Q. Install faucet spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

R. Install water supply flow control fittings with specified flow rates in fixture supplies at stop valves.

S. Install faucet flow control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

T. Install shower flow control fittings with specified maximum flow rates in shower arms.

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

1. Seal joints between fixtures and walls, floors, and countertops using sanitary type, one part, mildew resistant silicone sealant. Match sealant color to fixture color.

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.

E. Install fresh batteries in sensor operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts. Remove sediment and debris from drains. 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. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 40 00

SECTION 23 00 10 - BASIC REQUIREMENTS – HVAC CONSTRUCTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for HVAC installations. Administrative and procedural requirements are included in this Section and in other Non-technical/Division 01 Specification Sections.

1.3 PERMITS AND FEES

A. Refer to Non-technical/Division 01 Specification Sections, General Conditions of The Contract, for information relating to permits and fees.

1.4 PROJECT SCHEDULE

A. Refer to Non-technical/Division 01 Specification sections for contract completion time and project construction schedule.

1.5 SHOP DRAWINGS AND SUBMITTALS

A. Follow the procedures specified in the Non-technical/Division 01 Specification Sections. Also refer to individual sections of the Division 23 specifications for additional shop drawing and submittal requirements.

B. It is the responsibility of the contractor to thoroughly review any and all shop drawings prior to submission to the Architect/Engineer. The contractor's review shall include verifying conformance to the project documents. The contractor will also be responsible for verifying the quantities of materials are adequate.

C. All shop drawings shall be submitted with a cover sheet indicating the name of the project, the Architects and Engineers name, the name of the vendor and the contractor. There must be sufficient space on the title sheet to allow the appropriate stamping by both the Architect and the Engineer. Shop drawings and submittals not conforming to the above may be returned without review.

D. All shop drawing submittals will include a listing of any and all exceptions to the requirements indicated in the specifications and on the drawings. Where there are no exceptions, the submittals shall indicate such. Submittals that do not have this listing will not be reviewed.

1.6 COORDINATION DRAWINGS

A. Coordination drawings are required. Refer to Non-technical/Division 01 Specification Sections for the work required by this Contractor in preparing Coordination Drawings.

1.7 INSTALLATION ACCESSIBILITY

A. The installation of all equipment and appurtenances shall be completed so that access and clearances meet the requirements of the equipment manufacturer as well as the requirements of all applicable codes.

1.8 ACCEPTABLE MANUFACTURES

A. The design of the mechanical systems is based on the equipment manufacturer indicated on the drawings. Although individual sections of the specifications may list other manufacturers, these manufacturers will be accepted only if the following occurs:

1. Performance, as judged by the engineer, must be equal to the design-based equipment.
2. Operating characteristics, as judged by the engineer, must be identical to those of the design-based equipment.
3. Physical size of the equipment must be such that it can be installed in the available space, maintaining all required clearances for access/maintenance and meet the architectural requirements of the project such as installed height, length, width and operating weight. The contractor shall be responsible for verifying the equipment meets this requirement.
4. The contractor will be responsible for any costs associated for adding additional supports, changes in electrical wiring, piping changes, ductwork changes and / or controls that may be required if equipment other than the design based is used.

1.9 RECORD DOCUMENTS

A. Prepare record documents, including Operating and Maintenance Manuals, in accordance with Non-technical/Division 01 Specification Sections. In addition to the requirements specified, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
4. Contract Modifications, actual equipment and materials installed.
5. Record Documents are to be prepared and/or revised to indicate the room names and numbers to be used by the owner after the projects is complete.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. When materials and products are stored on site, provide protection from weather and temperatures that may cause damage to the items.

1.11 EXTRA MATERIALS

A. Various Division 23 Specification Sections may indicate extra materials (filters, fan belts, etc.) that are to be provided with the respective equipment. Where indicated, the contractor shall provide the required extra materials.

B. When directed by the owner's representative, the contractor shall install extra filters in the respective equipment. If no additional installation is required, the contractor shall forward, to the owner, all extra materials. When forwarding materials obtain a receipt for any materials forwarded.

C. The contractor shall also provide a list of all filter sizes for each type and size of unit provided on the project.

1.12 WARRANTY

A. All equipment, material and labor provided by the contractor shall be warranted for a minimum period of one year after the date of substantial completion. Refer to Division 23 Technical Specification sections for additional Warranties that may be required.

PART 2 - PRODUCTS

2.1 Not Applicable.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Obtain equipment shop drawings for the various items that require rough-in.

3.2 HVAC INSTALLATIONS

A. Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Coordinate requirements for chases slots, and openings in other building components during the progress of construction, to allow for mechanical installations.
4. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
5. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
6. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.

8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
9. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
10. Install systems, materials, and equipment giving right-of-way priority to the systems required to be installed at a specified slope.
11. Seal all places where piping or ducts pass through walls and floors.

3.3 CUTTING AND PATCHING

A. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.
2. Removal and replacement of defective Work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Remove samples of installed Work as specified for testing.
5. Install equipment and materials in existing structures.

B. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. In areas of the building where new finishes are being provided, the patching required on a surface which is to receive a new finish will be to bring the underlying surface up to the finish required to receive the final finish. This contractor shall coordinate subsurface finish requirements with the finish trade contractor(s).

D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

E. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 CLEANING

A. This contractor shall be required to thoroughly clean all installed equipment, ductwork and piping. Cleaning shall be required before substantial completion on any phase of the project. Do not use cleaning materials and agents that are hazardous to health or property or that may damage the finished surfaces.

END OF SECTION 23 00 10

SECTION 23 00 30 – ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment specified under other Divisions or furnished by Owner.

1.2 REFERENCES

A. NEMA WD 1 - General Purpose Wiring Devices

B. NEMA WD 6 - Wiring Device Configurations.

C. ANSI/NFPA 70 - National Electric Code.

1.3 COORDINATION

A. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other Divisions.

1. Should there be a difference between the design and the installed equipment; change orders shall only be paid for the difference in the rough-ins. If the Division 26 Contractor installs any rough-ins prior to requesting and receiving shop drawings for the equipment to be installed, and the equipment is different than designed, the required rework shall be performed at no additional cost to the owner aside from the difference is cost between the design documents and installed equipment.
2. Should there be a need to install rough-ins ahead of equipment review and final shop drawing, the Division 26 Contractor shall submit a Request for Information, outlining the equipment to be fed, and how the schedule is impacted for review by the Engineer, Architect, Owner and Owner’s Representative.

B. Determined connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

D. Sequence electrical connections to coordinate with start-up schedule for equipment.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

A. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.

B. Cord Construction: Oil-resistant thermoset insulated Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.

C. Cord Size: Same as rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 PREPARATION

A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

B. The Contractor shall be responsible to coordinate all electrical which are installed for roof top equipment. Refer to “Coordination” in Section 260010 for additional requirements.

3.2 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.3 ELECTRICAL CONNECTIONS

A. Electrical connections shall meet equipment manufacturer's instructions.

B. Conduit connections to equipment shall use flexible conduit. Liquidtight flexible conduit with watertight connectors shall be used in damp or wet locations.

C. Wiring connections shall use wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Receptacle outlets shall be used where connection with attachment plug is indicated. Where attachment plug is required, equipment shall have a cord and cap.

E. Suitable strain-relief clamps and fittings shall be used for cord connections at outlet boxes and equipment connection boxes.

F. Disconnect switches, controllers, control stations, and control devices shall be located as indicated and per NEC requirements.

G. Verify proper rotation of three phase equipment.

H. Where applicable, power wiring shall be extended through external disconnect switches, local control switches, remote mounted control panels, etc. and connected to terminals in the equipment.

I. Where applicable, wire and conduit shall be extended between control device (start/stop pushbuttons or lighted handle switch) and combination starter/disconnect switches.

J. Coolers and Freezers: freezer and cooler walls, floors and ceilings shall be cut and sealed around conduit openings.

3.4 MISCELLANEOUS CONNECTIONS

A. Fire alarm, security, data, telephone and other low voltage connections shall be installed as required at equipment.

3.5 CONTRACTOR RESPONSIBILITIES (DIVISION 23 CONTRACT)

A. HVAC Control System Panels & Equipment Controls

1. 120 volt – 1 phase.
2. Division 23 Contractor shall provide power connection to control panel from nearest 120/208 volt electrical panel. Power for control panels for equipment being fed from the emergency generator, including, but not limited to boilers, heating pumps, selected air handling and terminal equipment, etc., shall be derived from the nearest 120/208 volt normal/emergency panel.
3. In addition to HVAC control system panels, where terminal equipment, including, but not limited to shut-off VAV boxes are provided with 120V connection, Division 23 Contractor shall provide power connection to the unit as described above.
4. Division 26 Contractor shall assist the Division 23 Contractor in locating the appropriate panel, ensure there is a spare 20A/1P breaker to feed the control panels and label breaker accordingly.
5. All wiring associated with the unit shall be by the Division 23 Contractor per manufacturer requirements.

B. Duct-mounted Smoke Detector

1. Division 26 Contractor shall furnish duct mounted smoke detector, including detector base and appropriately sized sampling tube for duct being installed.
2. Division 23 Contractor shall install sampling tube and detector base in duct. Coordinate exact location with Division 26 Contractor.
3. Division 26 Contractor shall install detector in base, wire and program into fire alarm system.
4. Division 26 Contractor shall provide relay, and wiring to associated HVAC unit from fire alarm system so that unit shuts down and supervisory signal is provided upon detection of smoke. Refer to Division 28 “Fire Alarm and Detection System” and drawings for additional requirements.
5. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

C. Ductless Air Conditioner (AC)

1. 208 volt – 1 phase.
2. 2-pole toggle switch shall be furnished and installed by the Division 26 Contractor adjacent to unit.
3. Division 26 Contractor shall wire through switch and make one power connection to the line side terminals in the unit.
4. Division 26 Contractor shall power the AC unit from the exterior unit. In systems where indoor unit receives separate power feed, provide junction box adjacent to the disconnect at the outdoor unit and run to the indoor unit for connection so that a single breaker controls both units.
5. All other wiring within the unit and between the unit and associated condensing unit shall be by the Division 23 Contractor per manufacturer requirements.

D. Air Cooled Condensing Unit (CU)

1. 208 volt – 1 phase.
2. Division 26 Contractor shall furnish and install a NEMA 3R fused disconnect switch at unit and shall extend power wiring thru switch to unit and shall make one connection to terminals in unit.
3. Where CU is associated with an indoor AC, power wire for AC unit shall come from the exterior unit. In systems where indoor unit receives separate power feed, provide junction box adjacent to the disconnect at the outdoor unit and run to the indoor unit for connection so that a single breaker controls both units.
4. All other wiring within the unit and between the unit and associated indoor unit shall be by the Division 23 Contractor per manufacturer requirements.

E. Indoor Fans – Manually Controlled (EF)

1. 120 volt – 1 phase
2. Wall switch shall be furnished and installed by the Division 26 Contractor.
3. Division 26 Contractor shall install Division 23 Contractor speed control in space being served by fan. Coordinate location in field for balancing.
4. Division 26 Contractor shall make one power connection thru wall switch and speed control where applicable.

F. Roof Fans – Reverse Acting T-Stat or ATC Controlled (EF)

1. 120, 208, 277 volt – 1 phase.
2. Integral disconnect switch provided by the equipment manufacturer.
3. Division 26 Contractor shall install Division 23 Contractor speed control in space being served by fan. Coordinate location in field for balancing.
4. Division 26 Contractor shall make one power connection through speed control where applicable.
5. Any other connections and/ or equipment required shall be provided by Division 23 Contractor.

G. Fan Powered Variable Air Volume Box (FPV)

1. 120, 277 volt - 1 phase.
2. Division 26 Contractor shall furnish and install a toggle switch for 1 phase units and non-fused disconnect switch for 3 phase units adjacent to unit and shall extend power wiring thru switch to unit and shall make one connection to terminals in units.
3. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

H. Kitchen Ventilation System (KVS-1 & KEF-1)

1. 480 volt - 3 phase.
2. A Demand Control Ventilation control panel, complete with VFD drives, interface screen, controls equipment, etc. shall be provided with the KVS housing drives and local disconnect. The Division 26 Contractor shall install the control panel at the hood. Field verify exact location to ensure ADA heights are maintained to the interface.
3. Division 26 Contractor shall make power connection to the VFD control panel and extend power wiring to rooftop make-up air unit fan and rooftop exhaust fan. Division 26 Contractor shall provide interlock wiring between fans and VFD control panel.
4. Division 26 Contractor shall make additional 120V connection to the KVS disconnect for IBT heaters and provide additional control wiring between the KVS and the VFD control panel per manufacturer requirements.
5. Division 23 Contractor shall furnish and install heat sensors. Division 26 Contractor shall interconnect the heat sensor and hood control panel so that unit starts when heat is sensed per IMC.
6. Division 26 Contractor shall provide wiring from VFD control panel to microswitches and provide 120V power. Division 26 Contractor shall provide interconnecting wiring from microswitches to the fire alarm system, gas solenoid and shunt trip breaker(s). Division 26 Contractor shall provide additional relays as required.
7. Division 26 Contractor shall provide 120V power to the control panel.
8. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

I. Kitchen Dishwasher Exhaust Fan (EF)

1. 120 volt – 1 phase.

2. Integral disconnect switch provided by the equipment manufacturer.
3. Division 23 Contractor shall provide all interlock wiring between exhaust fan and dishwasher machine.
4. Division 26 Contractor shall make one power connection to fan through equipment disconnect switch.
5. Any other connections and/or equipment required shall be provided by Division 23 Contractor.

J. Shut-off Air Terminal Unit (SOV)

1. Control power or 120 volt – 1 phase (contractor discretion).
2. Division 23 Contractor shall provide power to unit. Should 120 volt be selected, Division 23 Contractor shall provide power connection to unit from nearest 120/208 volt electrical panel. Power for units connected to air handling equipment connected to the emergency generator shall be derived from the nearest 120/208 volt normal/emergency panel. An attempt shall be made to minimize the quantity of breakers required by feeding multiple units from the same breaker, not exceeding 20 ampere of load on a single circuit.
3. Division 26 Contractor shall assist the Division 23 Contractor in locating the appropriate panel, ensure there is a spare 20A/1P breaker to feed the unit and label breaker accordingly.
4. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

3.6 CONTRACTOR RESPONSIBILITIES (DIVISION 22 CONTRACT)

A. Domestic Water Heater Electric (DWH)

1. 120, 208 volt – 1 phase.
2. Equipment manufacturer shall provide disconnect switch integral to unit.
3. Division 26 Contractor shall provide power wiring to unit disconnect switch and make one power connection.
4. Any other connections and/or equipment required shall be furnished and installed by the Division 22 Contractor.

B. Recirculating Pumps (CP)

1. 120 volt – 1 phase.
2. Thermal overload switch or starter/disconnect switch shall be furnished and installed by the Division 26 Contractor adjacent to the unit. Wire thru switch to pump motor.
3. Any other connections and/or equipment required shall be furnished and installed by the Division 22 Contractor.

C. Electric Water Cooler

1. 120 volt – 1 phase.
2. Division 26 Contractor shall refer to Electric Water Cooler shop drawings and furnish and install a duplex receptacle contained within the enclosure where applicable or provide direct connection where cord and plug is not provided.
3. Any other connections and/or equipment required shall be furnished and installed by the Division 22 Contractor.

3.7 CONTRACTOR RESPONSIBILITIES (GENERAL TRADES CONTRACT(S))

A. Food Service Equipment

1. The food service equipment will be furnished and installed under the Food Service Equipment Contract, but all related electrical work shall be provided by the Division 26 Contractor. Necessary Disconnect switches, starters, thermal switches, and special control devices will be furnished, installed and wired by the Division 26 Contractor. Division 26 Contractor shall install all necessary inter-connecting wiring within the equipment.
2. Division 26 Contractor is required to bring electrical service where required to make final connections. The exact locations for such will be determined by the Food Service Equipment Installer and such information will be furnished to the Division 26 Contractor.
3. Division 26 contractor shall secure roughing-in shop drawings prior to rough-in.
4. Installation of fractional horsepower equipment shall be made by installing a duplex outlet, 3-wire grounding type in wall behind the machine, except where floor outlets are indicated, and making final connection through a 3-wire cap with cord grip. Each machine shall be provided with approved grounding. Flexible feeders from junction boxes shall be provided as required.
5. Interlock wiring for condensing units, evaporative blower units, and lighting in walk-in cooler/freezer units shall be provided by the Division 26 Contractor unless otherwise noted on Food Service Contract drawings and specifications.
6. All work shall be installed in accordance with the standards and requirements of the NSF, DER, and NEC.

B. Powered Furniture

1. Division 26 Contractor shall acquire shop drawings for powered furniture and provide electrical connection per shop drawings. Should shop drawings differ from electrical drawings, contractor shall submit, in writing, changes prior to rough-in.
2. Division 26 Contractor shall provide all wiring, jacks, conduits and boxes for data wiring in furniture. Division 26 Contractor shall coordinate with the Installing Contractor to insure proper placement of jacks.

END OF SECTION 23 00 30

SECTION 23 05 00 – COMMON WORK REQUIREMENTS – HVAC CONSTRUCTION

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 materials and methods that are common to various HVAC installations.

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.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Mechanical sleeve seals.
2. Escutcheons.
3. Access Doors.

B. Welding certificates.

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

1.7 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.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

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

2.2 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

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

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

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

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

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

F. 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 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.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Pipe wall penetration seals to be of the modular link type. Seals shall consist of a series of interlocking, molded synthetic rubber links, with heavy-duty plastic pressure plates, and corrosion resistant nuts and bolts. Seals to be designed to provide a hydrostatic seal between the pipe and wall penetration. Seals shall be sized and selected per manufacturer recommendations. Mechanical pipe seals shall be fabricated of an EPDM elastomer for general service and a Nitrile/ Buna-N for hydrocarbon / petroleum-based applications. Provide stainless steel hardware as required.

B. Steel wall sleeve: Cast in place concrete wall sleeves to be fabricated from galvanized heavy wall welded or seamless carbon steel pipe. All sleeves to have a 2" wide, full perimeter water stop, welded on both sides.

C. Mechanical pipe seals and wall sleeves shall be manufactured by The Metraflex Company®, or Flexicraft Industries.

2.5 SLEEVES

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

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

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

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

2.6 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, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated and rough brass.

2.7 CONCRETE EQUIPMENT BASES

A. Minimum compressive strength: 3500 p.s.i. at 28 days.

B. Minimum cementitious material content: 520 lb/cu. Yd.

2.8 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 (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.9 ACCESS DOORS

A. Manufacturers: Subject to review, provide access doors manufactured by Milcor, Inc or equal.

B. Description: Steel access doors and frames for installation in masonry and/or drywall/gypsum board assemblies. Provide fire rated access doors when doors are installed in a fire rated assembly.

C. Frames: minimum 16 gage steel with exposed nominal 1” flange around the perimeter of the unit. Where doors are to be installed in drywall/gypsum board assemblies provide frames with a drywall bead. Doors to be installed in masonry shall be furnished with adjustable metal masonry anchors.

D. Flush Panel Doors: minimum 14-gauge steel with concealed spring or piano hinge(s) with a minimum swing of 175 degrees. Finished with a factory-applied primer, suitable for field painting. Provide flush cylinder lock with key. Key all locks alike.

E. Access door schedule: In addition to access door(s) that may be shown on the drawings provide the following access doors to be installed where directed by the architect or engineer:

1. Five 16” x 16” to be installed in drywall/gypsum construction.
2. Five 16” x 16” to be installed in masonry construction.

2.10 FIRESTOPPING

A. The contractor shall be responsible for providing permanent, UL approved firestopping systems for all penetrations through fire rated floor or fire rated wall assemblies. All firestopping shall meet the requirements of ASTM E-814 and UL 1479. Firestopping for ducts shall be installed with materials and

methods identified in UL Ventilation Duct Assemblies (HNLJ), V Series as applicable to the wall assembly specified.

B. Subject to compliance with project requirements, firestopping materials may be provided by one of the following manufacturers:

1. Specified Technologies Inc. (STI) Somerville, NJ.
2. Tremco, Beechwood, OH.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, 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. Where piping and ducts are exposed in areas such as mechanical rooms and boiler rooms the installation shall an unobstructed passageway of not less than 42” in width and 80” minimum head clearance, as required by code.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal. Install piping to permit valve servicing. Install piping at indicated slopes. Install piping free of sags and bends.

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

H. Install piping and pipe supports to allow application of insulation.

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

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

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

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

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

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

2. Install sleeves in all new walls and floor slabs as walls and slabs are constructed.

3. Install sleeves that are large enough to provide sufficient annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

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

      1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.

M. Aboveground and Underground, Exterior-Wall Pipe Penetrations: Provide Mechanical Sleeve Seal and wall sleeve.

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

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at all pipe and duct penetrations. Where required seal all pipe and duct penetrations with firestop materials.

O. Verify final equipment locations for roughing-in.

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

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 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, 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.

3.3 PIPING CONNECTIONS

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

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

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

B. Install equipment to maintain unobstructed passageway of not less than 42” in width and 80” minimum head clearance as required by code.

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

D. 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.

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

3.5 INSTALLATION OF PIPING UNDER EXISITNG FLOORS

A. Where the drawings indicate new piping is to be installed under existing slab-on-grade construction, the installing contractor will be required to verify the location(s) of any existing pipes, conduits or any other system components, that are required to remain in service, before saw cutting existing slabs.

3.6 CONCRETE EQUIPMENT BASES

A. Provide concrete bases for all floor mounted mechanical equipment unless otherwise noted on the contract drawings.

1. Construct concrete bases with a minimum height of 6” and extend bases not less than 6” larger, in all directions, than supported equipment.
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 and according to anchor-bolt manufacturer's written instructions.
6. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project when applicable.

3.7 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors. Clean surfaces that will come into contact with grout.

B. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment.

C. Place grout around anchors. Cure placed grout.

3.8 ACCESS DOORS

A. Comply with manufacturer's written instructions for installing access doors and frames. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces. Install doors flush with adjacent finish surfaces or recessed to receive finish material.

B. Adjust doors and hardware after installation for proper operation. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 23 05 00

SECTION 23 05 30 - METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Thermometers, Gauges, Test plugs and accessories.

1.3 SUBMITTALS

A. Submit Product Data for type of product.

B. Provide operation installation and maintenance data.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide fully adjustable angle thermometers by one of the following:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
5. Miljoco Corporation.

B. Case: Cast aluminum with dark blue epoxy coating, 9 inches long.

C. Window: Clear acrylic for temperatures up to 300 deg. F; glass for higher temperatures.

D. Tube: blue reading, organic filled.

E. Window: Clear acrlylic.

F. Stem: brass for thermowell installation and of length to suit installation.

G. Accuracy: Plus or minus 1 scale division.

2.2 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.

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

2.3 PRESSURE GAUGES

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

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
5. Miljoco Corporation.

B. Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.

1. Case: Liquid-filled type, fiberglass reinforced polypropylene, 4-1/2-inch diameter, solid front, blow-out back.
2. Pressure-Element Assembly: Bronze tube.
3. Pressure Connection: Brass, NPS ¼ or ½".
4. Movement: Stainless steel rotary type with stainless steel bushings.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Acrylic plastic.
8. Accuracy: plus or minus .5 percent range.
9. Vacuum-Pressure Range: 30-in. Hg of vacuum to 150 psig of pressure.
10. Range for Fluids under Pressure: Two times operating pressure.
11. Temperature range: 250 deg. F for heating systems; 150 Deg. F for all other hydronic systems.

C. Pressure-Gauge Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type valve.

2.4 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements provide test plug (PT Plug) products by one of the following:

1. Flow Design, Inc.
2. Peterson Equipment Co., Inc.
3. Sisco Manufacturing Co.
4. Trerice, H. O. Co.
5. Watts Industries, Inc.; Water Products Div.

B. Description: Ports are to be suitable to accept thermometer stem or pressure gauge adapter and shall have dual EPDM internal seals, threaded brass cap with metal retainer strap. Ports are to be adequate length and suitable for installation in insulated or non-insulated piping.

C. Construction: Brass body with dual EPDM seals.

D. Minimum Pressure and Temperature Rating: 1000 psig at 270 deg F.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install thermometers where indicated on the drawings, see plans and detail drawings.

B. Provide the following temperature ranges for thermometers

1. Heating Hot Water System: 30 to 240 deg. F, with 2-degree scale divisions.
2. Chilled Water System: 0 to 100 deg. F, with 2-degree scale divisions.
3. Water Source System: 0 to 100 deg. F, with 2-degree scale divisions.
4. Geothermal System: 0 to 100 deg. F, with 2-degree scale divisions.

3.2 GAUGE APPLICATIONS

A. Install pressure gauges, where indicated in other Division 23 Sections, and where indicated on the drawings plans and detail drawings.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.

C. Install pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

D. Install shut-off needle-valve and snubber fitting in piping for each pressure gauge and thermometer.

E. Install test plugs in tees in piping.

3.4 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance for meters, gauges, machines, and equipment.

3.5 ADJUSTING

A. Calibrate meters according to manufacturer’s written instructions, after installation.

B. Adjust faces of meters and gauges to proper angle for best visibility.

END OF SECTION 23 05 30

SECTION 23 05 40 – GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes various types of general duty valves used in HVAC systems.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of valve from the same manufacturer.

B. ASME Compliance:

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping per the manufacturer’s recommendations and to prevent damage during shipping.

B. Store valves per the manufacturer’s recommendations.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to Part 3 for HVAC valve schedule and applications of valves.

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

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

2.2 BRONZE BALL VALVES

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

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

a. Conbraco Industries, Inc.
b. Crane Co.; Crane Valve Group.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.

2. Description:

a. Manufactured to comply with standard MSS SP-110.
b. Rated for 150 psig SWP and 600 psig CWP.
c. Two-piece cast bronze body.
d. Seats: TFE.
e. Anti-blowout stem and chrome plated bronze ball.

3. Where valves are to be installed in insulated piping, provide extended handles with memory stop, and made of a non-thermal conductive material. Provide a protective sleeve to allow operation of the valve without damaging the insulation.

2.3 BUTTERFLY VALVES

A. Cast-iron body butterfly Valves:

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

a. Conbraco Industries, Inc.
b. Crane Co.; Crane Valve Group.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co, Inc.

2. Description:

a. Manufactured to comply with MSS SP-67.
b. 200 PSI CWP Rating.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron.
e. Seat: EPDM.
f. Stem: 400 series stainless steel.
g. Disc: Aluminum bronze.
h. Operation: 6” and smaller, 10 position lever operator; 8” and larger gear operator.

3. Where valves are to be installed in insulated piping, provide extended neck.

2.4 HIGH PERFORMANCE BUTTERFLY VALVES

A. Class 150 Butterfly valve.

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

a. NIBCO model LCS 6822 or equal.
b. Victaulic model Vic 300 Master Seal with Grade E EPDM high temperature seat.

2. Description:

a. Manufactured to comply with MSS SP-68.
b. Class 150.
c. 250-degree rating at 200 PSI
d. Carbon steel body with stainless steel disc and stem.
e. PTFE seats.
f. Permanently lubricated 316 stainless steel bearings.
g. Operation: 6” and smaller, lever (locking) operator; 8” and larger gear operator.

3. Where valves are to be installed in insulated piping, provide extended neck.

2.5 BRONZE SWING CHECK VALVES

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

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

a. Crane Co.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

a. Manufactured to comply with MSS SP-67.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: bronze.
e. Disc: bronze.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

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

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.

2.7 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP, Iron, Grooved-End Swing Check Valves:

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

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

2. Description:

a. CWP Rating: 300 psig.
b. Body Material: ASTM A 536, ductile iron.
c. Seal: EPDM.
d. Disc: Spring operated, ductile iron or stainless steel.

2.8 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:

1. Description:

a. Standard: MSS SP-78, Type II.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
d. Plug: Cast iron or bronze with sealant groove.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

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

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

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

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

E. Install chain wheels on operators for ball and butterfly valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

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

1. Shutoff Service: Ball or butterfly valves.
2. Throttling Service except Steam: Ball, or butterfly valves.
3. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, resilient-seat check valves.

B. High Performance Valve locations are noted on the contract drawings.

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

END OF SECTION 23 05 40

SECTION 23 05 50 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment [and obtain approval from authorities having jurisdiction].

1.5 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following: include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

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

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

D. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of fiberglass, polyurethane, or stainless steel.

B. Strap-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Metallic Coating: Electroplated zinc.
7. Paint Coating: Acrylic.
8. Plastic Coating: PVC.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Coating: PVC.

2.5 FIBERGLASS STRUT SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.

1. Channels: Continuous slotted fiberglass[or other plastic] channel with inturned lips.

2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of fiberglass or stainless steel.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

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

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

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

2.7 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.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

E. High-Type, Multiple-Pipe Stand:

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 EQUIPMENT SUPPORTS

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

2.10 MISCELLANEOUS MATERIALS

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

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

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

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

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

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.

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

G. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) 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.

H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

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

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

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

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

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

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

P. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

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

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

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

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

a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 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 bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 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/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

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

3.4 ADJUSTING

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

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

3.5 PAINTING

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

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

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

3.6 HANGER AND SUPPORT SCHEDULE

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

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

C. Use 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 carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

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

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. 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 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. 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 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

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

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

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

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

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

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

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

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

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for

erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

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

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

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

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

END OF SECTION 23 05 50

SECTION 23 05 70 - IDENTIFICATION FOR HVAC SYSTEMS

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 identification materials:

1. Equipment markers.
2. Pipe markers.
3. Duct markers.
4. Valve tags.
5. Valve schedules.
6. Warning tags.

B. Refer to other Division 23 Specification Sections for requirements to label and identify materials, equipment and accessories relating to other components of the HVAC System(s).

1.3 SUBMITTALS

A. Submit Product Data for type of marker and tag along with a schedule where each type will be installed.

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 location of access panels and doors.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Provide identification materials available through Craftmark Pipe Markers or equal.

2.2 EQUIPMENT MARKERS

A. Equipment Markers: 1/8” thick black plastic tag with engraved data in white letters, pre-drilled holes for permanent attachment on equipment.

1. Minimum marker size: 4” wide by 2” high. Length and width to be larger if required for marker content.
2. Minimum letter size: ½”.
3. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate material.
4. Marker content: equipment name tag as shown on the drawings (i.e., AHU-1).

2.3 PIPING IDENTIFICATION DEVICES

A. Manufactured self-adhesive pipe markers: Preprinted, color-coded, with lettering indicating service, and showing direction of flow. Provide markers for all piping systems.

1. Colors: Comply with ASME/ANSI A13.1.
2. Lettering: Use standard piping system terms 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.

2.4 DUCTWORK IDENTIFICATION

A. Manufactured self-adhesive vinyl peel off markers, 4” x 24” with bold 2” letters. Include airflow direction, duct service (such as supply, return, and exhaust and air handling system identification (i.e. AHU-2 SUPPLY AIR).

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and ½-inch numbers, with numbering scheme reviewed and approved by the owner’s representative. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick brass.
2. Valve-Tag Fasteners: Brass wire-link or beaded chain.

2.6 VALVE SCHEDULES

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

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

PART 3 - EXECUTION

3.1 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment markers on each major item of HVAC equipment. Locate nameplates where accessible and visible. Nameplates are not required for HVAC equipment that is exposed to view in finished areas such as corridors, stairs, offices and classrooms. Include nameplates for the following general categories of equipment:

1. Exhaust Fans.
2. Make-up air units.
3. Air-cooled Condensing units
4. Air Terminal Units.

3.2 PIPING IDENTIFICATION

A. Provide labels for all piping systems including:

1. Chilled water.
2. Heating hot water.
3. Refrigerant systems.
4. Condensate piping.

B. Locate pipe markers where piping is above accessible ceilings, exposed in machine and/or equipment rooms and in maintenance spaces such as shafts, tunnels, and plenums 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 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.3 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts according to the following:

1. Supply ducts.
2. Return ducts.
3. Outside air intake ducts.
4. Exhaust ducts.

B. Locate duct markers where ducts are above accessible ceilings, exposed in machine and\or equipment rooms and in maintenance spaces such as shafts, tunnels, and plenums as follows:

1. Near each branch connection.
2. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
3. At access doors and similar access points.
4. Near major equipment items and other points of origination and termination.

5. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.4 VALVE-TAG INSTALLATION

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

B. Valve-Tag Application Schedule:

1. Valve-Tag Size and Shape for all piping systems:

a. 1-1/2 inches, round.

2. Valve-Tag Color: Natural.

C. The location of all valves shall be indicated by locator tags on the ceiling tile. Provide equipment locator tags in a color suitable to the owner. Tags to be push tack type with 7/8” diameter head as manufactured by Marketing Services Inc. or equal.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room. Provide a complete valve schedule in the O and M manuals.

END OF SECTION 23 05 70

SECTION 23 06 00 - HVAC SYSTEM TESTING, ADJUSTING, AND BALANCING

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. The firm responsible for TAB work on this project will be under contract with and has been hired directly by the owner.

B. Work under this section includes, but is not limited to, Testing, Adjusting and Balancing (TAB) of the following air systems, water systems and HVAC equipment:

1. All constant-volume and variable air volume systems.
2. All constant-flow hydronic systems and variable flow hydronic systems.
3. Primary-secondary hydronic systems.
4. Air handling units.
5. Variable air volume units.
6. Terminal units such as cabinet heaters, unit heaters and convectors.
7. Ductwork leak testing verification.
8. Existing air and water systems where noted on the drawings.

C. All TAB work shall comply with the requirements of TAB procedures required by the Associated Air Balancing Council, National Environmental Balancing Bureau, Testing Adjusting and Balancing Bureau and ASHRAE.

D. Coordinate and witness the installation work of the HVAC Contractor including all sub-contractors working for the HVAC Contractor and Electrical Contractor. Provide progress inspections of the work to ensure the installation of all systems is progressing as required and will operate as specified when completed. Report results of the progress inspection to the Owner's Representative.

E. Provide duct system leak testing verification. The work required for leak testing of various duct systems is indicated in Section 233110. The TAB contractor is required to verify the leakage rate of the various duct systems conforms to the requirements indicated in SMACNA's "HVAC Air Duct Leakage Test Manual." Based upon satisfactory initial duct leakage test results, the testing may be reduced. At a minimum leak test the following systems:

1. No less than 25% of the supply air systems with a pressure class of 3-Inch w.g. or higher.
2. No less than 25% of the other portions of all variable air volume systems.
3. No less than 25% of the supply air mains on all other systems and a minimum of 15% of the branch ducts on all systems.

F. Submit balancing reports for all air and water systems.

G. Validate the start-up and operation of all HVAC equipment and systems by the HVAC Contractor.

H. Validate the start-up and operation of the HVAC Controls system. Submit reports indicating the operation of all equipment, throughout the range of operation, meets the requirement of the Sequence of Operations.

I. Refer to Specification Section 01 91 13 – Building Systems Commissioning Requirements for additional work required by the TAB contractor.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TABB: Testing Adjusting and Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

1.4 SUBMITTALS

A. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified herein.

1.5 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and portions of the existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations. Review the project’s construction phasing plan and provide the necessary number of TAB visits to comply with the phasing plan.

B. Review the project’s construction phasing plan and provide the necessary number of site visits to comply with the phasing plan and complete all tab work before each phase is scheduled to be complete.

PART 2 - PRODUCTS

2.1 DUCT ACCESSORY HARDWARE

A. Instrument Test Ports: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit the specified eternal duct insulation thickness. Provide special gaskets where test holes are to be installed in round or oval ducts. Test Ports to be Duro-Dyne model TH1, IP2 and/or IP4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices,

balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

B. Refer to the Contract Drawings for notes that relate to balancing of the air and water systems.

C. Examine the approved shop drawing submittals for all HVAC systems and equipment prior to starting the TAB work.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section Metal Ducts, and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Verify all systems are complete, including controls, before starting the TAB work.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors where required.
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish to meet the requirements of the installation.

B. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. For variable-air-volume systems, develop a plan to simulate diversity.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Where required, verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

L. Install instrument test holes in ducts at all required locations for testing and balancing purposes.

M. Air Handling Unit(s) filters: Provide verification of controls and provide set points for monitoring the filter pressure drop in all air handling units where indicated in Specification Section 230905 HVAC Sequence of Operation. Provide adjustment when necessary.

N. Building Pressurization: Provide verification of controls and provide set points for building pressurization control in various systems as indicated in Specification Section 230905 HVAC Sequence of Operation. Provide adjustment when necessary.

O. Verify performance of air flow monitors. Measure outdoor air flow at all air flow monitors and verify the measured air flows are within 5% of the air flow indicated on the BMS. Provide verification in the final balancing report.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow. Measure air flows in main ducts and at terminal outlets and inlets.
2. Measure fan static pressures as follows to determine actual static pressure:

    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

    a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of branch ducts.
2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Re-measure each branch duct after all have been adjusted. Continue to adjust branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals. Adjust each outlet in same room or space to within specified tolerances of indicated quantities

without generating noise levels above the limitations prescribed by the Contract Documents. Adjust patterns of adjustable outlets for proper distribution without drafts.

E. Measure and verify ventilation air flows are as indicated on the equipment schedules.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Provide final settings for high static pressure sensors to be located at the air handling unit supply fan discharge.

B. Provide locations of high static pressure sensors to be installed in the variable air volume duct systems. Review the duct layout for each variable air volume air handling system. Provide an initial pressure setting and adjust the final setting as required, when balancing is complete.

C. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

D. Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
7. Record final fan-performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved. Monitor motor performance during procedures and do not operate motors in overload conditions.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Provide locations of piping system pressure sensors to be installed in variable flow piping systems. Review the piping system layout for each system. Provide an initial pressure setting and adjust the final setting as required, when balancing is complete.

B. Balance systems with automatic, two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.10 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

C. ECM Motors: Obtain and review manufacturer’s information which indicates methods and procedures to balance air flow.

3.12 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.13 PROCEDURES FOR HYDRONIC BOILERS

A. Perform testing, adjusting and balancing during the heating season. Measure and record entering- and leaving-water temperatures and water flow rates for all boilers. Measure and record the following data with each boiler operating at design conditions:

1. For systems with multiple boilers verify flow rates through each boiler meets the minimum flow rates established by the boiler manufacturer. Adjust and set the minimum flow rates for the boiler pumps.
2. Entering and leaving temperatures, pressure drop, and water flow rates in the common boiler loop.

3.14 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.

4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.16 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following general data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name and location.
4. Architect's and Engineer’s name and address.
5. Contractor's name and address.
6. Report date.
7. Signature of TAB supervisor who certifies the report.

8. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
9. Summary of contents.
10. Data for terminal units, including manufacturer's name, type, size, and fittings.
11. Notes to explain why certain final data in the body of reports vary from indicated values.
12. Test conditions for fans and pump performance forms.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air Handling Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

    a. Total air flow rate in cfm.
    b. Total system static pressure in inches w.g.
    c. Fan rpm.
    d. Discharge static pressure in inches w.g.
    e. Filter static-pressure differential in inches w.g.
    f. Dirty filter setpoint.
    g. Preheat-coil static-pressure differential in inches w.g.
    h. Cooling-coil static-pressure differential in inches w.g.
    i. Heating-coil static-pressure differential in inches w.g.
    j. Outdoor airflow in cfm.

k. Return airflow in cfm.
l. Outdoor-air damper position.
m. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft.
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Total supply air flow.
b. Total system static pressure in inches w.g.
c. Fan(s) rpm.
d. Discharge static pressure in inches w.g.
e. Filter static-pressure differential in inches w.g.
f. Dirty filter set point.
g. Preheat-coil static-pressure differential in inches w.g.
h. Cooling-coil static-pressure differential in inches w.g.
i. Heating-coil static-pressure differential in inches w.g.
j. Outdoor airflow in cfm.
k. Return airflow in cfm.
l. Outdoor-air damper position.
m. Return-air damper position.
n. Airflow monitor verification.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Entering-air temperature in deg. F.
c. Leaving-air temperature in deg. F.
d. Air temperature differential in deg. F.
e. Entering-air static pressure in inches w.g.
f. Leaving-air static pressure in inches w.g.
g. Air static-pressure differential in inches w.g.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg. F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h (kW).
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Air flow rate in cfm.
i. Face area in sq. ft.
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Air flow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg. F.
e. Leaving-air temperature in deg. F.
f. Voltage at each connection.
g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches w.g.
    c. Fan rpm.
    d. Discharge static pressure in inches w.g.
    e. Suction static pressure in inches w.g.

J. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

    a. System and air-handling-unit number.
    b. Location and zone.
    c. Traverse air temperature in deg. F.
    d. Duct static pressure in inches w.g.
    e. Duct size in inches.
    f. Duct area in sq. ft.
    g. Indicated air flow rate in cfm.
    h. Indicated velocity in fpm.
    i. Actual air flow rate in cfm.
    j. Actual average velocity in fpm.
    k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

    a. System and air-handling unit identification.
    b. Location and zone.
    c. Apparatus used for test.
    d. Area served.
    e. Make.
    f. Number from system diagram.
    g. Type and model number.
    h. Size.
    i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

    a. Air flow rate in cfm.
    b. Air flows for variable air volume units at the various settings (cooling, heating & minimum)
    c. Air velocity in fpm.
    d. Preliminary air flow rate as needed in cfm.

e. Preliminary velocity as needed in fpm.
f. Final air flow rate in cfm.
g. Final velocity in fpm.
h. Space temperature in deg. F.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Entering-water temperature in deg. F.
c. Leaving-water temperature in deg. F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg. F.
f. Leaving-air temperature in deg. F.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.

h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.17 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing is complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, submit the final report for review.
2. The Owner may select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
3. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
4. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

END OF SECTION 23 06 00

SECTION 23 07 00 - HVAC SYSTEM 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 insulation materials and accessories for insulating HVAC system piping, ductwork, and equipment.

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. Duct and pipe insulation, including adhesives, shall have a flame spread index not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E 84 or UL 723, using the procedures of ASTM E2231. Duct coverings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C 411 at the temperature to which they are exposed in service. The test temperature shall not fall below 250 degrees F.

B. All insulation values are to meet the requirements of the applicable edition of the International Energy Conservation Code.

C. Insulation installed on the exterior of ducts, located within the building, shall bear identification at intervals not greater than 36-inches, with the name of the manufacturer, the R value at the specified installed thickness and the flame spread and smoke developed indexes of the composite materials.

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. Store materials providing protection from the elements.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields. Coordinate clearance requirements with the duct and piping.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. 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. Insulation conductivity (k) shall not exceed 0.27 Btu per inch/h – ft2 – deg. F.

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

a. Armacell LLC; AP Armaflex.
b. Aeroflex USA Inc.; Aerocel.

B. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1136 with factory-applied FSK jacket. Insulation conductivity (k) shall not exceed 0.27 Btu per inch/h – ft2 – deg. F.

1. Products: Subject to compliance with requirements, provide Johns Manville Microlite insulation or equal products manufactured by one of the following:

a. CertainTeed Corp.
b. Knauf Insulation.
c. Owens Corning.

C. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. For duct and plenum applications, provide insulation with factory-applied FSK jacket.

1. Subject to compliance with requirements, provide Johns Manville 800 Series Spin-Glas insulation or equal products manufactured by one of the following:

a. CertainTeed Corp.
b. Knauf Insulation.
c. Owens Corning.
d. Manson Insulation.

D. Mineral-Fiber, Preformed Pipe Insulation:

1. Subject to compliance with requirements, provide Johns Manville Micro-Lok insulation or equal products manufactured by one of the following:

a. Knauf Insulation; 1000 Pipe Insulation.
b. 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.
3. Provide High-impact-resistant, UV-resistant PVC jacketed fitting covers complying with ASTM D 1784, Class 16354-C; Flame spread 25 or less; Smoke development 50 or less.

E. Mineral-Fiber Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied FSK jacket.

1. Subject to compliance with requirements, provide Johns Manville Micro-Flex insulation or equal products manufactured by one of the following:

a. Knauf Insulation; Pipe and Tank Insulation.
b. Owens Corning; Fiberglas Pipe and Tank Insulation.

F. Polyisocyanurate Board: Closed cell polyiso-foam board bonded on each side with a foil face. Flame Spread 25 or less: smoke development less than 450.

1. Subject to compliance with requirements, provide Johns Manville XSPECT Polyiso Foam Board. Exterior use only.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Subject to compliance with requirements, provide 3M Duct Wrap 615+.

B. Fire-Rated Blanket: high-temperature fiber blanket thermal insulation encapsulated in a fiberglass reinforced aluminized polyester foil. Duct Wrap density shall be nominal 6 p.c.f. and have a nominal 1-1/2 in. thickness. The fiber blanket shall have a continuous use limit of 1832 °F.

C. Smoke Developed Index and Flame Spread Index of the bare blanket, and of the foil encapsulated blanket shall be 0/0. The foil encapsulation shall be bonded to the core blanket material.

2.3 CEMENTS, ADHESIVES, SEALANTS AND MASTICS

A. Provide all required types of cements, adhesives, sealants, mastics and other accessories required to install all insulation materials and systems. Prepare surfaces as required by the insulation manufacturers. Install cements, adhesives, sealants and mastics per manufacturer’s recommendations.

2.4 PVC JACKETING

A. Provide High-impact-resistant, UV-resistant PVC jacketed fitting covers complying with ASTM D 1784, Class 16354-C; Flame spread 25 or less; Smoke development 50 or less. Temperature rating 150 degrees F.

1. Subject to compliance with requirements, provide Johns Manville Zeston Jacketing or equal.

2.5 CORRUGATED ALUMINIUM JACKETING

A. Corrugated aluminum jacketing, 0.020-inch thickness. ASTM Standard C1729.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes per the manufacturer’s instruction 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 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 per manufacturer’s instructions.

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.

3.2 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations. Seal penetrations with flashing sealant.

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

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

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

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

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies.

3.3 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

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

1. Apply adhesives according to manufacturer's recommended coverage rates.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Stagger joints between insulation layers at least 3 inches.

B. Flexible Elastomeric Thermal Insulation Installation for Equipment, Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism. Fabricate boxes from aluminum, at least 0.050 inch thick. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Union and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated. 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.

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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.
7. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

B. 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.

3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with adhesives to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulate all pipe fittings, elbows, valves and pipe specialties.

C. Apply weather resistant coating on all exterior insulation to protect the insulation from ultraviolet rays. Provide Armaflex WB Finish water based coating or equal.

3.6 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes per manufacturer’s instructions. Where vapor barriers are required, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c. 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 Fittings, Elbows, Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

C. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins, apply adhesives according to manufacturer's recommended coverage rates per unit area.

1. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
2. 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.
3. 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.

D. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins. Apply adhesives according to manufacturer's recommended coverage rates per unit area.

1. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
2. 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.

3.7 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation is indicated on the drawings, secure the insulation to ducts and duct hangers and supports to maintain a continuous fire rating. Insulate duct access panels and doors to achieve same fire rating as duct. Install fire-stopping at penetrations through fire-rated assemblies.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Duct systems requiring insulation on the exterior of the ducts:

1. Indoor exposed and concealed supply air and outdoor air ducts.
2. Indoor, exposed and concealed return air ducts located in an unconditioned space.
3. Indoor, exposed and concealed exhaust between isolation damper and penetration of building exterior.
4. Indoor, exposed and concealed, Type I kitchen hood exhaust.
5. Supply and return ducts located on the exterior of the building.
6. Other locations noted on the drawings.

B. Items Not Insulated:

1. Ducts with interior duct liner, unless otherwise noted.
2. Indoor exposed supply air ducts in heating only systems located in a conditioned space.
3. Indoor, exposed and concealed return ducts located in conditioned space.
4. Factory-insulated flexible ducts.
5. Factory-insulated plenums and casings.
6. Flexible connectors.
7. Factory-insulated access panels and doors.
8. Other locations noted on the drawings.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed supply air ducts and plenums, hydronic coils furnished on VAV air terminal units and hydronic duct coils shall be insulated with:

1. Mineral-Fiber Blanket: 2-inches thick and 1.5-lb/cu. ft. nominal density; uncompressed “R” value 8.0; with vapor barrier having a maximum permeance of 0.05 perm.

B. Concealed return air ducts and plenums shall be insulated with:

1. Mineral-Fiber Blanket: 1-1/2-inches thick and 1.5-lb/cu. ft. nominal density; uncompressed “R” value 6.0; with vapor barrier having a maximum permeance of 0.05 perm.

C. Concealed outdoor air ducts and plenums shall be insulated with:

1. Mineral-Fiber Blanket: 2-inches thick and 1.5-lb/cu. ft. nominal density; uncompressed “R” value 8.0; with vapor barrier having a maximum permeance of 0.05 perm.

D. Concealed exhaust air ducts and plenums shall be insulated with:

1. Mineral-Fiber Blanket: 1-1/2-inches thick and 1.5-lb/cu. ft. nominal density; uncompressed “R” value 6.0; with vapor barrier having a maximum permeance of 0.05 perm.

E. Concealed and exposed Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated duct wrap with a thickness as required to achieve 2-hour fire rating.

F. Exposed supply-air ducts, plenums and all hydronic coils shall be insulated with:

1. Mineral-Fiber Board: 2-inches thick, 3-lb/cu. ft. density, “R” 8.7 with vapor barrier.

G. Exposed return-air ducts and plenums shall be insulated with:

1. Mineral-Fiber Board: 1-1/2-inches and 3-lb/cu. ft. density, “R” 6.5 with vapor barrier.

H. Exposed exhaust air ducts and plenums shall be insulated with:

1. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. density, “R” 6.5 with vapor barrier.

I. Exposed outdoor-air ducts and plenums shall be insulated with:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. density, “R” 8.7 with vapor barrier.

3.10 PIPING INSULATION SCHEDULE, GENERAL

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

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

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

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water Piping

1. All Pipe Sizes: Insulation shall be Flexible Elastomeric, ¾-inch thick.

B. Chilled Water Piping

1. NPS 1½-inches and smaller: Insulation shall be Mineral-Fiber with vapor barrier, 1½-inches thick.
2. NPS 2-inches and larger: Insulation shall be Mineral-Fiber with vapor barrier, 2-inches.

C. Refrigerant and Hot-Gas Piping

1. All sizes: Flexible Elastomeric, 1-inches thick.

D. Heating-Hot-Water Supply and Return Piping

1. NPS 1¼-inches and smaller: Insulation shall be Mineral-Fiber, 1½-inches thick.
2. NPS 1½-inches and larger: Insulation shall be Mineral-Fiber, 2-inches thick.

E. Humidifier Steam and Condensate Piping

1. All sizes: Mineral-Fiber, 2-inches thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water Supply and Return

1. All Pipe Sizes: Insulation shall be Mineral-Fiber, Preformed Pipe Insulation, 3-inches thick with vapor barrier and corrugated aluminum jacket for pipe and fittings. Install aluminum jacket with seams on the bottom of horizontal pipe.

B. Refrigerant Liquid, Suction and Hot-Gas Piping

1. All Pipe Sizes: Insulation shall be Flexible Elastomeric, 1 inch thick with PVC jacket.

END OF SECTION 23 07 00

SECTION 23 09 00 – HVAC SYSTEM CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to other HVAC Specification Sections which describe the requirements of the HVAC system components.

C. Refer to Section 230905 “Sequence of Operation – HVAC Controls” for information related to the HVAC system controls.

1.2 SUMMARY

A. This Section includes direct digital control (DDC) equipment for control of HVAC systems and various other systems.

B. Refer to all Division 23 specification sections for controls that may be provided with the associated equipment.

C. Work under this section includes, but is not limited to, providing the required controls and accessories to accomplish the method of control as indicated in Section 23 09 05, Sequence of Operation, for the following HVAC equipment:

1. Exhaust fans.
2. Air terminal units.
3. Gravity ventilators.
4. Boilers.
5. Modular air handling units.
6. Ductless split system units.
7. Convectors, cabinet heaters and other terminal heating units.
8. Variable frequency drives.
9. Air flow monitoring units.
10. Sequence(s) that are indicated on the construction drawings.

D. The controls sub-contractor will be required to participate in the Start-Up as well as the Testing, Adjusting, Balancing and Commissioning of the HVAC System. Refer to other HVAC specifications for the work required by the controls sub-contractor.

E. The Building Management System (BMS) installer / supplier shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems as specified. Provide a complete and fully operational system. The system shall allow the Owner to have access through the internet with password security to suite the Owner's needs. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer.

F. The BMS shall be an extension to the existing Automated Logics based controls system currently used by the Berks County Intermediate Unit.

G. The BMS manufacturer/supplier shall be responsible for all BMS control and power wiring for a complete and operable system. All wiring shall be done in accordance with all applicable local, state and national codes.

H. The BMS installation must be supervised by personnel directly employed by the manufacturer/supplier.

I. All existing controls are to remain operational during construction. Provide the following to accommodate the phased construction schedule:

1. Temporary control and power wiring as required to accommodate the renovation phasing schedule.
2. Remove control system components (i.e., wiring, actuators) as phasing allows.
3. As construction phasing progresses provide extensions to the control system as needed and remove existing components that are no longer required.

1.3 DEFINITIONS

A. DDC: Direct Digital Control

B. BMS: Building Management System.

C. BAS: Building Automation System.

D. EMS: Energy Management System.

E. PC: Personal computer.

1.4 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

B. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

C. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

D. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

E. Shop Drawings: Provide detailed equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Include the following:

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.

4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC hardware including:

    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems including:

    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

F. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for the workstations and control systems.
6. All system and software development tools are to allow the owner to independently maintain the s6ystem.
7. Software Tools - All software tools needed for full functional use, including programming of BCs, BACnet controllers, network management and expansion, and graphical user interface development, of the BAS described within these specifications, shall be provided to the owner or his designated agent. Any licensing required by the manufacturer now and into the future, including changes to the licensee of the software tools, and the addition of hardware corresponding to the licenses, shall be provided to allow for a complete and operational system for both normal day to day operation and servicing shall be provided. Any such changes to the designated license holders shall be made by the manufacturer upon written request by the owner or his agent. Any cost associated with the license changes shall be identified within the BAS submittals.

G. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:

1. Interconnection wiring diagrams with identified and numbered system components and devices.
2. Keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Calibration records and list of set points.

1.5 SYSTEM PERFORMANCE

A. System shall have an open architecture utilizing the data infrastructure of fiber optic cables and/or copper cables to communicate between field panels.

B. Graphic software shall reside on the system server.

C. The graphic software shall provide a graphical representation of the building floor plan with icons/images to indicate HVAC system components and readings, generator annunciation, power metering information and locations and exterior lighting control. System software must interface with the separate systems to report activities by date, time.

D. System shall log events for report trends, alarm conditions, etc.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

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

C. UL listed to Standards UL864 (Fire), UL2017 (Signaling Systems), UL916 (Energy Management Systems), UL1017 (Security), UL1610 (Central Station) and UL 294 (Access Control).

1.7 CODES AND STANDARDS

A. Meet the requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.

B. Underwriters Laboratories: Products shall be UL-916-PAZX listed.

C. Federal Communications Commission -- Part J.

D. ASHRAE/ANSI 135-2016 (BACnet) - (System Level Devices) - Building Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

E. ASHRAE/ANSI 135-2016 (BACnet) - (Unit Level Devices) - Unit Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

F. EIA-709.1 LonTalk Standard and EIA 901.2 (LonMark Certification) - (Unit Level Devices) - Custom Application Controllers and Application Specific Controllers shall use FTT-10A transceivers and support the LonTalk communication protocol utilizing Standard Network Variable Types (SNVT) as defined by Echelon Corporation. This standard communication protocol provides interoperability with hundreds of other various building system manufacturers' control systems and devices.

1.8 DELIVERY, STORAGE AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

1.10 WARRANTY

A. The BMS supplier/installer shall warrant all work per the following:

1. All control systems labor, equipment and materials shall be warranted to be free from defects for a period of twelve (12) months after the date of substantial completion. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BMS manufacturer/installer shall respond to the Owner's request for warranty service within 24 hours of the initiated call.
2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the BMS is operational, and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.
3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by the Owner must be granted prior to the installation of these updates.

PART 2 - PRODUCTS

2.1 INSTALLERS

A. Subject to compliance with requirements provide an extension of the existing Automated Logics control system, with products furnished, engineered, and installed by one of the following:

1. Radius Systems LLC
   101 Ponds Edge Drive, Suite 201
   Chadds Ford, PA 19317
   (610) 388-9940

2.2 DDC EQUIPMENT

A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

   a. Global communications.
   b. Discrete/digital, analog, and pulse I/O.
   c. Monitoring, controlling, or addressing data points.
   d. Software applications, scheduling, and alarm processing.
   e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

    a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, anti-short cycling, PID control, DDC with fine tuning, and trend logging.
    b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
    c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing when applicable.
    d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
    e. Remote communications.
    f. Maintenance management.
    g. Units of Measure: Inch-pound.

4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

B. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position auto-manual switch, and manually adjustable potentiometer].
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

C. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

D. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.3 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

B. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.

C. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.

D. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.

E. BACnet Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.

F. Enclosure: Waterproof rated for operation at 40 to 150 deg F.T

2.4 PROGRAMABLE CONTROLLERS

A. Performance - Each PC shall have a minimum of 64K of Non-volatile Flash memory for control applications and 128K non-volatile flash memory for storage with an 8-bit processor. The PC shall have a minimum ambient operating temperature range of -0°C to 70°C or 32°F to 158°F.

B. Inputs - Analog inputs shall have the following minimum level of performance: 16-bit A to D resolution; allow monitoring of platinum 100 ohms, platinum 1000-ohm, nickel 1000 ohms, thermistor 10K type II, thermistor 10K type III, voltage input0-10VDC, current input 4-20mA, digital input, pulsed input minimum 2 Hz.

C. Outputs - Outputs shall be either software configurable to be either analog or digital or dedicated digital only - Analog outputs shall be selectable as voltage of 0-10 VDC (linear) or 4-20mA or Digital outputs shall be 0-12 VDC (off/on), floating or PWM. Outputs shall have an adjustable range of 2 seconds to 15 minutes. Output Resolution shall be a minimum 8 bits digital/analog converter. All individual outputs and power supply shall be protected by an auto reset fuse. There shall be an LED status indicator on each of the outputs.

D. Programmable Controller Features:

1. Provide an onboard network communication jack.
2. The PC shall be provided with a diagnostic indicator light for power and network communication of transmit and receive along with a light indication position for each output.
3. Hand/Off/Auto Switches - For all controllers applied to an AHU, Chiller, Pumps, Cooling Tower or Boiler, provide for the manual override and adjustment of all Analog and Digital outputs through a three-position switch giving the selection of Hand, Off and Auto (HOA). A HOA shall be provided for each separate digital and analog output from the controller and be an integral part of the controller. HOA switches external from the controller shall not be accepted. For the Analog outputs the Hand position of the switch shall provide for the adjustment of the output signal through a linear scaled potentiometer. The position of the HOA shall be monitored and an alarm shall be delivered to the Graphical User Interface should the switch be in an Off or Hand position. An indicating LED shall be provided on the controller for each HOA indicating position of the switch. For all Analog

outputs, the indicating LED shall provide a linear indication of the position of the Potentiometer through a variation in the intensity of the indicator LED and be provided as a numerical value that can be viewed at the Graphical User Interface.

4. Enclosures - Provide for a plastic enclosure with a separate back plate with terminals such that the electronic portion of the controller can be easily removed for ease of installation and servicing.

E. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

2.5 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Humidity Sensors: Bulk polymer sensor element.

1. Duct sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
2. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.

C. Static pressure transmitters: non-directional sensor with suitable range for expected input, and temperature compensated.

1. Accuracy: 2 percent full range with repeatability of 0.5 percent.
2. Output: 4 to 20 mA.
3. Building Static-Pressure Range: 0- to 0.25-inch wg.
4. Duct Static-Pressure Range: 0- to 5-inch wg.

D. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure.

E. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig.

F. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

G. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system.

2.6 ROOM SENSORS

A. Sensors shall be of the thermistor type and shall be recessed wall box mounting type per the following:

1. Set points: warmer/cooler adjustment, which can be programmed in the system to a maximum number of +/- degrees of adjustment
2. Temperature sensing accuracy: +/- 1 degree F.

a. Range: 40 to 104 deg. F.
b. Accuracy: +/- 1 deg. F.

3. Humidity sensing accuracy:

a. Range: 20% to 90%
b. Accuracy: +/- 3%.

4. CO2 sensing, where indicated on the drawings or in specification section 230905.

a. Range: 0 to 2000 ppm.
b. Accuracy: +/- 30 ppm or 3% of the reading.

5. Where noted in specification 230905 provide override pushbutton on the room sensor. The override time to be programmed through the BMS.
6. Where indicated in Part 3 provide cast aluminum guards for room sensors including but not limited to temperature sensor, temperature/humidity sensors and CO2 sensors.

2.7 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage, and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.8 CO2 SENSORS

A. Carbon Dioxide sensors shall measure CO2 in PPM in a range of 0-2000 ppm. Accuracy shall be +/- 3% of reading with stability within 5% over 5 years. Sensors shall be duct or space mounted as indicated on the drawings or in the sequence of operation.

2.9 ACTUATORS

A. Modulating valves and dampers: provide proportional modulating control capable of positioning the valve or damper at all points across the full range of operation with continuous control action. The sensor, controller, and control device (damper, valve, etc.) shall act as one unit to maintain a constant and precise

control of the controlled medium. Actuator drives proportional to input signal and modulates throughout its angle of rotation.

B. Two-position valves and damper: provide two-position actuators only where indicated.

C. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
2. Non-spring Return Motors for Valves Larger than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
3. Spring-Return Motors for Valves Larger than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
4. Non-spring Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. Size for running and breakaway torque of 150 in. x lbf.

D. Electric Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Provide full modulating damper and valves actuators unless otherwise noted.
2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: size for required torque calculated as follows:

    a. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    c. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring return actuators.
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.

2.10 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Unless otherwise indicated, heating system control valves on systems with outdoor air connections shall fail in the open position. Heating system control valves on systems without an outdoor air connection shall fail in the last position. Chilled water system control vales are to fail in the last position.

C. Hydronic system globe valves to have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with back seating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Sizing: 5 psi maximum pressure drop at design flow rate.

4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
5. Close-off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Butterfly valves: 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals. Size at 1 psig max pressure drop at design flow rate.

E. Terminal unit control valves: bronze body, bronze trim, two or here ports, replaceable plus and seats with union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Sizing: 3 psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2.11 DAMPERS

A. Dampers: AMCA-rated, opposed blade design; 0.108-inch minimum thick, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.064-inch-thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

B. Edge Seals: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 4 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lb f; when tested according to AMCA 500D.

2.12 PRESSURE TRANSDUCERS

A. Transducer shall have linear output signal. Zero and span shall be field adjustable. Sensor accuracy shall be 1 percent of full scale with repeatability/long-term stability of 0.25 percent.

B. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.

C. Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and block and bleed valves.

D. Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and five-valve manifold.

E. Selectable rate pulse output for kWh reading, 4-20 mA output for kW reading, N.O. alarm contact, and the ability to operate with 5.0 amp current inputs or 0-0.33 volt inputs.

F. 1.0% full-scale true RMS power accuracy, +0.5 Hz, voltage input range 120-600V, and auto range select.

G. Under voltage/phase monitor circuitry.

H. NEMA 1 enclosure.

I. Current transformers having a 0.5% FS accuracy, 600 VAC isolation voltage with 0 - 0.33 V output. If 0-5 A current transformers are provided, a three-phase disconnect/ shorting switch assembly is required.

2.13 SYSTEM COMMUNICATIONS

A. System components shall communicate via low voltage control wiring. The use of wireless devices shall only be allowed with prior authorization from the Owner and Architect/Engineer.

B. While the system is expected to have a few connections to the Owner's data network, the quantity of connections shall be kept to a minimum, unless otherwise permitted by the Owner and Architect/Engineer.

1. The Division 27 Contractor will provide up to ten (10) data connections to the Owner's network. Should additional data wiring be required, the HVAC Systems Controls installer shall provide, meeting all requirements of Division 27 "Communications Cabling."

C. All low voltage control wiring provided as part of the HVAC System Controls shall meet requirements of Division 27 "Communications Cabling."

1. HVAC system controls wiring shall be provided with a gray jacket.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Electrical power:

1. Verify that power supply is available to the operator workstation, all actuators, valves and all other components of the HVAC Control System. Where required, provide low and/or line voltage power from the nearest electrical panel.
2. Unless noted otherwise, line voltage power for system equipment shall be derived from the nearest electrical panel, and shall not be common with other HVAC, plumbing, electrical or architectural equipment. Unless noted otherwise, low voltage power shall be derived from transformers/drivers associated with the system equipment only, and shall not be connected to control power transformers associated with other HVAC equipment (i.e. air handling units, chillers, etc.). System equipment may share transformers/drivers with other system equipment, provided the transformers/drivers are sized to handle the total load.
3. Control panels for equipment being fed from the emergency generator, including, but not limited to boilers, heating pumps, selected air handling and terminal equipment, etc., power shall be derived from the nearest 120/208 volt normal/emergency panel. Verify equipment that is connected to emergency power with the Electrical Contractor.
4. Install all power and control wiring and cable per the National Electric Code and applicable Division 26 and 27 Sections. Install raceways, boxes, cabinets according to Division 26 and 27 Sections.
5. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
6. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

B. Low Voltage Control Wiring:

1. Install low voltage control wiring per applicable Division 26 and 27 sections.
2. Wiring shall be installed concealed above accessible ceilings and within wall cavities. When run in wall cavities, install in 1" EMT conduit (flexible non-metallic conduit may not be used).

a. Low voltage control wiring may be installed in cable tray, when available; however, it shall be bundled together, neatly trained with Velcro straps, separated from the data wiring.

3. All backboxes for sensors and other wall devices shall be full power rated galvanized boxes. Low voltage rings may not be used.
4. Wiring installed in spaces with open structure, i.e. mechanical spaces, etc., shall be installed in minimum 1" EMT conduit. Conduit shall be painted to match structure.
5. In existing construction, open cavity walls (gyp, open core CMU, etc.) shall be fished. Surface metallic raceway (Wiremold V700 series) may be used where walls cannot be fished.
6. Where data cabling (category 5e or 6) is installed, cables shall be terminated on their own patch panel, and meet all requirements of Division 27 "Communications Cabling," including, but not limited to terminations, labeling, testing and warranty.

C. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

D. Connect and configure equipment and software to achieve sequence of operation specified.

E. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

F. Install heavy duty cast aluminum guards on thermostats and other sensors in the following areas:

1. Entrances.
2. Public areas.
3. All Gymnasiums.
4. Locker Rooms.
5. Where indicated.

G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H. Furnish and install hydronic instrument wells, valves, and other accessories where required.

I. Install refrigerant instrument wells, valves, and other accessories where required.

J. Space sensors:

1. Verify location of thermostats, humidistats, and other control sensors with Drawings and room details before installation. Mount sensors in occupied spaces to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
3. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
4. In finished areas, recess electrical box within wall.
5. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted.
6. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

K. Control Valves:

1. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer recommended clearance.

2. Install flanges or unions to allow drop-in and -out valve installation.
3. Install pressure temperature taps in piping upstream and downstream of each control valve.

3.2 QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust all control system components. Report results in writing to the owner's representative.

B. Perform field tests and inspections. Ata minimum perform the following:

1. Operational Test: After electrical circuitry has been energized, start all equipment to confirm proper operation. Remove and replace malfunctioning units and retest.
2. Test and adjust all controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC System Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.
8. Check dampers. Verify that proper blade alignment, either parallel or opposed, has been provided.
9. Verify that DDC controller power supply is from emergency power supply, if applicable.
10. Verify that wires at control panels are tagged with their service designation and approved tagging system.
11. Verify that spare I/O capacity has been provided.
12. Verify that DDC controllers are protected from power supply surges.

3.3 CALIBRATION AND ADJUSTMENTS

A. Calibrate instruments. Make three-point calibration test for both linearity and accuracy for each analog instrument. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

1. Verify control system inputs and outputs:

a. Check analog inputs at 0, 50, and 100 percent of span.
b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
c. Check digital inputs using jumper wire.
d. Check digital outputs using ohmmeter to test for contact making or breaking.

e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

2. Verify flow:

a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
b. Manually operate flow switches to verify that they make or break contact.

3. Pressure:

a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

4. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

5. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
6. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
7. Provide diagnostic and test instruments for calibration and adjustment of system.
8. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

3.4 SYSTEM DEMONSTRATION AND ON-SITE ASSISTANCE

A. Pre-installation demonstration: the BMS Installer shall provide a complete demonstration of the proposed control system software architecture prior to final programming of the software. This demonstration is required to have the owner's representative agree on the system architecture including providing information on initial temperature set points desired by the Owner. The method and location of the demonstration shall be acceptable to the owner. The BMS Installer will be required to make any changes in the proposed system architecture, if desired by the owner's representative.

B. Post installation demonstration: provide documented (paper or electronic) proof of testing prior to scheduling post-installation demonstration. Documentation to provide proof of testing/verification of all system inputs and outputs, including verification of analog input values (temp, CO2, etc.) with independent handheld NIST calibrated device. Post installation testing will engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. The training shall be comprised of a minimum of 8 hours on-site training at a time suitable to the owner's representative.

C. On-site assistance: during the warranty period, the Controls Manufacturer/Installer shall provide additional on-site assistance for training and re-programming, when requested by the owner. This on-site assistance shall be for a period of 8 hours for each visit, with a total of 2 visits.

3.5 FINAL REVIEW

A. Submit written report to Architect and Owner's representative when DDC system is 100% complete. Report shall state the following:

1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
4. DDC system is complete and ready for final review.

END OF SECTION 23 09 00

SECTION 23 09 05 - SEQUENCE OF OPERATIONS – HVAC CONTROLS

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 control sequences. Sequence of operation is hereby defined as the manner and method by which various controls and systems function.

B. The requirements for the operation of each type of control system are specified in this section and/or on the contract drawings.

1.3 SUBMITTALS

A. The control system supplier/installer shall review all HVAC equipment shop drawings prior to their shop drawing submission. The supplier shall note in the submission that all relative shop drawings have been reviewed prior to submission to the engineer.

B. Shop Drawings: Submit shop drawings containing the following information:

1. Schematic flow diagram of system showing fans, pumps, coils, dampers, valves, and control devices.
2. Label each control device with setting or adjustable range of control.
3. Indicate difference between factory and field wiring.
4. Indicate each control panel required, with internal and external piping and wiring clearly indicated. Provide detail of panel face, including controls, instruments, and labeling.
5. Include verbal description of sequence of operation.
6. Maintenance Data: Include copy of all shop drawings in each maintenance manual.
7. When preparing submittals and programming, use a room number schedule generated by the architect and/or the owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, revise the initial submittal when a schedule is available, to reflect the proper room numbers.

PART 2 - PRODUCTS

2.1 Not Applicable

PART 3 - EXECUTION

3.1 BUILDING MANAGEMENT SYSTEM

A. The BMS shall include all hardware, software and programming required to fully execute all control sequences and monitor all control points described in this specification. The BMS shall have the capabilities to perform the control strategies, energy management functions, and building management functions. All BMS software shall reside on the Operator Workstation to be located within the building at a location to be determined.

1. Set Point Control: The BMS shall have full editing capabilities for any set point listed in these control sequences regardless of whether set point control logic resides in a local control unit or the building management software. All controls shall be capable of fully executing all control sequences in the event of a communication loss between the BMS operator workstation and any local control unit(s).
2. Operating Mode Control: The BMS shall have full 24-hour / 365-day scheduling capabilities for occupied/unoccupied modes of operation for all systems regardless of whether sequencing logic resides in a local control unit or the building management software. Provide programming that utilizes various global commands for zoning portions of the building as required by the owner. The control system shall be capable of fully executing all schedule sequences in the event of a communication loss between the operator workstation and any local control unit(s).
3. Control Offset: The BMS shall be capable of offsetting the control set points for any heating/cooling system equipment by an operator adjustable amount. This capability will allow for automatic set point changes based on system requirements, such as demand limiting.
4. Alarm Management: The BMS shall monitor, buffer, and direct alarm reports to operator devices and memory files. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three (3) priority levels shall be provided. Each local control unit as well as the BMS software shall be capable of performing distributed, independent alarm analysis and filtering based on priority level.

    a. The conditions under which alarms need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date shall be definable by the user.
    b. Report Routing: Alarm, reports, messages, and files will be directed to a user-defined list of operator devices for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
    c. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.
    d. Auto-Dial Alarm: The user shall define which critical alarms shall initiate a call to a remote operator device.

5. Historical Data and Trending: The BMS shall be capable of automatically sampling, storing, and displaying system data and as a minimum do so in the flowing ways:

    a. Continuous Point Histories: A point history routine shall continuously and automatically sample the value of all analog and binary inputs and outputs at fifteen-minute intervals. Samples shall be stored for the past 72 hours to allow the user to immediately analyze equipment performance and all problem-related events. History files shall include a continuous record of the last ten status changes or commands for each point.

b. Control Loop Performance Trends: Operator adjustable resolution sampling of 10-300 seconds in 1-second increments for verification of control loop performance.
c. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting performance data over extended periods of time. Sample intervals of 1-minute to 2-hours, in 1-minute intervals, shall be provided.
d. Data Storage and Archiving: Trend data shall be uploaded from local unit controllers to the Operator Workstation at user-defined intervals or when the trend buffers become full. All trend data shall be available in disk file form for use in third party personal computer applications.

6. Totalization: The BMS shall be capable of automatically sampling, storing, and displaying totals as follows:

a. Runtime: Automatically accumulate, store, and display runtime hours for binary input and output points as specified in sequence of operations specifications. The totalization routine shall have a sampling resolution of 1-minute or less. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
b. Analog/Pulse: Automatically sample, calculate, store and display consumption totals on a daily basis for user selected analog and binary pulse input-type points. The totalization routine shall have a sampling resolution of 1-minute or less. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
c. Event: Automatically count, store, and display event occurrences (such as the number of times a pump or fan system is cycled) on a daily basis for user selected events.

3.2 TEMPERATURE SETTINGS

A. All temperatures shown in the control sequences are indicated in degrees Fahrenheit. The temperature settings shall be fully adjustable through the use of simple key stokes on the operator workstation.

B. Unless otherwise indicated in the sequences the initial settings are to be as follows:

1. Unoccupied heating: 60 degrees F.
2. Unoccupied cooling: 80 degrees F.
3. Occupied heating: 70 degrees F.
4. Occupied cooling: 75 degrees F.
5. Space humidity: 58%.

3.3 HOT WATER SYSTEM SEQUENCE

A. The hot water system plant, including all associated boilers, pumps, and controls, is existing to remain. Modify the existing controls to eliminate the hot water reset valve and allow the hot water supply temperature to be controlled by the existing Boiler Sequence Control System (BSCS).

B. Reprogramming of the existing BSCS shall be completed by a factory authorized technician.

C. Remove all points and graphics associated with the hot water reset valve from the BMS and graphics.

3.4 EXISTING AIR HANDLING UNIT (existing AHU-1)

A. This existing exterior modular air handling unit served a single zone system that shall be renovated to a system with shut-off and fan-powered air terminal units. Modify existing control components, wiring, and programming as required to complete the following sequence. Portions of the sequence indicated in *italics* are previously implemented on this existing unit. BMS installer shall verify operation of all existing controls.

B. The air handling unit serves areas conditioned with fan powered and/or shut-off type variable air volume units. The unit contains a variable speed supply fan, hydronic pre-heat coil, chilled-water cooling coil, filters, air flow monitoring, and other components.

C. The unit shall be controlled by the BMS and shall be indexed to the occupied and unoccupied settings at the fully adjustable programmed times. Provide optimal start/stop programming.

D. Provide control wiring between the unit starter and a relay furnished by others to allow for fan(s) shut down when the fire alarm system activates. If activated close all outdoor air dampers.

E. Space temperatures shall be controlled by room temperature sensors for each fan powered or shut-off variable air volume units. The minimum and maximum heating and cooling set points shall be set at the operator workstation.

F. Provide fully modulating heating control valves that fail in the open position. Provide fully modulating chilled water control valves that fail in the last position. Outdoor air dampers are to fail in the closed position with return dampers failing in the open position.

G. Freeze Protection: Provide a freeze stat, with manual reset, serpentined across the leaving air side of the heating coil and provide programming per the following sequence if the leaving air temperature falls below 35 Degrees F (adjustable):

1. Signal an alarm on the operator workstation.
2. Close the outdoor air dampers.
3. Fully open the heating coil control valve.
4. Stop the fans.

H. In unoccupied modes provide controls to monitor the temperature in the mixed air section of the air handling unit. When the outdoor air temperature is below 35 deg. F. (adjustable) and the temperature in the mixed air section falls below 35 deg. open the heating coil control valve to maintain a temperature of 40 Deg. F (adjustable) in the unit section.

I. Provide a transducer to monitor and record pressure drop across the cartridge filters in the air-handling unit. An alarm will be activated at the BMS workstation if the actual filter pressure drop exceeds the dirty filter pressure drop established by the TAB Contractor.

J. Fan Pressure Optimization Control: At a frequency of once every 2 minutes, the BMS shall monitor the damper position of all VAV terminal units. The BMS shall calculate a new supply fan duct static pressure set point based on the position of the furthest open VAV damper, and send this newly-calculated set point to the AHU controller. When any VAV damper is more than 75% (adjustable) open, the supply fan duct static pressure set point shall be reset upward by 5% until no damper is more than 75% (adjustable) open or the static pressure set point has reset to the maximum setting. When all VAV dampers are less than 65% (adjustable) open, the supply fan duct static pressure set point shall be reset downward by 5% until at least one damper is more than 65% (adjustable) open or the static pressure set point has reset to the minimum setting.

K. Duct System Static Pressure Limit Control: Provide a supply duct static pressure sensors located at approximately two-thirds of the total supply duct distance. The system shall decrease the unit supply fan(s)

and alarm the system if the supply duct static pressure is above the set point. The sensor shall be hardwired and have an automatic reset. The initial duct static pressure set point shall be +1.5" w.c. The TABC will determine the final static pressure set point.

L. Duct System Static Pressure High Limit Safety: Provide a high static pressure sensor, located at the supply fan discharge. The system shall stop the unit fan(s) and alarm the system if the supply duct static pressure is above the high limit set point. The sensor is to be hardwired with manual reset. The initial set point for this sensor is to be +3.0" w.c. with final adjustment by the TABC Contractor.

M. Ventilation Optimization Control: The actual outdoor air flow shall be sensed at the outdoor air intake of the air handling unit and controlled to an air flow set point determined according to ASHRAE Standard 62.1. When the BMS indicates the air handling unit is occupied, the required outdoor airflow for that system shall equal the design outdoor airflow. The required outdoor-air fraction (current required outdoor airflow divided by the current primary airflow) shall be continuously calculated for each VAV terminal unit. At a frequency of once every 2 minutes, the BMS shall gather this data from all VAV terminal units, calculate the minimum required outdoor airflow for the system according to ASHRAE 62.1, and send this newly-calculated outdoor airflow set point to the AHU controller. Monitor ventilation airflow c.f.m.

N. Unoccupied heating cycle:

1. The air handling unit fans will be off and all outside air and relief air dampers will be closed.
2. When the space temperature in any 5 (fully adjustable) areas, is below the unoccupied heating setpoint, start the AHU supply fan.
3. Modulate the supply fan based on Fan Pressure Optimization Control and modulate the heating coil control valve to maintain a leaving air temperature of 60-degrees F (adjustable).
4. VAV boxes will operate per the unoccupied sequence.
5. When the setback temperature has been restored, reverse the above sequence.

O. Unoccupied cooling cycle: Two modes of operation shall be available. One mode is to have no cooling with all fans off and the outside air damper will be closed. The second mode is for a higher space cooling setpoint, which is described as follows:

1. The air handling unit fans will be off and all outside air and relief air dampers will be closed.
2. When the space temperature in any of 5 areas (adjustable), is above the unoccupied cooling setpoint, start the AHU supply fan.
3. Modulate the supply fan based on Fan Pressure Optimization Control and modulate the cooling coil control valve to maintain a leaving air temperature of 54-degrees F (adjustable).
4. VAV boxes will operate per the unoccupied sequence.
5. When the unoccupied temperature has been restored, reverse the sequence.

P. Occupied heating cycle:

1. Warm-up: provide optimal start through the BMS to index the respective zone to the occupied status. At this time, the unit will operate in the same mode as the unoccupied heating cycle. When the space temperatures reach the occupied set point the unit will operate in the occupied heating cycle.
2. During the occupied cycle the supply fan shall run continuously and modulate based on Fan Pressure Optimization Control.
3. Modulate the heating coil control valve to maintain a fully adjustable leaving air temperature with an initial set point of 60-degrees F. (adjustable).
4. Modulate the outdoor air damper to provide Ventilation Optimization Control.
5. Gravity relief vent dampers shall open to maintain the proper space pressure in relationship to the atmosphere at no more than +0.025” water column (adjustable).
6. Provide programming to reset the supply air temperature based on the outdoor air temperature with the set points fully adjustable. Provide the following initial set points:

a. Outdoor air temperature below 30-degrees F: 60-degrees F.
b. Outdoor air temperature 31 to 55-degrees F: 58-degrees F.

Q. Occupied cycle cooling:

1. Cool-down: provide optimal start through the BMS to index the respective zone to the occupied status. At this time, the unit will operate in the same mode as the unoccupied cooling cycle. When the space temperature reaches the occupied set point the unit will operate in the occupied cooling cycle.
2. During the occupied cycle the supply fan shall run continuously and modulate based on Fan Pressure Optimization Control.
3. Modulate the cooling coil control valve to maintain a fully adjustable leaving air temperature with an initial set point of 54-degrees F. (adjustable).
4. Modulate the outdoor air damper to provide Ventilation Optimization Control.
5. Gravity relief vent dampers shall open to maintain the proper space pressure in relationship to the atmosphere at no more than +0.025” water column (adjustable).
6. Provide programming to reset the supply air temperature based on the outdoor air temperature with the set points shall be fully adjustable. Provide the following initial set points:

   a. Outdoor air temperature above 80 degrees F – 54 degrees F.
   b. Outdoor air temperature 58 to 80 degrees F – 58 degrees F.

7. Provide controls for economizer cooling. If the enthalpy of the outdoor air is less than the enthalpy of the respective indoor spaces, allow the unit to operate in an economizer mode. Modulate the outdoor air damper(s) up to 100-percent open to maintain a fully adjustable leaving air temperature with the initial set point of 54-degrees F. Continue this sequence while unit remains in economizer cooling. When conditions are no longer acceptable to operate in economizer cooling, return the unit back to mechanical cooling.

R. Dehumidification Mode: The air handling unit will operate in both the occupied and unoccupied cycles to provide dehumidification. During occupied cycles, the unit shall operate in dehumidification mode when the return air is above 60% RH and shall terminate when below 55%. Provide a minimum of two space temperature humidity sensors located in representative spaces within area served to enable and disable dehumidification mode when unit is unoccupied. During unoccupied cycles, the unit shall operate in dehumidification mode when the spaces are both above 65% RH and shall terminate when below 60% RH.

1. Modulate the cooling coil control valve to maintain a leaving air temperature of 54 degrees F.
2. All associated VAV terminal units shall index to cooling airflow.
3. Modulate VAV terminal unit reheat coils to maintain space temperature setpoints.
4. Dehumidification mode shall only be enabled when boilers are operating.

S. Also refer to VAV sequences for additional requirements.

T. The BMS shall display the following monitoring points on a custom graphic at the operator workstation:

1. System status (Occupied / Unoccupied) - indication and adjustment.
2. Supply fan status - indication and alarm.
3. Supply V.F.D. status: indication and alarm.
4. Supply duct static pressure setting - indication and adjustment.
5. Supply duct static pressure - indication and alarm.
6. Heating coil control valve position - indication.
7. Cooling coil control valve position - indication.
8. Final filter differential pressure - indication and alarm.
9. Mixed-air-temperature - indication.
10. Supply air temperature setpoint - indication and adjustment.

11. *Supply air temperature - indication and alarm.*
12. *Return air temperature – indication and alarm.*
13. Outdoor airflow c.f.m. setpoint - indication.
14. *Outdoor airflow c.f.m. - indication.*
15. *Smoke detector status - indication and alarm.*
16. *Freeze stat status - indication and alarm.*
17. *Space temperature(s) set point - indication and adjustment.*
18. *Space temperature(s) - indication.*
19. Building pressurization: indication and adjustment.
20. Humidity set point: indication and adjustment.
21. Space humidity: indication and alarm.
22. Return air humidity: indication and alarm.
23. Economizer: indication.

3.5 EXISTING AIR HANDLING UNITS (existing AHU-2, 3, 4, 5, 6, 7, and 8)

A. This existing exterior modular air handling unit serves a system with shut-off and fan-powered air terminal units. Modify existing control components, wiring, and programming as required to add the following sequence. BMS installer shall verify operation of all existing controls.

B. Dehumidification Mode: The air handling unit will operate in both the occupied and unoccupied cycles to provide dehumidification. During occupied cycles, the unit shall operate in dehumidification mode when the return air is above 60% RH and shall terminate when below 55%. Provide a minimum of two space temperature humidity sensors located in representative spaces within area served to enable and disable dehumidification mode when unit is unoccupied. During unoccupied cycles, the unit shall operate in dehumidification mode when the spaces are both above 65% RH and shall terminate when below 60% RH.

1. Modulate the cooling coil control valve to maintain a leaving air temperature of 54 degrees F.
2. All associated VAV terminal units shall index to cooling airflow.
3. Modulate VAV terminal unit reheat coils to maintain space temperature setpoints.
4. Dehumidification mode shall only be enabled when boilers are operating.

C. Add the following monitoring points on the existing BMS custom graphic at the operator workstation:

1. Humidity set point: indication and adjustment.
2. Space humidity: indication and alarm.
3. Return air humidity: indication and alarm.

3.6 FAN-POWERED AIR TERMINAL UNITS (FPV)

A. Control of the units will be through the BMS system with all controls furnished by the BMS supplier / installer. The units shall be indexed to the occupied and unoccupied settings at the fully adjustable programmed times. Provide optimal start/stop programing.

B. Provide a room sensor with adjustable setpoints for all variable air volume units. Refer to individual air handling unit sequence to determine which units require humidity sensors. The minimum and maximum room setpoints shall be adjusted through the BMS.

C. Provide a modulating control valve for the associated hydronic heating coil. Refer to the drawings for the required valve configurations. Valves are to fail in the last position.

D. Unoccupied heating: the primary air valve shall be open to 10% (adjustable). When the space temperature is below the unoccupied setpoint, cycle the unit fan and modulate the heating coil control valve to satisfy

the setpoint. Some systems will use the air handling unit fan to provide unoccupied heat. In this case, also modulate the primary air valve to maintain the minimum airflow.

E. Unoccupied cooling: the primary air valve shall be open to 10% (adjustable). When the associated air handling unit energizes and the space temperature is above the unoccupied setpoint, cycle the fan and modulate the primary air damper from minimum to maximum cooling to maintain the unoccupied space temperature. Reverse the sequence when the space temperature is above the unoccupied setpoint.

F. Occupied: Modulate the primary air damper to maintain the required minimum airflow and operate the fan continuously. When the room temperature is above the cooling setpoint, gradually modulate open the primary air damper up to the maximum cooling airflow to maintain the cooling setpoint. As the space temperature is satisfied, gradually close the primary air damper to the minimum airflow. When the space temperature is below the room heating setpoint, the primary air damper shall remain at the minimum airflow and the heating coil control valve shall modulate to maintain the heating setpoint.

G. Dehumidification: when the associated air handling unit is operating in dehumidification mode, provide the following sequence:

1. Dehumidification shall be controlled at the unit level and therefore, all terminal units associated with the air handling unit shall operate in unison.
2. The fan shall operate continuously.
3. Modulate the primary air damper to maintain maximum cooling airflow.
4. Modulate the heating coil control valve to prevent over-cooling and therefore the space temperature from falling below the heating setpoint.
5. Resume the previous mode of operation when the air handling unit dehumidification mode is terminated.
6. Dehumidification mode shall only be enabled when boilers are operating.

H. Occupancy Control: Provide wiring and all required controls to allow all terminal units to enter a stand-by mode when indicated to do so by the room occupancy sensor. The occupancy sensor will be provided by others. When in the stand-by mode the fan will be off and the air inlet valve will be closed. If the room temperature falls more than 4 deg. F. (adjustable) below the normal room occupied heating temperature start the supply fan and open the heating coil control valve to heat the space. If the room temperature rises more than 4 deg. F. (adjustable) above the normal room occupied cooling temperature start the supply fan and open the vav box inlet valve to cool the space.

I. The BMS shall display the following monitoring points on a custom graphic at the operator workstation:

1. Room setpoint: indication and adjustment.
2. Room temperature: indication.
3. Room humidity level (where required): indication.
4. Primary minimum airflow setpoint: indication and adjustment.
5. Primary maximum airflow setpoint: indication and adjustment.
6. Primary airflow command: indication.
7. Primary airflow reading: indication and alarm.
8. Leaving air temperature setpoint: indication and adjustment.
9. Leaving air temperature: indication.

3.7 SHUT-OFF AIR TERMINAL UNITS (SOV)

A. Control of the units will be through the BMS system with all controls furnished by the BMS supplier / installer. The units shall be indexed to the occupied and unoccupied settings at the fully adjustable programmed times. Provide optimal start/stop programing.

B. Provide a room sensor with adjustable setpoints for all variable air volume units. Refer to individual air handling unit sequence to determine which units require humidity sensors. The minimum and maximum room setpoints shall be adjusted through the BMS.

C. Provide a modulating control valve for the associated hydronic heating coil. Refer to the drawings for the required valve configurations. Valves are to fail in the last position.

D. Unoccupied

1. The primary air valve shall be open to 10% (adjustable).
2. When the associated air handling unit energizes and the space temperature is below the unoccupied setpoint, open the primary air damper to the heating position and modulate the heating coil control valve to maintain the unoccupied space temperature. Reverse the sequence when the space temperature is above the unoccupied setpoint. This sequence shall only be enabled when the boilers are operating.
3. When the associated air handling unit energizes and the space temperature is above the unoccupied setpoint, modulate the primary air damper from minimum to maximum cooling to maintain the unoccupied space temperature. Reverse the sequence when the space temperature is above the unoccupied setpoint.

E. Occupied:

1. When the room setpoint is satisfied, modulate the primary air damper to maintain the required minimum airflow.
2. When the space temperature is above the room cooling setpoint, gradually modulate open the primary air damper up to the maximum cooling airflow to maintain the cooling setpoint.
3. When the space temperature is below the room heating setpoint, modulate the primary air damper to maintain the heating airflow and modulate the heating coil control valve to maintain the heating setpoint. This sequence shall only be enabled when the boilers are operating.

F. Dehumidification: When the associated air handling unit is in dehumidification mode, provide the following sequence:

1. Dehumidification shall be controlled at the unit level and therefore, all terminal units associated with the air handling unit shall operate in unison.
2. Modulate the primary air damper to maintain maximum cooling airflow.
3. Modulate the heating coil control valve to prevent over-cooling and therefore the space temperature from falling below the heating setpoint.
4. Resume the previous mode of operation when the air handling unit dehumidification mode is terminated.
5. Dehumidification mode shall only be enabled when boilers are operating.

G. The BMS shall monitor, record, and display the following monitoring points on a custom graphic at the operator workstation:

1. Room setpoint: indication and adjustment.
2. Room temperature: indication.
3. Room humidity level (where required): indication.
4. Primary minimum airflow setpoint: indication and adjustment.
5. Primary maximum cooling airflow setpoint: indication and adjustment.
6. Primary heating airflow setpoint: indication and adjustment.
7. Primary airflow command: indication and adjustment.
8. Primary airflow reading: indication and alarm.
9. Leaving air temperature setpoint: indication and adjustment.
10. Leaving air temperature: indication.

11. Fan command: indication and adjustment.
12. Fan status: indication and alarm.

3.8 EXISTING AIR TERMINAL UNITS (exFPV and exSOV)

A. Control of the units will be through the BMS system with all controls furnished by the BMS supplier / installer. The units shall be indexed to the occupied and unoccupied settings at the fully adjustable programmed times. Provide optimal start/stop programing.

B. Dehumidification: When the associated air handling unit is in dehumidification mode, provide the following sequence:

1. Dehumidification shall be controlled at the unit level and therefore, all terminal units associated with the air handling unit shall operate in unison.
2. Modulate the primary air damper to maintain maximum cooling airflow.
3. Modulate the heating coil control valve to prevent over-cooling and therefore the space temperature from falling below the heating setpoint.
4. Resume the previous mode of operation when the air handling unit dehumidification mode is terminated.
5. Dehumidification mode shall only be enabled when boilers are operating.

3.9 KITCHEN VENTILATION SYSTEMS (KVS-1 and KEF-1)

A. Provide control wiring between the unit starter and a relay furnished by this contractor to allow for fan(s) shut down when the fire alarm system activates. If activated close all outdoor air dampers.

B. The unit shall have the following safety controls: duct smoke detector located in the supply mains shall signal an alarm, interrupt power to the supply fan only, and close outside air dampers when products of combustion are sensed.

C. The ventilation equipment will be provided with controls to energize the system when the associated process equipment is energized and shall run continuously until the process equipment is de-energized. When the outside air temperature is 65 deg. F. (adjustable) or lower, a supply duct temperature sensor shall modulate the gas valve to the heating section to maintain a constant discharge temperature of 65 deg. F. (adjustable).

D. The BMS shall monitor, record, and display the following monitoring points on a custom graphic at the operator work station:

1. System status (on/off): indication.
2. Gas furnace status: indication.
3. Gas furnace leaving air temperature: indication.
4. Exhaust fan status: indication.

3.10 DUCTLESS SPLIT SYSTEMS

A. The units shall be controlled by the BMS.

B. Provide a space thermostat with adjustable set points. The minimum and maximum heating / cooling and humidity set points shall be set at the operator workstation.

C. Cooling Cycles: When the space temperature in a room is above or below the unoccupied fully adjustable set point, energize the respective unit to satisfy the unoccupied temperature. When the unoccupied space temperature has been restored, reverse the sequence.

D. The BMS shall monitor, record, and display the following points on a custom graphic at the operator workstation:

1. System status (Off/On): indication and adjustment.
2. System trouble alarm: indication and alarm.
3. Compressor status: indication and alarm.
4. Space temperatures, set point: indication and adjustment.
5. Space temperatures: indication.

3.11 EXHAUST FANS

A. Refer to the drawings for notes to indicate fans that are to be controlled by the BMS.

B. Provide controls for exhaust fans noted as "Time of Day Schedule" to allow the fan(s) to operate during the occupied cycle of the respective area. De-energize the fan(s) during the unoccupied cycle.

C. Where fans are noted to have a manual switch, provide an interlock to allow the fan(s) to operate during the occupied cycle of the respective area. De-energize the fan(s) during the unoccupied cycle.

D. Refer to the contract drawings for exhaust fans that are to be operated with an interlock to other equipment. Where so indicated, provide the required interlock and controls. Provide programming to prevent fan operation when the area is in an unoccupied mode.

E. Where noted as "Reverse Acting T'stat", provide a reverse acting thermostat in the space to energize the fan when the space temperature is above the set point. De-energize the fan when the space temperature is below set point. If required, provide motorized dampers as well as the required interlock with the fan and damper(s).

F. Where the drawings indicate a motor operated damper (MOD) is required, provide the damper, and control the damper to open when the fan is on and closed when the fan is off.

G. The BMS shall monitor, record, and display the following points on a custom graphic at the operator workstation:

1. Status for all fans: indication and adjustment.
2. Occupied and unoccupied scheduling: indication and adjustment.

3.12 DOMESTIC WATER SYSTEM PUMPS

A. Provide controls to start and stop all domestic hot water system re-circulating pumps based on a fully adjustable schedule that is to be determined by the owner.

B. Provide a alarm to indicate pump(s) failure.

C. The BMS shall display the following monitoring points on a custom graphic at the operator work station:

1. Status of all pumps: indication, adjustment, and alarm.

3.13 DOMESTIC HOT WATER SYSTEM DIGITAL MIXING VALVE

A. The mixing valve and control module will be furnished and installed by others. Provide integration to the mixing valve control module to allow remote control of the mixing valve. Record and display all available points provided by the Digital Mixing Valve Control Module. At a minimum the BMS shall display the following monitoring points on a custom graphic at the operator workstation:

1. Valve position: indication.
2. Mixed outlet temperature setpoint: indication and adjustment.
3. Mixed outlet temperature: indication and alarm.
4. Supervisory alarm: indication and alarm.

3.14 LIGHTING CONTROL INTERFACE

A. Provide a web link to the lighting control system “Home Page” so that the use may enter the lighting control system without leaving the BMS.

B. In addition to the web link, provide a digital connection with the lighting control system utilizing BACnet over TCP to display information from the lighting control system and to control particular features as listed. Coordinate with the appropriate contractor.

1. Provide wiring, gateways and other equipment as required to communicate with system.
2. Refer to electrical drawings and specifications for coordination.

C. The lighting control system will initially operate as described in Division 26 Specifications. Provide a schedule to provide occupied/unoccupied modes to the lighting control system. Provide an additional schedule for exterior lighting, time-of-day control.

3.15 STATIC UNINTERRUPTIBLE POWER SUPPLY

A. Locate the static uninterruptible power supply on a graphical floor plan with a "clickable" icon to link the user to the following information.

B. Provide an interconnection with the static uninterruptible power supply specified in the 26 division using IP connection with communications utilizing the Modbus protocol. Coordinate the connection and programming with the division 26 contractor.

1. Provide wiring, gateways and other equipment as required to communicate with system.
2. Refer to electrical drawings and specifications for coordination and additional information.

C. Information to be displayed at the static uninterruptible power supply shall be as follows:

1. Nominal Input Voltage
2. Nominal Input Frequency
3. Nominal Output Voltage
4. Nominal Output Frequency
5. Nominal VA Rating
6. Nominal Output Power
7. Nominal Battery Life
8. The Following Alarms (at a minimum):

a. Temperature
b. Overload

c. UPS Shutdown
d. Charger Failure
e. System Off
f. Fan Failure
g. Fuse Failure
h. Shutdown Pending
i. Shutdown Imminent
j. General Fault

D. In addition to the instantaneous information listed above, the BMS shall provide the following trending from the building power meters:

1. Provide trending for the input voltage and frequency, output voltage and frequency, VA rating and output power. This information shall be able to be displayed in a graphic form (both tabular as well as x/y chart). Trending shall be performed on a daily, monthly and annually basis.

3.16 MISCELLANEOUS POINTS

A. The BMS shall monitor, record, and display the following points on a custom graphic at the operator workstation:

1. Provide additional (10) monitoring points to be used as directed by owner.

END OF SECTION 23 09 05

SECTION 23 21 10 - HYDRONIC 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 pipe and fitting materials, joining methods, special-duty valves, and specialties for the piping systems.

B. Water treatment work is part of the HVAC contract and shall be completed by the following:
ProAsys
318 Hendel Steet
Shillington, PA 19607
610-775-1505

1.3 SUBMITTALS

A. Product Data: For each type of the following:

1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves.
2. Air control devices.
3. Hydronic specialties.
4. Grooved joint pipe couplings and fitting.
5. Water Treatment provider. Provide verification of experience including a list of completed projects, similar to the size and scope of this project, and a list of references for those projects.

B. Shop Drawings: Detail the piping layout indicating dimensions and elevations of all piping.

C. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. The installation is to conform to the requirements of the 2018 International Mechanical Code and any applicable local codes. Verify local code requirements with the Authority Having Jurisdiction.

B. 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.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

D. All grooved joint couplings, fittings, valves and other specialties shall be provided from a single manufacturer. Grooving tools shall be from the same manufacturer as the grooved components. All castings used for coupling housings, valve bodies, fittings, etc. shall be date stamped for traceability and quality control.

E. Pressure seal piping systems: Installer shall be a qualified installer, licensed within the jurisdiction, and familiar with the installation of the copper press joint system. The copper press fittings shall be installed using the proper tool, actuator, jaws and rings as instructed by the press fitting manufacturer. The installation of copper tubing in Hydronic systems shall conform to the requirements of the ICC International Mechanical Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 125 psig at 200 deg. F.
2. Chilled-Water Piping: 125 psig at 100 deg F.
3. Condensate-Drain Piping: 150 deg. F.
4. Air-Vent Piping: 200 deg. F.
5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings and Unions: ASME B16.22.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

2.3 PRESSURE SEAL PIPING SYSTEMS

A. Subject to compliance with requirements, provide products manufactured by Veiga LLC or NIBCO Inc.

1. Copper tubing shall conform to ASTM B 75 or ASTM B88.
2. Copper fittings shall conform to ASME B16.18, ASME B16.22 or ASME B16.26.
3. Press Fitting: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed.
4. System to have minimum 200-psig working-pressure rating at 250 deg F.

2.4 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, 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. Grooved Mechanical-Joint Piping Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by Victaulic Company of America or Anvil International.
2. Steel Pipe: ASTM A 53, carbon steel, schedule 40, roll or cut grooved ends.
3. Fittings: ASTM A 395, grade 65-45-12 ductile iron; ASTM A 536, grade 65-45-12 wrought steel conforming to ASTM A-235/A 53M, Type F, E, or S, Grade B factory fabricated steel; or ASTM A 234, Grade WPB steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, to secure grooved pipe and fittings.
4. Couplings: Ductile iron conforming to ASTM A-536, Grade 65-45-12.

    a. NPS 2 through NPS 8; rigid coupling with high temperature range (-30 degrees F to 250 degrees F; Grade EP EPDM gasket.
    b. NPS 10 through NPS 12; rigid coupling with Grade EP EPDM gasket (-30 degrees F to 230 degrees F).
    c. NPS 2 through NPS 12: flexible coupling for use in locations where vibration attenuation and stress relief is required. Three flexible couplings may be used in lieu of a flexible connector.

I. Mechanical-Joint Piping Systems:

1. Manufacturers: Victaulic Company of America, Quick-Vic Systems.
2. Steel Pipe: ASTM A 53, schedule 40.
3. Couplings and Fittings: ASTM A 536, grade 65-45-12.
4. Gaskets: Grade EHP EPDM (-30 degrees F to +250 degrees F).

J. Carbon Steel Press-Connect Fittings

1. Manufacturers: Subject to compliance with requirements, provide products by Veiga LLC.

2. Listed to ASTM F3226, ICC-ES AC156, ASME B31.1, B31.3, and B31.9 standards.
3. Approved for use with ASTM A53 Schedule 5 to 40 carbon steel pipe with up to 50% Ethylene / Propylene glycol mix.
4. Carbon steel alloy fitting with corrosion-resistant zinc/nickel coating.
5. Sealing element shall be uniform in size/width and free from manufactured deformities or indentations.

    a. NPS 3/4 through NPS 2; EPDM sealing element rated to 200 psi (max) with a temperature range of 0-250 degrees (F) and ≤50% Ethylene / Propylene glycol.
    b. NPS 3/4 through NPS 4; FKM sealing element rated to 200 psi (max) with a temperature range of 14-284 degrees (F) and temperature spikes (24hr) up to 356 degrees (F) and ≤50% Ethylene / Propylene glycol.

6. 420 stainless steel grip ring.
7. 304 stainless steel separator ring for 1/2“ to 2“, graphite separator ring for 2-1/2“ to 4“.
8. Color-coded markings on exterior of fitting for readily identifying/inspecting sealing element type.
9. Press Connect fitting shall have the Viega Smart Connect feature to detect unpressed fittings during the testing process.
10. Single source manufacturer. Technology and installation instructions vary between manufacturers. Installers shall have current training credentials issued from selected manufacturer by on-site representative.
11. Join pipe and press-connect fittings with recommended tooling.

2.5 JOINING MATERIALS

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

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

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

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

E. Grooved Joint Lubricants: lubricate gaskets using a lubricant supplied by the coupling manufacturer. Lubricant shall be suitable for the gasket elastomer and fluid media.

1. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.6 EXPANSION FITTINGS AND COMPENSATORS

A. Grooved Mechanical-Joint Piping Systems:

1. Victaulic Style 150 Mover slip type expansion joint with 3” axial movement. Designed for service temperature to 230 degrees F and a working pressure of 350 psi maximum. Provide Grade “E” EPDM gaskets.

2. Victaulic Flexible Loop Series 159 with 4' axial movement: Designed for service temperatures to 350 degrees F. maximum and working pressure of 150 psi. Schedule 40 carbon steel end connections and 321 stainless steel corrugated hose.

B. Welded or Soldered Joint Piping Systems: Provide in-line expansion compensators manufactured by Hyspan Precision Products or Metraflex Inc. Compensators to be rated for a maximum pressure of 175 psi and 230 degrees F. operating temperature.

2.7 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 Flanges:

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

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

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

D. Dielectric Couplings:

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

a. Calpico, Inc.
b. Lochinvar Corporation.

2. Galvanized-steel coupling with inert and non-corrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg. F.

E. 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. Victaulic Company of America.

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.

2.8 VALVES AND SPECIALTIES

A. Calibrated Balancing Valves:

1. Provide pressure independent and field adjustable venture type manual balancing valves.
2. Valves ½" to 2": to have venturi type bronze body, chrome plated ball, EPDM seals. Provide pressure & temperature test ports across valve measurement area. Ports to be fitted with dual

durometer EPDM cores, brass cap & O-ring seal. Valves to have drain/purge port. Provide valve with memory stop, memory lock & calibrated position indicator. Valves to be rated at 200 PSIG at 250º F and be 100% positive shut-off. Measurement accuracy to be +/- 3%.

3. Valves 2-1/2" & Larger: to have venturi type cast carbon steel/ductile iron body, with SS steam, EPDM seat & Buna seals. Provide memory stop, memory lock & calibrated position indicator. Valves to be rated at 200 PSIG at 225º F and be 100% positive shut-off. Measurement accuracy to be +/- 3%.

B. Coil hook-up kits

1. The contractor may provide coil hook-up kits for connections to coils. The kits shall be comprised of the following items:

   a. Calibrated balancing valves as indicated in 2.9.A.
   b. Shut-off valves.
   c. Strainers.
   d. Other components indicated on the drawings.

C. Flow Meters:

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

   a. Bell & Gossett Domestic Pump; a division of ITT Industries or equal.

2. Description: Differential-pressure-design wafer type orifice insert for installation between pipe flanges; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid. Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.
3. Construction: Cast-iron body, brass valves with integral EPT check valves and caps, and calibrated nameplate.
4. Temperature/Pressure Rating: 250 degrees F. at 250 psig.

D. System Fill Pressure-Reducing Valves:

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

   a. Amtrol, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Bronze body construction with NPT threaded inlet and outlet connections, a tight seating check valve, purge lever for manual purging, and built-in integral strainer. High capacity performance suitable for use in hydronic heating and cooling systems. Maximum Pressure: 100psi.

E. Safety Relief Valves (Diaphragm-Operated):

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

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: for NPT ¾" and 1", Bronze with 125 PSIG maximum working pressure and 250-degree F. maximum operating temperature.
3. Body: for NPT 1 ½" and 2", Cast Iron with 50 PSIG maximum working pressure and 250-degree F. maximum operating temperature.
4. Diaphragm and Seat: EPDM.
5. Wetted, Internal Work Parts: Brass.
6. Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Mechanical Sleeve Seals:

1. Manufacturers: The Metraflex Co. of Flexcraft Industries.
2. Description: Pipe wall penetration seals to be of the modular link type. Seals shall consist of a series of interlocking, molded synthetic rubber links, with heavy-duty plastic pressure plates, and corrosion resistant nuts and bolts. Seals to be designed to provide a hydrostatic seal between the pipe and wall penetration. Seals shall be sized and selected per manufacturer recommendations. Mechanical pipe seals shall be fabricated of an EPDM elastomer for general service and a Nitrile/ Buna-N for hydrocarbon/petroleum based applications. Provide stainless steel hardware as required.
3. Steel wall sleeve: Cast in place concrete wall sleeves to be fabricated from galvanized heavy wall welded or seamless carbon steel pipe. All sleeves to have a 2" wide, full perimeter water stop, welded on both sides.

2.9 AIR CONTROL DEVICES

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

1. Amtrol, Inc.
2. Bell & Gossett Domestic Pump; a division of ITT Industries.
3. Taco.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. CWP Rating: 150 psig (1035 kPa).
4. Maximum Operating Temperature: 225 deg. F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg. F.

D. Expansion Tanks/Diaphragm Bladder-:

1. Tank: Welded steel, rated for 125-psig working pressure and 240 deg. F. maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Diaphragm/Bladder: Heavy duty Butyl Rubber, securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

E. In-Line Air Separators:

1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig.
3. Maximum Operating Temperature: Up to 300 deg. F.

F. Air Purgers:

1. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
2. Maximum Working Pressure: 150 psig.
3. Maximum Operating Temperature: 250 deg. F.

2.10 WATER TREATMENT

A. HVAC System water treatment shall be provided by the firm indicated in Paragraph 1.2.B

B. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for chilled water systems, hydronic heating systems, hot-water piping and equipment. Services and chemicals shall be provided for a period of one year from the date of Substantial Completion, and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation consisting of a minimum of one site visit per month.
4. Provide reports indicating the type of treatment and date of the site visit.
5. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

2.11 CHEMICAL TREATMENT AND EQUIPMENT

A. Chemicals: Provide specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

B. Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

2.12 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers: Subject to compliance with requirements, provide products by Metraflex, Hoffman Specialty, Armstrong or equal:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded or sweat for NPS 2 and smaller: grooved or flanged for NPS 2-1/2 and larger.
3. Strainer Screen: perforated stainless steel with 50 percent total free area.
4. CWP Rating: 150 psig.

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg. F.
6. Three Victaulic Style 77 couplings may be used in lieu of a flexible for vibration attenuation and stress relief at equipment connections. The couplings shall be in close proximity to the vibration source.

C. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg. F.

2.13 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides: Where required provide alignment guides manufactured by Metraflex Inc or equal. Guides to be factory-fabricated alignment guides suitable for installation with insulated piping where applicable.

B. Anchors: Provide factory fabricated anchors manufactured by Metraflex or equal. In lieu of factory fabricated anchors provide field fabricated anchors fabricated from ASTM A36 / A36M steel shapes and plates.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating and chilled water piping, aboveground, NPS 2 and smaller, shall be one of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
3. Pressure seal piping systems.
4. Victaulic Quick-Vic systems.
5. Carbon steel press-connect fittings.

B. Hot-water heating and chilled water piping, aboveground, NPS 2-1/2 and larger, shall be:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, welded and flanged joints, and carbon steel press-connect fittings.
3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

    a. Provide high temperature couplings at all connections to boilers and heat exchangers and on all heating system piping located within the boiler room.

b. Provide flexible couplings at connections to all pumps.

C. Makeup-water piping installed aboveground shall be:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Makeup-Water Piping Installed Belowground and within Slabs: Type K (A), annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

E. Condensate-Drain Piping:

1. Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Install condensate drain piping at a minimum slope of 1% in the direction of flow.

F. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

G. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
2. Outlet: Type K (A), annealed-temper copper tubing with soldered or flared joints.

H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.2 VALVE APPLICATIONS

A. Install shut off-duty valves at each branch connection to supply mains, and at supply and return connection to each piece of terminal equipment and at other locations indicated on the drawings. All valves are to be installed in an accessible location.

B. Install calibrated balancing valves in the return pipe of each heating or cooling terminal and elsewhere as shown on the drawings. Valves are to be installed with the test ports facing 40 degrees to vertical above the centerline of the pipe.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Where indicated, install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

F. Isolation valves for each boiler are to be labeled with warnings required by the PA Department of Labor and Industry. Verify requirement before installation begins.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general routing, location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings. Provide offsets where required to clear steel, electrical conduit and / or other construction components.

B. Install cast-iron sleeve with water stop and provide Mechanical Sleeve Seal where HVAC piping penetrates a foundation wall or exterior. Select number of interlocking rubber links required to make installation watertight.

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

D. Install piping 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 fittings for changes in direction and branch connections. Install piping to allow application of insulation.

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

I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

J. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

K. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

L. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

M. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

N. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

O. Install unions or flanges at the inlet and outlet of all control valves.

P. 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, ball valve and hose connection in blowdown connection of strainers. Match size of strainer blow-off connection for strainers smaller than NPS 2.

Q. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

R. Provide Firestopping at all rated partitions. Provide a caulked and sealed installation at all non-rated partitions.

3.4 HANGERS AND SUPPORTS

A. Support all HVAC system piping to conform to ASME B31.9. Provide adjustable clevis hangers for all horizontal piping. Each hanger shall allow for adjustment, after installation, while supporting the pipe. Attach hangers to structural steel in accordance with MSS SP-69 and MSS SP-89. Install piping hangers and supports to provide the indicated pipe slopes.

B. Provide miscellaneous structural steel for support of HVAC equipment and piping. In areas with exposed construction, install miscellaneous supports prior to painting of ceiling and walls.

C. Provide a 12” long 18 gage protective saddle for all clevis hangers that support insulated piping.

D. Use carbon-steel pipe hangers and supports and attachments for general service applications.

E. Use stainless-steel pipe hangers or fiberglass pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Install hangers for steel piping with the following maximum spacing:

1. NPS 3/4 to NPS 2: 8 feet maximum horizontal spacing.
2. NPS 2 and larger: 12 feet maximum horizontal spacing.
3. Vertical supports at roof, at each floor, and at 10-foot maximum intervals.

H. Install hangers for drawn-temper copper tubing with the following maximum spacing: a

1. NPS 1-1/4 and smaller: 6 feet maximum horizontal spacing.
2. NPS 1-1/2 and larger: 10 feet maximum horizontal spacing.
3. Vertical supports at roof, at each floor, and at 10-foot maximum intervals.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: 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.
4. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
b. 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.

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

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

D. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts in accordance with the manufacturer's written instructions. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings of the same manufacturer.

1. The grooved couplings factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and the installation of grooved joints.
2. The representative shall visit the job site periodically to review the installation and verify the system is being installed per the manufacturer's recommendations.
3. A direct employee of the grooved piping system manufacturer must conduct the training and site visits. A distributor representative is not acceptable.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at all high points in all piping systems, at heat-transfer coils, where required for system air venting and at locations indicated on the drawings.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Where indicated, install air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Where indicated, install tangential air separator in pump suction piping.

F. Install bypass chemical filter/feeders in each hydronic system where indicated, in upright position with top of unit more than 48 inches above the floor. Install feeder with bypass line, full-size ball valve and balancing valve. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a ball valve. Verify installation details with the manufacturer to verify inlet and outlet connection locations.

G. Install expansion tanks on the floor or properly suspended from the structure. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system project requirements. Provide ASME relief valves and pressure gauges on all expansion tanks per PA Labor and Industry requirements. Connect piping from the system to the expansion tank and the side of the pipe main, not the top or bottom of the main.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections. Install control valves in accessible locations close to connected equipment.

B. Provide shut-off valves on the supply and return connections to all terminal equipment. Where indicated, install bypass piping with ball or butterfly valve around control valve.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

D. Connections to any control valve, shut-off valve, strainer, balancing devices or other similar devices with bronze construction shall be made with an adapter fitting and/or nipple made of the same material.

3.8 CHEMICAL TREATMENT

A. For the initial system fill perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep the chilled water and heating hot water system free of scale, corrosion, and fouling, and to sustain the proper water characteristics. Sample water at one-week intervals after equipment startup for a period of six weeks, and prepare test report. Sample water at four-week intervals following the testing noted above to show that automatic chemical-feed systems are maintaining water quality within performance requirements.

B. At four-week intervals following Substantial Completion, perform separate water analyses on all hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements.

C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

D. Prior to start-up of any HVAC equipment, provide the required type of water treatment for all closed loop and open systems including but not limited to

1. Closed loop heating system.
2. Closed loop chilled water system.
3. Closed loop heat pump systems.
4. Open circuit cooling tower systems.
5. Natatorium system.
6. Snow melt systems.

E. Provide initial chemical treatment of all systems and maintain the required water quality within the proper ranges for a period of one year after the date of substantial completion. If the project has multiple construction phases, the date of substantial completion for the final phase of construction shall be used to begin the time period for water treatment.

3.9 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 all strainer screens. If the project has multiple construction phases provide the necessary labor and materials for flushing and cleaning of the hydronic system for each phase.
4. Utilize chiller bypass valve to isolate the chiller evaporator from the chilled water system during initial system flushing.
5. 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.
6. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Clean all new and existing to remain strainer screens installed throughout the building prior to hydronic system balancing. This includes strainer screens at system pumps and all air handling units and terminal equipment. All system screens shall be free of substantial dirt, debris, metal filings, and other contaminants at substantial completion.
2. Open manual valves fully.
3. Inspect pumps for proper rotation.
4. Set makeup pressure-reducing valves for required system pressure.
5. 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).
6. Set temperature controls so all coils are calling for full flow.
7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
8. Verify lubrication of motors and bearings.

END OF SECTION 23 21 10

SECTION 23 31 10 - 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 metal ducts and accessories for various types of air distribution systems.

1.3 SUBMITTALS

A. Shop Drawings: Provide ductwork shop drawings to indicate the dimensioned locations and elevations of all ducts and duct accessories.

B. Provide submittal data for Cable Support Systems with SMACNA STRI verification.

C. Product data for each of the following products:

1. Duct liner and adhesives.
2. Duct sealants.

1.4 PERFORMANCE REQUIREMENTS

A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article as indicated in Part 3 of this specification.

B. Refer to the contract drawings for any notes that indicate requirements for duct construction that may differ from the SMACNA standard requirements. Where indicated provide duct construction that meets requirements.

1.5 QUALITY ASSURANCE

A. Comply with the requirements of NFPA 90A and 90B.

B. The installation of all ductwork shall comply with the requirements of the 2018 International Mechanical Code and all applicable local codes and code amendments.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect all ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent dirt and moisture from entering ducts and duct fittings. Store ductwork in an area which

is protected from the weather. All ductwork shall be shipped with a protective polyethylene film or other water tight covering at the ends of all ducts and fittings. To prevent condensation in the ducts, the covering shall not be added while excessive moisture is present in the duct.

B. While ducts are stored on-site the protective covering shall remain in place with the ducts stores on skids and placed such that the duct openings are not subject to water infiltration.

PART 2 - PRODUCTS

2.1 SINGLE WALL RECTANGULAR DUCTS AND FITTINGS

A. Refer to and comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Rectangular Duct Construction," for fabrication of ducts based on the static-pressure class indicated in Part 3 of this specification.

B. Unless otherwise indicated on the drawings fabricate ducts with a gauge thickness per the requirements of Chapter 2.

C. Longitudinal Seam, Traverse Joints and Reinforcements: Select and fabricate seam, joint, reinforcement types and sealing requirements and according to the requirements in Chapter 2 for required static-pressure class, applicable sealing requirements, duct-support intervals, and other provisions in the SMACNA Standard."

D. Duct fittings: fabricate elbows, turning vanes, branch connecters, offsets and transitions in accordance with Chapter 4 of the SMACNA "HVAC Duct Construction Standards - Metal and Flexible."

1. Radius elbows: type RE 1 with a center line radius equal to 1.5 times the duct width.
2. Square throat elbows: type RE 2 with turning vanes per figure 4-3 and 4.4.
3. Branch connections: 45-degree entry.

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.

B. Unless otherwise indicated on the drawings fabricate ducts with a gauge thickness per the requirements of Chapter 3.

C. Longitudinal Seam, Traverse Joints and Reinforcements: Select seam, joint, reinforcement types and sealing requirements and fabricate according to the requirements in Chapter 3 for required static-pressure class, applicable sealing requirements, duct-support intervals, and other provisions in the SMACNA Standard."

D. Duct fittings: fabricate elbows and tees in accordance with Chapter 3.

1. Elbows: fabricate with a center line radius equal to 1.5 times the duct diameter.
2. Tees and laterals: fabricate per figure 3-5

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60 for interior ductwork conveying non-hazardous materials; G90 for interior ductwork conveying hazardous materials; G90 for exterior ducts without exterior insulation.
2. Finishes for Surfaces Exposed to View: Mill phosphatized and suitable for painting.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions.
3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

E. 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.

F. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. 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.

H. 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.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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

a. CertainTeed Corporation.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.

2. Materials: ASTM C 1071; surfaces exposed to airstream shall have a factory applied coating to prevent erosion of glass fibers and a factory applied coating on the edge of the liner.

    a. Thickness: 1 inch or as noted on the drawings.
    b. Density: 2.0 pcf.
    c. Thermal performance: “R” equals 4.2 for 1” thick; 6.0 for 1.5” thick; 8.0 for 2” thick.
    d. Sound Absorption Coefficient (NRC): 0.70 for 1” thick; 0.80 for 1.5” thick; 0.85 for 2” thick.
    e. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
    f. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
    g. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

B. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," and manufacturer’s instructions.

1. Where lined ducts are indicated, the duct dimensions indicated on the drawings are the metal size. The net free area size of the duct is the metal size minus the liner thickness.
2. Adhere to a single layer of liner with adhesive coverage per the manufacturer’s recommendations.
3. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
4. Butt transverse joints without gaps, and coat joint with adhesive.
5. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
6. Secure liner with mechanical fasteners per SMACNA standards and the manufacturer’s recommendations.
7. 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.

8. 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.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) 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.

2.6 HANGERS AND SUPPORTS

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

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," "Rectangular Duct Hangers Minimum Size," - "Minimum Hanger Sizes for Round Duct."

D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

F. Cable Support Systems: Provide cable support systems and accessories that have been verified through the SMACNA Testing and Research Institute (STRI).

1. Manufacturer's:

a. Duro Dyne.
b. Gripple Hang-Fast Systems.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Fabricate, install and support ductwork and accessories according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

B. The installing contractor is required to field verify all duct locations and elevations prior to fabrication of the ductwork.

C. 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.

D. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures. Do not locate ducts over electrical panels.

E. Ship and store all ductwork with a protective closure at the ends of all ducts and fittings. During construction, provide temporary polyethylene film enclosures at all openings in the duct systems, at the time of ductwork installation, to prevent entrance of dust and debris until final connections are completed.

1. Protective film shall be applied only after excessive moisture has been removed from ductwork, including moisture generated from sealants and adhesives. If moisture levels are not acceptable within the sealed ductwork, provide relief vent in temporary film.
2. Failure to protect duct systems from construction dust and debris will result in the installing contractor being required to Mechanically Clean the affected duct system(s) as indicated in this specification.

F. Install round and flat-oval ducts in maximum practical lengths.

G. Install ducts with fewest possible joints. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

H. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

I. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

J. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

K. Where ducts pass through non-fire-rated interior masonry or drywall partitions and any type of exterior wall(s), 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.

L. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Duct Accessories" for fire and smoke dampers. Provide firestopping as specified in Section 233300.

M. Paint interiors of metal ducts that do not have duct liner for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer.

N. Refer to contract drawings for locations where sprinklers are to be located within various duct systems. Coordinate locations with the sprinkler installer. Refer to contract drawing details for work required for a complete duct installation.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install ducts per the requirement indicated in Chapter 5 of the International Mechanical Code.

B. Refer the International Mechanical Code, Chapter 5; 506.3.2.5 and provide all testing, as stated, for grease ducts and systems prior to use or concealment. Report results of the testing to the Owner’s representative and the code official, if required.

C. Grease duct supports shall be of noncombustible material securely attached to the structure. Any attachments or fasteners shall not penetrate the grease duct.

D. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and at a minimum of 2 percent slope to the hood. Where the length of horizontal grease duct exceeds 75 feet, the slope shall not be less than 8.3 percent.

E. Provide vibration connector where the exhaust duct connects to the fan. Connector to be listed and labeled for the application.

F. Provide horizontal cleanouts as required by the International Mechanical Code.

3.4 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports and the requirements of the International Mechanical Code Section 603. Support spacing of all hangers shall be per SMACNA standards but in no case shall hangers be spaced at more than 10’-0” intervals.

B. Supports for Clothes Dryer exhaust ducts shall be at a maximum spacing of 4’-0”.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," "Rectangular Duct Hangers Minimum Size," and "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. 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 maximum intervals of 12 feet.

E. 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.

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.

G. Cable Support Systems: Where ducts are exposed to view in finished areas provide cable duct support systems installed per the manufacturer’s installation instructions.

3.6 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.

3.7 FIELD QUALITY CONTROL

A. Duct system leak testing will be provided by a Testing, Adjusting and Balancing (TAB) firm that is under contract directly with the Owner.

B. The installing contractor is required to construct and install the appropriate duct systems in order to comply with the requirements indicated in SMACNA's "HVAC Air Duct Leakage Test Manual."

C. The following duct systems will be tested:

1. All duct systems with a Pressure Class of 3-Inch w.g. or higher: Test representative duct sections totaling no less than 25 percent of total installed duct lineal feet of duct for each designated pressure class.
2. All Variable Air Volume supply systems from the air handling unit outlet to the entry connection at all variable air volume terminal units.
3. All duct systems located on the exterior of the building.

D. All duct systems with a Pressure Class of 3-Inch w.g. or higher: Test representative duct sections totaling no less than 25 percent of total installed duct lineal feet of duct for each designated pressure class.

E. All Variable Air Volume supply systems form the air handling unit outlet to the entry connection at all variable air volume terminal units.

F. All duct systems located on the exterior of the building.

G. If leak testing indicates the duct system(s) leakage is greater than the allowed amount, the installing contractor is required to provide labor to reseal and / or reinstall the system(s) and provide a system that will meet the allowable leakage rate.

3.8 DUCT CLEANING

A. Where indicated on the contract drawings mechanically clean all ductwork connected to existing systems as described in this specification section.

B. New duct system installations: manually clean ductwork internally, section by section as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

C. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

D. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

E. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

3.9 MECHANICAL DUCT CLEANING METHODOLOGY

A. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

B. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

C. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

D. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

E. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

F. Provide drainage and cleanup for wash-down procedures.

G. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 DUCT SCHEDULE

A. Fabricate ducts with G90 galvanized sheet steel unless otherwise indicated in the following:

1. Type I range hood exhaust duct construction: comply with the requirements of Section 506 of the 2018 International Mechanical Code (IMC) and NFPA 96.

    a. Concealed ducts: minimum 14-gauge carbon steel with liquid tight welded joints.
    b. Exposed ducts: minimum 14-gauge Type 304 stainless steel with liquid tight welded joints.

2. Dishwasher exhaust ducts: Type 304 stainless steel. Provide watertight joints and slope ducts to allow drainage to the dishwasher.
3. Shower area exhaust ducts: Aluminum ducts and fittings with sealed watertight joints.
4. Clothes dryer exhaust ducts: Minimum 28-gauge aluminum. Installation to comply with all requirements indicated in the 2018 International Mechanical Code; Chapter 5, Section 504.

B. Supply Ducts:

1. Ducts Connected to the discharge of Air Terminal Units:

    a. Pressure class: positive 1-inch wg.
    b. Minimum SMACNA seal class: B.

2. Ducts Connected to the discharge of Modular and Packaged Air-Handling Units:

    a. Pressure class: positive 2-inch wg.
    b. Minimum SMACNA seal class: B.

3. Ducts Connected to the discharge of Variable Air Volume Air-Handling Units:

    a. Pressure class: positive 4-inch wg.
    b. Minimum SMACNA seal class: A.
    c. SMACNA leakage class for rectangular ducts: 4.
    d. SMACNA leakage class for round and oval ducts: 2.

4. Exterior Round Ducts: Pre-insulated double wall, shop-fabricated ducts.

C. Return Ducts:

1. Pressure Class: Positive or negative 2-inch wg.

    a. Interior ducts: minimum SMACNA seal class B.
    b. Exterior ducts: minimum SMACNA seal class B.

2. Exterior Ducts: Pre-insulated double wall shop fabricated ducts.

D. Exhaust Ducts:

1. Pressure Class: Positive or negative 1-inch wg.

    a. Minimum SMACNA seal class: B if negative pressure, and B if positive pressure.

E. Outdoor-Air:

1. Pressure Class: positive or negative 1-inch wg.

    a. Minimum SMACNA Seal Class: B.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

    a. Radius Elbows: type RE-1 with a center line radius of R= (3W)/2
    b. Square (mitered) Elbows: type RE-2 with the fitting width (W) equal.

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "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) Radius-to Diameter Ratio = 1.5.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-5, "Divided Flow Branches."

a. Type 2 or 3 as indicated on the contract drawings.

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.

3. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Provide fittings as indicated on the contract drawings.

END OF SECTION 23 31 10

SECTION 23 33 00 - DUCT ACCESSORIES

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 various duct accessories such as fire dampers, volume dampers and other items that are typically part of a duct system.

1.3 SUBMITTALS

A. Submit Product Data for all accessories provided on the project.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.5 EXTRA MATERIALS

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

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Where indicated in Part 2, provide products manufactured by the listed companies.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G60 or G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M.

D. Aluminum Sheets: 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: 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.

2.3 BACKDRAFT DAMPERS

A. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

B. Frame: 0.052-inch thick, galvanized sheet steel, with welded corners and mounting flange.

C. Blades: 0.025-inch thick, roll-formed aluminum.

D. Blade Seals: Vinyl or Neoprene.

E. Blade Axles: Nonferrous.

F. Tie Bars and Brackets: Galvanized steel.

G. Return Spring: Adjustable tension.

2.4 MANUAL BALANCING DAMPERS

A. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

B. Standard Balancing Dampers: Multiple or single-blade, with opposed blade design, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications. Provide single blade dampers where the duct dimension is 10 inches or less in height. Provide dampers with multiple blade design in larger ducts.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; provide frames with flanges where required for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch thick, galvanized sheet steel.
3. Blade Axles: Galvanized steel.
4. Bearings: Molded synthetic.
5. Tie Bars and Brackets: Galvanized steel.

C. Jackshaft: 1-inch diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware: 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. Include center hole to suit damper operating-rod size. Include factory supplied or field installed elevated platform for insulated duct mounting.

2.5 REMOTE DAMPER OPERATORS

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

1. Pottorff.
2. Young Regulator

B. General description: cable system designed for remote control of manual dampers. Provide stainless steel cable and wall box mounting.

2.6 FIRE DAMPERS

A. Manufacturers:

1. Arrow.
2. CESCO Products.
3. Greenheck.
4. Nailor Industries Inc.
5. Pottoroff, Inc.
6. Ruskin Company.

B. Fire dampers shall be listed and bear the label of an approved testing agency indicating compliance with the requirements of the International Mechanical Code 607.3.1. Fire dampers shall be labeled according to UL 555.

C. Fire Rating: 1-1/2 or 3 hours as noted on the drawings.

D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, minimum 22-gauge galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory or field-installed, galvanized sheet steel.

F. Mounting Orientation: Vertical or horizontal as required.

G. Blades: Roll-formed, interlocking, minimum 24-gauge galvanized sheet steel. In place of interlocking blades, use full-length galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Fusible Links: Replaceable, 165 deg F rated.

2.7 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes with the edge of the vanes parallel with the air flow.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch wide, double vane, curved blades of galvanized sheet steel; support with bars perpendicular to blades set 2 inches and set into vane runners suitable for duct mounting.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill and install where noted on the drawings.

2.8 DUCT MOUNTED ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
2. Provide number of hinges and locks as follows:

a. Less Than 12 Inches Square: Secure with two sash locks.
b. Up to 18 Inches Square: Two hinges and two sash locks.
c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

D. Insulation: 1-inch thick, fibrous-glass or polystyrene-foam board.

2.9 FLEXIBLE CONNECTORS

A. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

B. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 0.028-inch thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Select metal compatible with ducts.

C. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
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.

D. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

3. Service Temperature: Minus 50 to plus 250 deg F.

2.10 FLEXIBLE DUCTS AND ACCESSORIES

A. Manufacturers:

1. Thermaflex MK-E or equal.

B. Insulated Flexible Duct: UL 181, Class 1, flexible air duct complying with NFPA Standards 90A and 90B. Flexible duct shall be factory made and composed of a resilient film liner duct liner permanently bonded to a coated spring steel wire helix and supporting a fiberglass insulating blanket. Provide with a low permeability outer vapor barrier of fiberglass reinforced film laminate insulation.

C. Operating temperatures: -20 Deg. F. minimum; 250 deg. F. maximum.

D. Operating pressure: 10” w.g. positive; 1” w.g. negative.

E. Insulation: minimum R 6.0.

F. Rated velocity 5000 fpm.

G. Maximum flame spread = 25. Maximum smoke developed = 50.

H. Flexible Duct Clamps: Nylon strap to suit duct size.

I. Flexible duct elbow supports: Thermaflex FlexFlow or FlexRight.

2.11 DUCT ACCESSORY HARDWARE

A. Instrument Test Ports: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit the specified eternal duct insulation thickness. Provide special gaskets where test holes are to be installed in round or oval ducts. Test Ports to be Duro-Dyne model TH1, IP2 and/or IP4.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install manual balancing dampers in ducts with liner utilizing an insulated “hat” section at the damper frame. Avoid damage to and erosion of duct liner. Where balancing dampers are located in ducts with exterior insulation, provide and insulated hat section to house the damper operator.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as required.

G. Install fire dampers, with fusible links, according to manufacturer's UL-approved written instructions. Provide the required identification for all fire dampers as indicated in the International Mechanical Code, Chapter 6; 607.4

H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. Adjacent to all fire dampers, providing access to reset or reinstall fusible links.
2. To interior of ducts for cleaning at maximum 100-foot spacing between access doors.

I. Install the following sizes for duct-mounting, rectangular access doors:

1. Minimum size 12 x 12 inches.
2. Ducts with one dimension 24" or larger, install a 20" x 20" access door.

J. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

K. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

L. Where indicated on the drawings, connect diffusers to low pressure ducts with maximum 72-inch length of insulated flexible duct. Connect flexible ducts to metal ducts and support flexible ducts in accordance with SMACNA Duct Construction Standards Metal and Flexible, Chapter 3. Install flexible duct elbow supports at all 90-degree flex connections to diffusers.

M. Install duct test holes where indicated and required for testing and balancing purposes. Coordinate location with testing, adjusting and balancing contractor.

N. Provide turning vanes in all mitered elbows.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

END OF SECTION 23 33 00

SECTION 23 34 00 – HVAC FANS

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 various types of fans, exhaust, and supply, as well as fan accessories. Refer to the drawings plans and schedules and provide all required options and accessories.

1.3 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 gages and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For power ventilators to include in maintenance manuals specified in Division

D. Submittals for exhaust fans will require a coordination review by the HVAC Controls manufacturer/installer prior to submission to the Engineer. Refer to Section 23 09 00.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain all similar types of fans from one source and from a single manufacturer, regularly engaged in production of exhaust fans.

B. 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.

C. 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."

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

E. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

F. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

G. UL Standard: Power ventilators shall comply with UL 705.

1.5 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.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.7 WARRANTY

A. All equipment, material and labor provided under this specification section shall be warranted for a period of one year from the 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. One set of belts for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL DOWNBLAST ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide roof ventilators manufactured by Loren Cook models ACE-B and / or ACE-D. Subject to review, equipment meeting the full requirements of the specifications, manufactured by the following will be considered:

1. Carnes Corp.
2. Greenheck.
3. Penn Barry.

4. Solar & Palau, USA.
5. CaptiveAire

B. Description: Belt-driven or direct-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 with square aluminum base and venturi cone inlet for exhaust applications; and die formed louvered aluminum inlet panels in rectangular configuration with square base and rectangular outlet for makeup applications.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from airstream on exhaust fans.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent on direct drive units.
2. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, ½-inch mesh, aluminum, or brass wire.
4. Dampers: parallel-blade, backdraft dampers mounted in curb base on exhaust fans; factory set to close when fan stops.

2.2 CEILING MOUNTED FANS

A. Manufacturers: Subject to compliance with requirements, provide ceiling mounted fans manufactured by Loren Cook, model GC. Subject to review, equipment meeting the full requirements of the specifications manufactured by the following will be considered:

1. Carnes Corp.
2. Greenheck.
3. Penn Barry.
4. Solar & Palau, USA.
5. CaptiveAire

B. Description: Fan shall be ceiling, wall, or inline mounted, direct driven, centrifugal exhaust fan.

C. Construction: The fan housing shall be minimum 20-gauge galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 14 gauge reinforcing channel and shall be easily removable from the housing. Motor shall be mounted vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different ceiling thickness, an adjustable pre-punched mounting bracket shall be provided. A powder painted white steel grille shall be provided as standard.

D. Fan Wheel: Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Larger fan wheels shall be Wheels shall be twin DWDI centrifugal forward curved type, constructed of galvanized

steel. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

E. Motor: Motor shall be open drip proof type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall be furnished at the specified voltage.

F. Accessories: Provide accessories noted on the drawings.

2.3 TRANSFER AIR FAN

A. Manufacturers: Subject to compliance with requirements, provide fans manufactured by Loren Cook, model CBF. Subject to review, equipment meeting the full requirements of the specifications manufactured by the following will be considered:

1. Carnes Corp.
2. Greenheck.
3. Penn Barry.
4. CaptiveAire

B. Description: direct drive axial transfer air fan.

C. Construction: The unit shall be of bolted and riveted construction utilizing corrosion resistant fasteners. Housing shall be constructed of galvanized steel with integral pre-punched wall mounting flange. Unit to have dual direct driven axial propellers, specified for either exhaust or supply arrangement. Internal assembly shall be constructed for easy removal for access to the disconnect plug and for cleaning. A powder painted white steel grille shall be provided as standard. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM and static pressure.

D. Motor: Axial propellers motors shall be 115/1/60, open drip proof, permanently lubricated, heavy duty type, carefully selected to match fan load.

2.4 ROOF CURBS

A. Furnish insulated metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints, with integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

B. Refer to drawings for the type of curb required for the specified roofing system and the required curb height. Furnish curbs with an integral metal cant, stepped integral metal cant raised the thickness of roof insulation or as required to suit the details.

C. Furnish curbs to match the roof slope. Refer to contract drawings to verify roof slope.

D. Curb Material: Galvanized sheet, minimum 16 Gauge.

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.

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Install units with clearances for service and maintenance.

E. Where roof curbs are to be installed by others, provide locations for all curbs to the installer. Install the roof mounted unit(s) on the roof curb immediately after the curb is installed. If immediate installation is not performed provide temporary watertight covering, for all curb openings, consisting of minimum ¾" exterior grade plywood and watertight rubber or plastic cover.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment.

3.3 FIELD QUALITY CONTROL

A. Equipment Startup Checks: Perform startup per Manufacturer's Instructions on all fans. Verify that unit is secure on mountings and supporting devices and connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

B. Verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.

C. Verify lubrication for bearings and other moving parts.

D. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

E. Starting Procedures: Energize motor and adjust fan to indicated rpm and measure and record motor voltage and amperage.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Shut unit down and reconnect automatic temperature-control operators.

I. Replace fan and motor pulleys as required to achieve design airflow.

J. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

K. The installing contractor shall provide a completed written startup report that records results of all tests and inspections and verifies all fans, associated controls and wiring are installed properly. The start-up report shall be forwarded to the owner's representative.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation and adjust belt tension where required.

3.5 CLEANING

A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 23 34 00

SECTION 23 36 00 - AIR TERMINAL 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 fan-powered and shutoff type variable air volume terminal units.

1.3 SUBMITTALS

A. Exceptions: Shop drawing submittals are required to include a listing of any and all exceptions to the requirements indicated in this specification and on the drawings. If no exceptions are taken the submittal shall indicate this. Submittals that do not have this information will be returned without review.

B. Provide product data for Air Terminal Units including rated capacities. Include a listing of any required specialties, sound-power ratings, and accessories.

C. Shop Drawings: For all air terminal units provide a schedule indicating performance data required for a proper evaluation. Include drawings indicating the physical size and weight of all units. For fan-powered units provide wiring diagrams.

D. Submittals for all variable air volume units will require a coordination review by the HVAC Controls manufacturer/installer prior to submission to the Engineer. Refer to Section 23 09 00.

E. Provide Operation and Maintenance data for all air terminal units.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain all terminal units through one source from a single manufacturer, regularly engaged in production of Air Terminal Units.

1.5 WARRANTY

A. Provide written warranty indicating all terminal units and components will be warranted for a period of 1 year from the date of substantial completion. The warranty will include all parts, materials and labor for replacement of any of the unit’s components that fail in materials and/or workmanship within the warranty period.

1.6 EXTRA MATERIALS

A. In addition to the filter required for all fan powered terminal units, provide (one/two) extra set of filters for all fan powered units to be installed on the project.

PART 2 - PRODUCTS

2.1 FAN-POWERED AIR TERMINAL UNITS

A. Subject to compliance with all requirements provide Fan-Powered Air Terminals manufactured by Trane which is the Basis of Design Equipment.

B. Subject to review, terminal units meeting the full requirements of the specifications and manufactured by the following will be considered:

1. Johnson Controls.
2. Nailor Industries Inc.
3. Price Industries.
4. Titus.

C. Manufacturers other than the Basis of Design manufacturer shall carefully review the contract drawings, prior to bidding, to verify the equipment will meet all requirements including installation clearances and electrical characteristics. When necessary, the contractor shall provide modifications to the ductwork and / or piping to accommodate terminal units that may have different connection locations than the Basis of Design Equipment. Any required modifications shall be included in the contractor's bid and shall be indicated on the Coordination Drawings prepared by the Contractor.

D. DDC Controller: provide microprocessor based terminal unit controller to provide accurate, pressure-independent control through the use of proportional integral control algorithm and direct digital control technology.

E. Casing: provide minimum 22-gauge galvanized steel casing with filter housing.

F. Casing Lining: Provide 1-inch x 1.0 lb/ft3 foil-faced insulation with an R value of 3.8. Insulation to be UL listed and meet the requirements of NFPA-90A and UL 181 standards. There are to be no exposed edges of insulation.

G. Primary Air Valve Inlet: construct of minimum 18-gauge galvanized steel cylinder sized to fit round ducts. Provide a multiple port averaging flow sensing ring with balancing taps for measuring +/- 5% of the unit airflow. Provide 22-gauge galvanized steel damper blade with foam seals, steel shaft and self-lubricating bearings. Provide damper position indicator on the steel shaft. Valve leakage shall not exceed 1% of cataloged air flow at 4.0 in. w.g.

H. Fan Motor: provide electrically commutated motor.

I. Disconnect Switch: provide toggle type disconnect.

J. Outlet: Provide flanged connection.

K. Filters: Provide 1" MERV 8 filters for units not provided with filter return grilles.

L. Access: Provide removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.

M. Hot-Water Heating Coil: Provide 1 or 2 row coil as required to meet the performance indicated on the drawings. Coil to have copper tubes mechanically expanded into aluminum-plate fins. Coils to be proof tested at 450 psig and leak tested underwater to 300 psig. Provide brazed coil connections.

2.2 SHUTOFF AIR TERMINAL UNITS

A. Subject to compliance with all requirements provide Shut-off Air Terminals manufactured by Trane which is the Basis of Design Equipment.

B. Subject to review, terminal units meeting the full requirements of the specifications and manufactured by the following will be considered:

1. Johnson Controls.
2. Nailor Industries Inc.
3. Price Industries.
4. Titus.

C. Manufacturers other than the Basis of Design manufacturer shall carefully review the contract drawings, prior to bidding, to verify the equipment will meet all requirements including installation clearances and electrical characteristics. When necessary, the contractor shall provide modifications to the ductwork and / or piping to accommodate terminal units that may have different connection locations that differ from the Basis of Design Equipment. Any required modifications shall be indicated on the Coordination Drawings prepared by the Contractor.

D. DDC Controller: provide microprocessor based terminal unit controller to provide accurate, pressure-independent control through the use of proportional integral control algorithm and direct digital control technology.

E. Casing: provide minimum 22-gauge galvanized steel casing with filter housing.

F. Casing Lining: Provide 1-inch x 1.0 lb/ft3 foil-faced insulation with an R value of 3.8. Insulation to be UL listed and meet the requirements of NFPA-90A and UL 181 standards. There are to be no exposed edges of insulation.

G. Primary Air Valve Inlet: construct of minimum 18-gauge galvanized steel cylinder sized to fit round ducts. Provide a multiple port averaging flow sensing ring with balancing taps for measuring +/- 5% of the unit airflow. Provide 22-gauge galvanized steel damper blade with foam seals, steel shaft and self-lubricating bearings. Provide damper position indicator on the steel shaft. Valve leakage shall not exceed 1% of cataloged air flow at 4.0 in. w.g.

H. Outlet: Provide s-slip or flanged connection.

I. Where indicated on the drawings provide a factory installed and insulated galvanized sheet metal outlet plenum attached to the terminal unit casing. Provide circular openings in the plenum with outlet dampers. Refer to the drawings for the number of plenum openings required for each unit.

J. Access: Provide removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.

K. Hot-Water Heating Coil: Provide 1 or 2 row coil as required to meet the performance indicated on the drawings. Coil to have copper tubes mechanically expanded into aluminum-plate fins. Coils to be proof tested at 450 psig and leak tested underwater to 300 psig. Provide brazed coil connections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all air terminal units level and plumb with sufficient clearance for normal service and maintenance and filter replacement for fan powered boxes. Provide supports as required and indicated in the manufacturer's installation manuals.

B. Field conversion of any air terminal unit due to ordering the wrong piping connections will not be permitted.

C. Install piping adjacent to air terminal unit to allow service and maintenance.

D. Hydronic Piping: provide connections to the inlet of heating coils to include shutoff valve, strainer and union. Outlet connections to include union, control valve, balancing valve and shutoff valve.

E. Connect ducts to air terminal units as required.

F. Coordinate control power requirements with BMS contractor. Provide all 120v power, control power, and transformers as required. See specification section 23 09 00 for additional requirements.

G. Insulate the hydronic duct coil portion of the terminal units per the requirements indicates in Specification Section 23 07 00.

H. Filters: Provide a filter at all fan powered terminal units. Refer to drawings for filter locations which could be in a return grille or installed at the terminal unit return connection. Where filters are to be installed at the terminal unit provide a filter frame or multiple clip type attachments to prevent filter from being displaced during the fan powered box operation.

1. At the direction of the Owner's Representative the contractor shall remove and dispose of filters from the fan powered terminal units and install a new filter obtained from the Extra Materials required in Part 1 of this specification. If additional filter installation is not required, forward all filters to the owner as extra stock, at the completion of the project.

3.2 IDENTIFICATION

A. The location of all variable volume units shall be indicated by locator tags on the ceiling tile. Provide equipment locator tags in a color suitable to the owner. Tags to be push tack type with 7/8" diameter head as manufactured by Marketing Services Inc. or equal.

3.3 FIELD QUALITY CONTROL

A. Clean all units internally, on completion of installation, according to manufacturer's written instructions. Clean interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

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

3.4 STARTUP SERVICE AND DEMONSTRATION

A. Perform startup service complying with the requirements of the manufacturer's instructions.

B. Provide training to Owner's personnel on the methods to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00

SECTION 23 37 10 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes ceiling and wall mounted diffusers, registers, grilles and accessories.

1.3 DEFINITIONS

A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.

B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

C. Register: A combination grille and damper assembly over an air opening.

1.4 SUBMITTALS

A. Submit manufacturer’s technical product data for all air outlets. For each model indicated, include the following:

1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
2. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished. The schedule shall also indicate static-pressure drop, and noise criteria ratings (NC) for each air outlet and inlet. A generic catalog sheet indicating pressure drop and NC ratings is not acceptable.

1.5 QUALITY ASSURANCE

A. Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems.

B. Source Limitations: Obtain diffusers, grilles and registers through one source from a single manufacturer, regularly engaged in production of the equipment.

1.6 EXTRA MATERIALS

A. Provide two additional filters for each filter grille/register furnished on the project. The extra filters will be given to the owner at the close of the project.

PART 2 - PRODUCTS

2.1 LOUVERED FACE CEILING AIR DIFFUSERS

A. General: Provide louvered face ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation. Provide diffusers manufactured by Titus. Subject to review, diffusers meeting the full requirements of the specifications and manufactured by one of the following will be considered:

1. Krueger
2. Price Industries.
3. Nailor.
4. Anemostat.
5. Metalaire.

B. Ceiling diffusers shall have a fixed or adjustable horizontal discharge pattern. The inner louver assembly shall be flush with the outer frame with a 1, 2, 3 or 4-way directional pattern. Individual louvers shall have a horizontal lip to create a ceiling pattern at reduced air flows. The inner core must be easily removable.

C. Ceiling Compatibility: Provide louvered diffusers with border styles that are compatible with adjacent ceiling systems. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Types: The model numbers and manufacturers indicated on the diffuser schedule set the standard for the products to be used. Provide louvered diffusers of type as scheduled and with accessories as required.

E. Provide each diffuser in the manufacturer’s standard white electro-coated finish unless otherwise indicated on the drawings.

F. Diffusers shall be provided with the same style and characteristics as provided with the basis of design product named on the drawings.

2.2 REGISTERS AND GRILLES

A. General: Provide registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation. Provide opposed blade damper on all registers. Provide registers and grilles manufactured by Titus. Subject to review, registers and grilles meeting the full requirements of the specifications and manufactured by one of the following will be considered:

1. Krueger
2. Price Industries.
3. Nailor.
4. Anemostat.
5. Metalaire.

B. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Structural Integrity: floor registers and grilles are required to meet the structural requirements indicated in the International Mechanical Code Chapter 6: 603.18.1.

D. Compatibility: Provide registers and grilles with border styles indicated and that are compatible with adjacent wall or ceiling systems, and that are specifically manufactured to fit into construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of construction which will contain each type of register and grille.

E. Types: The model numbers and manufacturers indicated on the drawing schedules set the standard for the product(s) to be provided. Provide registers and grilles of type as scheduled, with accessories as required to match the basis of design product named on the drawing.

F. Provide each register and/or grille in manufacturer’s standard white electro-coated finish. Refer to equipment schedules for grilles/registers that require a custom color. When required, the Architect will select the custom colors.

G. Filter Grilles: Provide aluminum construction with 35-degree ¾" bar spacing and with hinged face for access to filter. Provide MERV 8 or MERV 13 filter for each filter grille.

2.3 SLOT DIFFUSERS

A. General: Provide linear type slot diffusers; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation. Provide slot diffusers manufactured by Titus. Subject to review, diffusers meeting the full requirements of the specifications and manufactured by one of the following will be considered:

1. Krueger
2. Price Industries.
3. Nailor.
4. Anemostat.
5. Metalaire.

B. The units shall be fabricated of extruded aluminum. Diffusers shall be provided with separate adjustable pattern deflectors capable of providing a 180-degree pattern adjustment for each slot.

C. When required, provide mounting frames and margins suitable for the intended installation. Where continuous diffuser lengths are required, separate sections shall butt with a hairline joint and interlocking splines shall be provided by the diffuser manufacturer. Provide mitered corners where indicated on the drawings. In locations where the diffusers are to be installed as part of the ceiling grid, provide units that are compatible with the specific type of ceiling grid.

D. Units are to be furnished in manufacturer’s standard white enamel finish or with an etched satin anodized finish. Finish to be selected by the Architect during the submittal phase. Refer to equipment schedules for slot diffusers that require custom colors. When required, the Architect will select the custom colors.

E. Provide a distribution plenum for each slot diffuser. Each plenum to be constructed of galvanized steel and furnished with an inlet damper and internal or external insulation.

F. The model numbers and manufacturers indicated on the schedules set the standard for the products to be used. Provide outlets of type as scheduled and with accessories as required.

G. Slot diffusers shall be provided with the same style and characteristics as provided with the basis of design product named on the drawings.

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 practicable. 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.

D. Provide any fasteners (screws, tamper proof screws, etc.) that are required by the manufacturer for installation.

E. Filters: Where filters are required for grilles and/or registers install filter before associated HVAC system(s) is operational. At the direction of the Owner's Representative the contractor shall remove and dispose of filters from the respective units and install a new filter obtained from the Extra Materials required in Part 1 of this specification. If additional filter installation is not required, forward filters to the owner as extra stock, at the completion of the project.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 23 37 10

SECTION 23 58 30 – KITCHEN VENTILATION SYSTEMS

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 natural gas fired make-up air units, up-blast exhaust fans and other accessories. Refer to the contact drawings which may indicate optional equipment that is required. The System to be furnished with controls supplied by the equipment manufacturer and are to be integrated with the process cooking equipment.

1.3 SUBMITTALS

A. Shop Drawings: Provide 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 and demand ventilation control wiring.

B. Operation and Maintenance Data: For gas-fired make-up units, exhaust fans, controls sequences and other accessories.

1.4 QUALITY ASSURANCE

A. Unit(s) assembly shall be tested in accordance with UL Standard UL 795, and shall bear the ETL label. The duct furnace shall be certified by the American Gas Association.

1.5 WARRANTY

A. All equipment, material and labor provided under this specification section shall be warranted for a period of one year from the date of substantial completion.

B. The make-up air unit is to be provided with a two-year parts warranty. The stainless-steel furnace shall have a twenty-five-year parts warranty.

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. Filters: Two additional sets for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide make-up air units, exhaust fans, controls and all required accessories manufactured by Captive-Air Systems. Products meeting the full requirements of the specification manufactured by one of the following may be considered.

1. Greenheck.
2. Rupp Air Management systems.

2.2 EXHAUST FANS

A. Fan(s) shall be a spun aluminum and G90 Galvanized, roof or wall mounted (as required), direct drive, up-blast centrifugal exhaust ventilator. Fans to be ETL Listed and comply with UL705 (electrical) Standards. Models 12 thru 85 are ETL Listed and comply with UL762. Fan shall bear the AMCA certified ratings seal for sound and air performance. Fans to be direct drive and furnished with a factory mounted and wired variable frequency drive.

B. B. Exhaust Fan Construction:

1. Housing: The fan windband shall be constructed of heavy gauge aluminum and shall be spun on an automatic lathe to provide consistent dimensions. Horizontal and vertical internal supports shall be used to securely fasten the windband to the discharge apron to provide rigidity for hinging and added strength to reduce shipping damage. The discharge apron shall have a rolled bead for added strength.
2. Base: The base shall be constructed of galvanized steel for improved rigidity. Base corners shall be welded to provide strength and support for hinging and cleaning and to prevent leakage into the building.
3. Fan wheel: The fan wheel shall be centrifugal backward inclined and non-overloading. Wheels shall be balanced in two planes and in accordance with AMCA standard 204-96, Balance Quality and Vibration Levels for Fans. The wheel blades shall be aerodynamically designed to minimize turbulence, increase efficiency, and reduce noise. The wheel blades shall be welded to the wheel inlet cone. In the event that balancing weights are required they shall be riveted to the blades or wheel. The wheel inlet shall overlap the fan base inlet for maximum performance and efficiency. The wheel shall be firmly attached to the motor shaft with two set screws.
4. Motor and Motor Compartment: Standard 115-volt, open drip motors shall be permanently lubricated, rated for continuous duty, and thermally protected. Motors shall be mounted out of the airstream and furnished at the specified voltage, phase, and enclosure. The motor mounting plate shall be constructed of heavy gauge galvanized steel. The motor compartment shall be cooled by outside air drawn through an extruded aluminum conduit tube. To seal the conduit tube passage and prevent noise silicone rubber grommets shall isolate the conduit tube from the fan housing. The motor compartment shall be of a two-piece construction with the cap having quick release clips to provide quick and easy access to the motor compartment.
5. Provide NEMA 3R disconnect switch.
6. Grease spout and box: Provide a grease spout made of aluminum tubing shall be welded to the fan housing. The weld shall be factory tested to ensure it will not leak.
7. Provide nylon washers to offer a tight seal all fasteners in the fan housing shall be backed with nylon washers.

C. Exhaust Fan Roof Curb(s): Provide / Furnish ventilated roof curb(s) fabricated from minimum 20-gauge galvanized steel. Where required provide curbs to match the roof slope. The roof curb height shall be such that the attached up-blast exhaust fan discharge is located a minimum of 40” above the roof surface.

2.3 GAS FIRED MAKE-UP AIR FURNACE

A. General Description: Indirect-fired natural gas heating and ventilating make-up air unit(s). The unit(s) shall be factory assembled, tested, and shipped as a complete packaged assembly, for outdoor installations. Unit(s) assembly shall be tested in accordance with Standard, ANSI Z83.8-2006 and shall bear the ETL label. The duct furnace shall be certified by the American Gas Association. Provide factory testing. The make-up air units shall consist of the following:

1. Natural gas fired gas indirect fired furnace.
2. Centrifugal blower selected for the indicated performance requirements.
3. Motor starter with thermal overload protection.
4. Motor and drive assembly.
5. Temperature control system.
6. Fuel burning and safety equipment.
7. Factory installed gas components including but not limited to the following:

    a. Modulating gas valve(s).
    b. On/off redundant gas valves.
    c. Gas burner.
    d. Main gas shut-off valve.
    e. Main gas regulator.
    f. Two solenoid valves.
    g. Gas pressure gauge.
    h. High pressure regulator, when required.

8. Safety controls including but not limited to the following:

    a. Motor starter with adjustable overloads.
    b. Main air flow safety switch.
    c. Electronic flame safety relay.
    d. Non fused disconnect.
    e. Flame roll out switch.
    f. Combustion air proving switch.
    g. Low temperature blower safety control.
    h. High gas pressure switch, when required.

B. Furnace Housing Construction:

1. Unit housing shall be double wall and constructed of 20 Gauge G-90 galvanized steel. The wall panels and roof panels shall be fabricated by forming double-standing, self-locking seams that require no additional support. The floor and wall panels shall be caulked air tight with a silicone caulk. All casing panels shall be attached with sheet-metal screws or rivets, which can be removed to field service large components. The unit base shall be suitable for curb or flat mount. The base shall be constructed of galvanized steel for improved rigidity. Base shall be structurally reinforced to accommodate the blower assembly and burner. Housing construction should be suitable for outdoor installation and shall be insulated.
2. All doors and at least one side of every sheet metal surface of the unit separating two air-masses of different air temperatures shall be faced with properly secured 1” aluminum-faced insulation for condensation prevention.
3. The discharge of the unit shall be internal to the heating module containing the furnaces.
4. All electrical controls on the control board shall be mounted in an isolated, fully enclosed, and insulated vestibule, completely separated from any combustion air, but accessible for servicing needs.

5. All furnace exhaust flues shall be provided and fabricated of double-wall construction. All furnace exhaust flue connections and the unit roof penetration seams shall be sealed with High-Temp Fire-Barrier 2000+ type silicone caulking.
6. All unit housings, sizes 1-3, shall be equipped with Internal Air Distribution Screens on the upstream side of each furnace heat-exchanger.
7. All gas valves and electrical safety-limits shall be mounted within the burner vestibule; wiring to these components shall be properly secured and away from all high temperature metal surfaces. The burner vestibule shall be an integral part of the unit and not extend outside the exterior casing of the unit and not exposed to the main air stream.
8. Provide high wind rain caps installed at the termination of the furnace discharge flues.
9. Provide factory mounted freezestat.
10. The vestibule full-size door shall provide easy access to controls and gas-train components. Blower door shall provide easy access to blower, motor, and drives. Access doors shall be provided on both front and back side of unit providing full access to every part of the unit.

C. Furnace Blowers: Wheels shall be balanced in two planes and done in accordance with AMCA standard 204-96, Balance Quality and Vibration Levels for Fans. The wheel blades shall be aerodynamically designed to minimize turbulence, increase efficiency, and reduce noise. The wheel blades shall be securely attached to the wheel inlet ring. The wheel shall be firmly attached to the fan shaft with set screws and keys. The blower assembly shall be isolated from the fan structure with factory installed vibration isolators.

1. Direct drive blowers shall consist of a centrifugal backward inclined, non-overloading wheel secured directly to a heavy duty, ball bearing type motor via two set screws. The motor and wheel assembly shall be mounted to a heavy gauge galvanized steel frame. The motor shall be controlled by a variable frequency drive, allowing for variable airflow without the need of belts and pulleys.

D. Furnace Motor & Motor Compartment: Motors shall be heavy duty ball bearing type and furnished at the specified voltage and phase. Motor mounting plate shall be constructed of heavy gauge galvanized steel and shall be designed to provide easy adjustment of belt tension.

E. Furnace Shaft and Bearings: Shafts shall be precision ground and polished. Heavy duty, pre-lubricated bearings shall be selected for a minimum (L50) life in excess of 200,000 hours of operation at maximum cataloged operating speed. They shall be designed for, and individually tested specifically for use in air handling applications.

F. Furnace Burner & Heat Exchanger: The gas burner shall be an indirect-fired, push-through type, sized to provide an output indicated on the drawings. The unit shall operate using natural gas at an inlet-supply pressure to the unit of 7" w.c. minimum for natural gas and 11” w.c. minimum for LP gas. The burner shall be a tubular in-shot fired design capable of using either gas. Each burner ignition shall be of the direct-spark design with remote flame sensing at inlet of the last firing tube of the gas manifold. Each burner ignition module shall be pre-programmed with an ignition sequence comprised of a 1-minute pre-purge, 1 min inter-purge, 2-minute post-purge, 15 second ignition, 3 trials for ignition, and 60 min lockout. Direct-sparking sequence shall last through the complete trial ignition period for guaranteed light-off. Burner shall always be lit at maximum gas flow and combustion airflow for guaranteed light-off. Each burner ignition module shall have LED indicators for troubleshooting and a set of exposed prongs for testing flame indication signal. All furnaces shall be controlled by an electronic fully modulating control system capable of achieving 80% combustion efficiency over the entire gas firing range of the unit. Each furnace shall be provided with the following:

1. A minimum turndown ratio of 6:1 for natural gas and 5:1 for LP gas.
2. The heat exchanger shall be a bent-tube style design made entirely of type 409 stainless steel.
3. Include a blocked vent safety airflow switch with high temperature silicone tubing operating off of absolute pressure measured inside of the power-vent blower housing.
4. Include a high temperature auto-recycling limit with a maximum non-adjustable set-point of 200F.

5. Include a manual reset high temperature flame roll out switch with a non-adjustable set-point of 325F.
6. The furnace shall be accessible from both sides of unit.
7. Include a power-vent assembly for exhausting flue gases with a type PSC type motor that is securely mounted with rubber vibration isolators and easily accessible/removable for service.
8. Each furnace module gas inlet shall be equipped with a 0-35” w.c. gas pressure gauge. A 0-10” w.c. gas pressure gauge shall be installed on the gas manifold of each furnace.

G. Filters: Provide 2" thick washable aluminum mesh filters coated with super-filter adhesive. Aluminum mesh filters shall have aluminum frames with media to be layers of slit and expanded aluminum, varying in pattern to obtain maximum depth loading.

H. Electrical and wiring:

1. Provide single point electrical connection.
2. Provide 24-volt control circuit and transformer. Unit shall have standing 120 volt power. The control wiring shall be carried in wire channel or conduit. Wiring in control enclosures shall be in accordance with the National Electrical Code and the local code, as it may affect the installation.
3. Provide a line voltage motor starter shall be provided.
4. Unit(s) shall be complete with all items such as relays, starters, switches, safety controls, conduit and wire as previously mentioned, and as required for proper operation.
5. Provide a blower delay timer to pre-heat the heat-exchanger prior to energizing the main blower.
6. Convenience outlet shall be provided on the control board with 120-volt service.
7. Provide a freeze stat with adjustable temperature set point to shut down the main blower in case of burner failure.
8. Provide dirty filter airflow switch with LED indicator light on remote panel.
9. Cabinet heater strip with thermostat.
10. All factory-mounted controls shall be factory prewired to the unit control panel.

I. Inlet Dampers: Provide a two-position, motor-operated damper with internal end switch to energize the blower-starter circuit, when damper is 80% open. Blades shall be a maximum of 6" wide 16 Gauge G-90 galvanized steel shall be made to guarantee the absence of noticeable vibration at design air velocities. Damper blades to be mounted on friction-free synthetic bearings. Damper edges shall have PVC coated polyester fabric mechanically locked into blade edge. Jamb seals to be flexible metal, compression type.

J. Fresh Air Inlet Hood: Provide inlet hood constructed of G-90 galvanized steel with birdscreen.

K. Roof curb: Provide 20” high roof curb(s) fabricated from 20-gauge galvanized steel. Provide curbs to match the roof slope.

2.4 DEMAND CONTROL VENTILATION (DCV) SYSTEM

A. Provide a Demand Control Ventilation System that is ETL and UL listed. The system shall comply with the requirements indicated in the International Energy Efficiency Code. The Demand Control Ventilation System is designed to automatically reduce exhaust and supply airflow quantities, while ensuring hood performance is maintained. The DCV uses variable frequency rives (VFD) and temperature sensors in the exhaust ducts to modulate the fans speed during cooking operation and maximize energy savings. The LCD screen interface provides fan(s) control, system configuration, and diagnostic information.

B. DCV System to include the following:

1. Smart controller.
2. LCD screen interface.
3. Duct temperature sensors.

4. Variable frequency drives.

C. All controls to be listed by ETL (UL 508A)

D. The system includes an LCD screen interface for fan(s) and hood lights control, gas valve reset, programmable schedule, Max Air Override function, Preparation Time mode, and diagnostics including VFD status. The LCD screen shows descriptive plain text explaining the functions or values. Provide a NEMA 1 rated control enclosure listed for installation inside of the exhaust hood utility cabinet. Control enclosure to be constructed of stainless steel.

1. The LCD screen interface shall be remote mounted, where indicated on the drawings.

E. The smart controller will constantly monitor the exhaust air temperature through the riser mounted temperature sensor and modulate the fan speeds accordingly.

F. A room temperature sensor will also be provided for field installation in the kitchen space in order to start the fan(s) based on the fixed temperature differential between the room and the exhaust air in the duct rather than fixed set-points.

G. Fan(s) maximum and minimum speeds will be adjustable for proper kitchen balance.

H. Duct Temperature Sensor(s) will be mounted in the exhaust hood duct riser. Temperature probe will be constructed of stainless steel. The system will be factory pre-set to modulate fan speed within a range of 45° F for 600° F and 700° F cooking applications and a range of 5°F for 400° F cooking applications. Set-points are fully adjustable through the touch screen interface based on application needs.

I. The panels include color coded wiring with as-built wiring diagrams and spare terminals controlled by the fire system micro switch. The panel is factory pre-wired to shut supply fans down in a fire condition. Options to turn ON the exhaust fans or turn off the hood lights in a fire condition will be configurable through the smart controller, but only through a password protected menu to prevent any changes after a fire inspection has been performed.

J. DCV System Sequence of Operation: The system shall be capable of operating in any of the following methods:

1. Automatic operation based on controls provide with the system that will determine the temperature difference between the room and the temperature within the hood. The controls will modulate the exhaust fan and make-up air units accordingly.
2. Manual control.
3. Scheduled operation to be operational at a specified period throughout the dat.
4. Fire mode: upon activation of the hood fire protection system the exhaust fan will start or continue to run and the make-up air unit will shut-down. The gas supply will be shut off.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units according to manufacturer's written instructions. Include all required controls and control wiring to provide a fully operational system.

B. Provide installation of the exhaust fan(s), make-up air units, temperature sensors and all required controls to provide a complete and fully operational ventilation system(s). This work is to be performed per the manufacturer installation instructions.

C. Roof curb: provide a roof curb for all roof mounted units. Install the roof mounted unit(s) on the roof curb immediately after the curb is installed. If immediate installation is not performed provide temporary watertight covering, for all curb openings, consisting of minimum ¾" exterior grade plywood and watertight rubber or plastic cover.

D. At the direction of the owner's representative, the contractor shall install the extra filters in the respective equipment. If no additional installation is required, the contractor shall forward, to the owner, all extra filters.

3.2 CONNECTIONS

A. Install piping adjacent to gas-fired duct heaters to allow service and maintenance. Duct Connections: Comply with Division 23 Section, Metal Ducts.

B. Provide control wiring and interlocks to shut down the supply fan when the fire suppression system is activated, the exhaust fan shall continue to operate. If the system is not operating, provide an interlock to start the exhaust fan if the fire suppression system is activated. Provide all control and relay wiring between the ventilation system fans and an adjustable temperature switch to be located within the kitchen hood to automatically activate the Kitchen Ventilation system when heat is detected.

3.3 START-UP AND COMMISSIONING

A. Start-up service shall be provided by the equipment manufacturer's authorized representative and shall include complete testing of all controls and unit operation for all units. The agency responsible for start-up shall record all operating data. Copies of this data are to be supplied to the owner.

3.4 ADJUSTING AND CLEANING

A. Adjust initial temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

C. Clean units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

3.5 DEMONSTRATION

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

END OF SECTION 23 58 30

SECTION 23 81 20 - DUCTLESS SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes packaged mini-split heat pump and cooling only systems.

1.3 SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Provide wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Provide operation and maintenance Data.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain all mini-split units and accessories through one source from a single manufacturer, regularly engaged in production of heat pumps and the associated components.

B. All units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

C. All wiring shall be in accordance with the National Electrical Code (N.E.C.) and local codes as required.

D. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute’s (AHRI) Standard 210/240 and bear the ARI Certification label.

E. A dry air holding charge shall be provided in all indoor units.

F. All outdoor units shall be pre-charged with R-454B refrigerant.

1.5 DELIVERY, STORAGE, AND HANDLING

A. All system components shall be stored and handled in accordance with the manufacturer’s recommendations.

1.6 WARRANTY

A. Provide written warranty indicating the entire installation will be warranted for a period of 1 year from the date of substantial completion. The warranty will include all parts, materials and labor for replacement of any of the unit's components that fail in materials and/or workmanship within the warranty period.

B. In addition to the above all units shall have a manufacturer’s parts and defects warranty for a period five (5) year from date of installation. All compressors shall have a warranty of seven (7) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. The warranty does not include labor.

1.7 EXTRA MATERIALS

A. In addition to the equipment and materials furnished with the mini-split systems, furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing the contents:

B. Filters: provide one additional filter(s) for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide mini-split units manufactured by Mitsubishi Electric. Subject to review, equipment meeting the full requirements of the specifications and project installation limitations and manufactured by one of the following will be considered:

1. Daikin.
2. LG Electronics.

2.2 WALL MOUNTED INDOOR UNITS

A. The wall-mounted indoor unit shall be factory assembled, wired, and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

B. Unit Cabinet: All casings shall have a white finish. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard. There shall be a separate back plate which secures the unit firmly to the wall.

C. Fan: The indoor fan shall be statically and dynamically balanced to run on a single motor with permanently lubricated bearings. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right). A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.

D. Filter: Return air shall be filtered by means of an easily removable, washable filter.

E. Coil: The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy. The coils shall be pressure tested at the factory.

F. Electrical: The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit using the manufacturer's recommended system. Provide conductor wire and ground per manufacture's requirements.

2.3 CEILING CASSETTE UNIT

A. The ceiling-cassette indoor unit shall be factory assembled, wired, and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function, a test run switch, and the ability to adjust airflow patterns for different ceiling heights. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. Unit Cabinet: The cabinet panel shall have provisions for a field installed filtered outside air intake. Supply ducts may be connected to the unit(s).

C. A four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow. The grille vane angles shall be individually adjustable from a wired remote controller to customize the airflow pattern for the conditioned space.

D. Fan: The indoor fan shall be an assembly with a statically and dynamically balanced turbo fan direct driven by a single motor with permanently lubricated bearings. The indoor unit shall include an AUTO fan setting capable of maximizing energy efficiency by adjusting the fan speed based on the difference between controller set-point and space temperature. The indoor fan shall be capable of five (5) speed settings, Low, Mid1, Mid2, High and Auto. Provide adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow. The indoor unit fan logic must include multiple setting that can be changed to provide optimum airflow based on ceiling height and number of outlets used. Provide unit vanes with 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution. The vanes shall have a selectable option in the heating mode that shall randomly cycle the vanes up and down to evenly heat the space. The grille shall include a factory-installed sensor, to work in conjunction with indoor unit control sequence to prevent unnecessary cooling or heating in unoccupied areas of the zone without decreasing comfort levels. The sensor must detect occupancy (not simply motion) and location of occupants by measuring size & temperature of objects within a standard range.

E. Filter: Return air shall be filtered by means of an easily removable, washable filter.

F. Coil: The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy. The coils shall be pressure tested at the factory. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 33 inches above the condensate pan.

G. Electrical: The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit using the manufacturer's recommended system. Provide conductor wire and ground per manufacture's requirements.

2.4 OUTDOOR UNITS

A. General: Provide outdoor units compatible with the indoor units. The outdoor unit shall be equipped with an electronic control board that interfaces with the indoor unit to perform all necessary operation functions. The system shall be capable of cooling operation down to ambient temperature of 0°F for heat pump systems and -20°F for cooling only systems without additional low ambient controls. The outdoor unit shall be able to operate with a maximum height difference of 100 feet between indoor and outdoor units.

B. Cabinet: Provide a casing constructed from galvanized steel plate, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. Mounting feet shall be provided and shall be welded to the base of the cabinet and be of sufficient size to afford reliable equipment mount and stability. Easy access shall be afforded to all serviceable parts by means of removable panel sections. The fan grill shall be of ABS plastic.

C. Fan: Provide single or dual DC fan motors. The fan blade(s) shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent external contact with moving parts.

D. Coil: The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up and allow maximum airflow. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve metering device which shall be a microprocessor-controlled step motor. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ACR Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free, elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1” thick insulation shall have a - Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50.

E. Compressor: The compressor shall be a DC twin-rotor rotary compressor with Variable Speed Inverter Drive Technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which shall result in significant energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used. The outdoor unit shall have an accumulator and high-pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

F. Electrical: The electrical power of the unit shall be 208volts or 230 volts, single phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. Power for the indoor unit shall be supplied from the outdoor unit via a factory controller. The power to the indoor unit shall be supplied from the outdoor unit.

2.5 CONTROLS

A. Provide wall mounted thermostat for each system.

B. Provide BACnet interface.

C. Provide all required wiring and controls including two microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from a wireless or wired controller, providing emergency operation, and controlling the outdoor unit. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Indoor units shall have the ability to control supplemental heat.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install unit(s) level and plumb.

B. Install outdoor unit(s) per manufacture’s installation instructions. Where indicated provide roof support curbs.

C. Provide pipe portals for installation of refrigerant piping.

D. Install roof-mounted compressor-condenser components on roof support curbs.

E. Provide a complete and operational system including remote thermostat with back box and all control and line voltage wiring as necessary.

3.2 CONNECTIONS

A. Provide all required refrigerant piping and specialties including insulation on the refrigerant pipe.

B. Install piping adjacent to the indoor and outdoor units with clearance for servicing.

3.3 COMMISSIONING

A. Engage a factory-authorized service representative to perform startup service and to train Owner's maintenance personnel to adjust, operate, and maintain units. Start-up to include complete testing of all controls and unit operation. Provide records of all start-up procedures and provide copies of this data are to the owner.

END OF SECTION 23 81 20

SECTION 26 00 10 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:

1. Submittals.
2. Coordination Drawings.
3. Record documents.
4. Maintenance manuals.
5. Rough-ins.
6. Electrical installations.
7. Cutting and patching.

1.2 SUBMITTALS

A. Follow the procedures specified in Division 1.

B. Submit, in electronic format, as a PDF, electrical related Shop Drawings and Product Data. Provide requested Samples of sufficient quantity, to allow for required distribution to Owner, Owner's Representative, Architect and Engineer.

C. Submittals must be provided with all catalog information clearly identified indicating all options to be provided as part of the product. Any submittal not containing this information will be rejected.

D. Provide the following shop drawings in booklet form:

1. Light fixtures cuts shall be submitted all at one (1) time in a single packet.
2. Electrical switchgear, including, but not limited to panelboards, transformers, disconnect switches, manual motor starters, combination motor starters / disconnect switches, and contactors shall be submitted all at one (1) time in a single packet. All equipment shall be of one manufacturer.
3. Wire devices shall be submitted all at one (1) time in a single packet and be from one (1) manufacturer.
4. Occupancy sensors shall be submitted all at one (1) time in a single packet and be from one (1) manufacturer whether connected to a lighting control system or provided with power packs, unless noted otherwise. Layout drawings may be submitted after the devices are approved.
5. **All required layout drawings shall be shown on architectural backgrounds and not the electrical drawings to ensure that the manufacturer locates all devices. It is the contractor's responsibility to acquire the CAD drawings per Division 1 requirements.**

1.3 PRODUCT REVIEWS AND SUBSTITUTIONS

A. Refer to Division 1 for substitutions requirements under this contract. Division 1 requirements supersede requirements listed elsewhere.

1.4 SHOP DRAWINGS

A. Refer to the Conditions of the Contract (General and Supplementary) and Division-1 for submittal definitions, requirements, and procedures.

B. Where submittals include multiple items, a bill of material (not including quantity) shall be provided at the front of the shop drawing. The bill of material shall include product identification, manufacturer and model number.

C. Submittal of Shop Drawings, Product Data, and Samples will be reviewed only when submitted by the Prime Contractor. Submittals from sub-Contractors and material suppliers directly to the Architect/Engineer will not be reviewed. No equipment/materials shall be installed until the Shop Drawings have been stamped with "No Exceptions Taken" or "Make Corrections Noted" by the Architect/Engineer.

D. Submit Shop Drawings as listed in each specification section. Following is a list of shop drawings to assist the contractor; however, the contractor shall supply all shop drawings as listed in each individual section whether listed below or not.

1. Coordination Drawings.
2. Secondary Distribution Board.
3. Power and Lighting Panelboards.
4. Disconnect Switches.
5. Individually-Mounted Circuit Breakers.
6. Combination Motor Starter/Disconnect Switches.
7. Fuses.
8. Contactors.
9. Thermal Overload Switches.
10. Wiring Devices and Wall Plates.
11. Flush Floor Outlets / Boxes and/or poke-thrus.
12. Surface Raceway.
13. Dimmer Switches.
14. All Lighting Fixtures (submit in booklet form and with detail drawings where required).
15. Low Voltage Lighting Control Equipment and associated wiring diagrams and layout drawings.
16. Occupancy Sensors and associated layout drawings.
17. Static Uninterruptible Power Supply.
18. Transient Voltage Surge Suppression.
19. Fire Alarm Equipment and associated wiring diagrams, and layout drawings.
20. Data Equipment including, but not limited to equipment shop drawings, warranty information, Installer information, testing information and layout drawings.
21. Paging Equipment.
22. Fire Stopping Material.
23. Access Panels.

E. When preparing submittals and any required final programming, use a room number schedule generated by the architect and/or the owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, revise the initial submittal, when a schedule is available, to reflect the proper room numbers.

F. Submittal Plans: Submittal plans **MUST** be provided with only the system being presented. Plans not submitted that have not been cleaned of extraneous systems (i.e. a low voltage system being installed on the power drawing, showing all the power and other low voltage systems), will be grounds for immediate rejection without review.

1.5 COORDINATION SUBMITTALS

A. The Contractor shall coordinate with other trades, and provide building coordination drawings for all major components. Following is a MINIMUM list of components that must be included on the coordination drawings; however, the Contractor must also include all other components and systems of substantial size to ensure proper coordination.

1. Conduit pathways, denoting pathways for larger conduits (3” and larger) as well as bundles of MC cable.
2. Cable tray.
3. Switchgear (unit substations, switchboards, motor control centers, panelboards, transformers, large disconnect switches (200A and larger).
4. Static uninterruptible power supply.
5. Transient voltage surge suppression equipment.
6. Lighting.
7. Theatrical lighting and control system.
8. Intercommunications cabinet.
9. Remote sound reinforcement cabinet and speakers.

B. In addition to the above equipment being installed, the Contractor shall be responsible to review the existing conditions with the coordination drawings, and ensure other contractor installed equipment and systems (i.e. piping, ductwork, etc.) will not impact the clearance requirements of existing electrical equipment per NEC (i.e. panelboards, disconnect switches, electrical boxes, etc.) Should there be a conflict, this shall be brought to the Architect/Engineer in writing immediately.

1.6 PRODUCT OBSOLESCENCE

A. In all cases, the most current iteration of the specified product shall be submitted. Where the specified product is no longer manufactured, the contractor shall submit an equivalent product with the same or better specifications. Where specific manufacturers are specified, the contractor shall supply from the same manufacturer the recommended replacement; however, under no circumstances shall the replacement product be deficient in any aspect to the specified product.

B. In the submittal for the product, the Contractor shall provide a signed letter clearly indicating the reason for the replacement product, and confirmation that the replacement product meets or exceeds all of the specified product's specifications to the best of the Contractor's knowledge.

C. The replacement product shall be provided at no additional cost to the owner, and shall not constitute any extension to the project schedule.

D. These requirements shall be inclusive to requirements listed elsewhere in the specifications, and shall not void any other requirements.

1.7 INSPECTIONS

A. The Contractor shall provide certificates of approval, in triplicate, for service equipment, building rough wiring, and building finished wiring.

B. Inspection certificates shall be submitted to the Engineer within 30 days after the inspections are made. Contractor shall use an independent NEC Certified Inspection Agency as the approved agency. Contractor must verify that the Certified Inspection Agency is approved by the local municipality and the Owner to inspect electrical installations in the project locality. All inspection certificates must be received before final payment can be made.

C. Refer to General Conditions for additional information.

1.8 INDEPENDENT COMMISSIONING

A. Independent Commissioning of electrical systems meeting local and state codes, and owner requirements shall be provided as part of this project. The independent commissioning authority may be hired by this Contractor, another project Contractor or the Owner, as indicated in the documents. However, this does not absolve the installing Contractor and manufacturer from ensuring full functionality of the systems, and manufacturer commissioning as outlined in the individual sections.

B. The Contractor shall schedule and coordinate shop drawing submissions, systems installation and systems start-up with the commissioning authority as required to allow the commissioning authority to perform their work.

C. Commissioning of the lighting control system shall take place on every project, and shall meet the local currently adopted version of the International Energy Conservation Code. This Contractor shall ensure this takes place, and contract with the applicable party as required.

1.9 MANUFACTURER'S REQUIREMENTS

A. All material shall be new, of the best respective kinds, manufactured by the company or companies mentioned and shall be of domestic manufacture unless specified otherwise.

B. All equipment, material or apparatus of any one system must be the product of one Manufacturer, or system tested products.

C. Manufacturers not listed in the Contract Documents must submit to the Engineer, via a Bidding Contractor, all product information per Division 1 requirements.

1.10 NAMEPLATE DATA

A. Each item of power operated equipment shall be provided with a permanent operational data nameplate on indicating Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance, and similar essential data. Nameplates shall be located in an accessible location.

1.11 FAMILIARITY WITH PROPOSED WORK

A. All Contracts are with the understanding that the Contractor, prior to submission of his bid, acquainted himself with the requirements of the Drawings and Specifications, including "Conditions of the Contract," conditions of the site, its terrain, soil conditions, all other requirements of the Contract, and that he obtained all information necessary for completion of the work on or before the date specified for receiving of bids.

B. In all cases where a device or part of the equipment is herein referred to in the singular, such reference shall apply to as many such items as are required to complete the installation.

C. "Existing" information does not necessarily represent "as-built" conditions. The Contractor shall verify all existing conditions. If discrepancies are found the Contractor shall notify the Architect/Engineer for a resolution before proceeding.

1.12 DEFINITIONS

A. The terms "The Contractor" or "This Contractor" mentioned in these Specifications refers to the Electrical Contractor responsible for the work and equipment included in these Specifications.

B. The term Sub-Contractor refers to any reference to, or letting of work contained in these Specifications to any Sub-Contractor or Manufacturer by the Prime Contractor. This does not relieve the Prime Contractor of his responsibility for all work, material and equipment in this Specification.

C. The term "Provide," when used separately, shall mean to "Furnish and Install."

D. The term "Furnish," when used separately, shall mean to obtain and deliver on the job for installation by other trades.

E. The term "Install," when used separately, shall mean to mount in place, connect and make operable.

1.13 INTENT OF THE DRAWINGS AND SPECIFICATIONS

A. The Drawings which accompany the Specifications are for the purposes of illustrating the character and extent of the work, and are subject to such modifications by Architect/Engineer as may be found either necessary or advisable before ordering the prosecution of the work. The Contractor shall conform to and abide by whatever Supplementary Drawings and explanations which may be furnished by the Architect/Engineer for the purpose of illustrating the work. The Architect/Engineer shall decide as to the meaning or intention of any portion of the Specifications and Drawings.

B. Where the work is shown in complete detail on only half or a portion of a Drawing, or there is an indication of continuation, the remainder being shown in outline, the work drawn out in detail shall be understood to apply to other like portions of the structure. All work that may be called for in the Specifications and not shown on the Drawings, or shown on the Drawings and not called for in the Specifications, shall be executed and furnished by the Contractor as described in both.

C. Should any incidental work or materials be required, but not set forth in the Specifications or Drawings, either directly or indirectly, but which is necessary to fulfill the intent thereof, the Contractor is to understand same to be implied and required, and he shall perform all such work and furnish all such materials as fully as if they were particularly delineated or described, without additional cost to Owner. This shall include all materials, devices, methods peculiar to the machinery, equipment, apparatus, or systems as described herein.

1.14 EQUIPMENT ENCLOSURE RATINGS

A. Electrical equipment installed within the building shall carry a NEMA rating 1 or higher if indicated in the specifications or on the drawings.

B. Electrical equipment installed outside the building, or in environmentally wet locations shall carry a NEMA rating 3R or higher if indicated in the specifications or on the drawings.

C. Electrical equipment installed in harsh environments (i.e. natatoriums, greenhouses, etc.) shall carry a NEMA rating 4X, and be manufactured from stainless steel.

D. Where specifications and drawings conflict (i.e. drawings indicated NEMA 3R, but specifications indicate NEMA 1), the higher rating shall be provided at no additional cost to the project.

1.15 WIRING LAYOUTS

A. Should it become necessary to rearrange any of the circuit or feeder wiring, approval to do so shall first be obtained from the Engineer. The Contractor will be supplied with a spare set of Drawings on which all such approved changes shall be noted. Upon completion of all work under this Contract, these Drawings shall be returned to the Architect/Engineer, who will issue a receipt for same.

1.16 FIELD MEASUREMENTS

A. Before ordering any materials or doing any work, Contractor shall verify all measurements at the building site, and shall be responsible for correctness of same. At no time shall the Contractor scale Drawings for the purpose of installation.

B. No extra compensation will be allowed on account of differences between actual dimensions and those indicated on the Drawings. Any difference which may be found shall be submitted to the Architect/Engineer for consideration before proceeding with the work.

1.17 COORDINATION

A. The Contractor shall cooperate with the other Contractors and shall arrange to eliminate conflicts with the equipment and work of the Contractors.

B. The Contractor shall be responsible for coordinating all electrical devices/equipment with the casework before rough-in. Any conflicts with casework and electrical devices/equipment shall be brought to the attention of the Architect/Engineer before rough-in. Any electrical device/equipment installed in conflict with casework shall be removed and reinstalled at the Contractor's expense.

C. The Contractor shall be responsible to coordinate all electrical conduits which are installed for rooftop equipment. Where the equipment can be fed from within the equipment curb, the contractor shall utilize this space. Where the equipment must be fed from the exterior, the contractor shall furnish and install a roof curb designed for conduit penetrations.

D. Refer to Division 01 “Multiple Contract Summary” and other portions of the contract documents (drawings and specifications) to determine who is responsible for exterior excavation, trenching, preparations of the utility trances, embedment material, subsurface backfill and grade backfill/ surface patching. Where other Contractors are responsible for any of these activities, coordinate all work associated with excavation, trenching and backfilling with that Contractor prior to starting this work. Schedule activities to minimize disruptions to the Owner and project site, and ensure all work is performed properly and completely.

1.18 CHASES AND OPENINGS

A. The Contractor shall determine, in advance, the locations and sizes of all chases and openings necessary for the proper installation of his work and have same provided during construction. Any chase or opening not made during construction, due to the Contractor's failure to determine same in advance, shall be done by the Contractor at his own expense. Any unnecessary cutting shall be repaired to match the original conditions of the area disturbed at the Contractor's expense.

1.19 AIR PLENUMS

A. The Contractor shall use a conduit system or approved plenum rated wiring for all wiring located above ceilings.

1.20 RECORD DOCUMENTS

A. Refer to Division 1 for Record Document requirements. The following requirements supplement the requirements of Division 1.

B. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned from column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; work performed via Change Orders; concealed control system devices.

C. Mark Specifications to indicate changes by addendum or Change Orders; actual equipment and materials used.

D. All new underground utilities shall be marked and dimensioned on site plan as-built drawings.

1.21 OPERATION AND MAINTENANCE DATA

A. Refer to Division 1 for Operation and Maintenance Manual requirements.

B. Contractor shall provide Operation and Maintenance data listed in individual section in addition to requirements listed in Division 1.

C. Included with operation and maintenance data, under a separate tab or volume, complied into a single place, shall be manufacturer recommended preventative maintenance measures for each piece of equipment installed as part of this project.

1.22 WARRANTIES

A. Division 1 warranties shall be considered minimum warranties. Any warranties listed in the individual sections that are longer than Division 1 warranties shall be honored.

B. Refer to individual sections for warranty requirements beyond those as specified in Division 1.

1.23 TEST AND ADJUST

A. All systems installed under this Contract shall be tested and adjusted to ensure that all equipment and systems meet or exceed the specified requirements.

1.24 PHASE LOAD BALANCE

A. A reasonable balance shall be secured on the phases of all main distribution feeders and bus bars.

B. Following installation and with the system in operation, the Electrical Contractor shall check the balance and rearrange connections so that the ampacity on any of the two single-phase phases of the main bus shall not vary more than 10% of each other.

1.25 PAINTING

A. Refer to the Division 1 for general painting requirements.

B. The Contractor shall be responsible for all touch up painting on this project for electrical work.

C. The Contractor shall be responsible for painting of all conduits that is installed after general painting has been completed. In areas where the General Trades Contractor is not painting, this Contractor shall be responsible for painting conduits and boxes to match adjacent surfaces.

1.26 CLEANING

A. Refer to Division 1 Section, "Project Closeout" or "Final Cleaning" for general requirements for final cleaning.

B. The Contractor shall keep the building free of rubbish and material during the course of construction insofar as the work under this Contract is concerned.

C. Upon completion of the project, the Contractor shall remove all rubbish, surplus equipment and shipping labels and have all areas broom clean. The Contractor shall thoroughly clean all fixtures, and other electrical equipment, leaving same in first-class working condition.

1.27 INSTRUCTION OF OWNER'S PERSONNEL

A. The Contractor shall provide instruction of the owner's personnel as outlined in Division 1. The following requirements shall be included in addition to Division 1 requirements.

B. The Contractor shall provide the services of competent personnel and/or Manufacturer trained personnel to instruct employees designated by the Owner in the proper operation, care and maintenance of the equipment and system installed under the Contract.

C. A letter of certification itemizing the equipment, system, instructor, and bearing signatures of the employees instructed shall be delivered to the Engineer and the Owner upon completion of the project. The letter of certification shall note the number of hours spent in explanation and actual operation of system with maintenance personnel. If the Contractor cannot turn over this letter of certification with employee signatures, the Contractor shall be prepared to provide additional owner training, meeting the specification requirements, at no additional cost to the owner.

1. The Contractor shall keep notes of all of the training sessions, list discussion topics, questions and answers. The contractor shall provide these typed meeting minutes of the training sessions to all of the attendees and owner's representative. A final copy of these minutes shall also be provided with the O and M manuals for the applicable product.

D. The Contractor shall be responsible to video record each trained presentation session with the owner and the manufacturer and turn over the recordings to owner after completion of training session. The recordings may be turned over on DVD or Thumb drive. The Contractor shall obtain a signed receipt for the recordings proving the owner received them. If a copy of the receipt cannot be turned over and validated when requested, the contractor shall be responsible to provide additional training sessions as requested. A generic training video shall be acceptable in lieu of recording the owner's training session; however, this does not absolve the contractor of providing a private training session with the owner.

1.28 DELIVERY AND STORAGE OF MATERIALS

A. Refer to the Division 1 for delivery and storage of materials requirements.

B. The Contractor shall provide for, or secure use of, suitable-dry storage space for the safe delivery and storage of his materials. The Contractor shall be responsible for providing their own storage trailers on site. The use of Owner's inside-building storage will not be permitted, unless specifically noted otherwise.

1.29 PROTECTION OF EQUIPMENT AND MATERIALS

A. Responsibility for care and protection of electrical work rests with the Contractor until it has been tested and accepted by the Owner. After delivery, before and after installation, protect equipment and materials against theft, injury, or damage in all cases.

B. Protect equipment outlets, and pipe openings with temporary plugs, caps, or burlap. Electrical conduit openings shall be covered with capped bushing or fiber disks and bushings.

C. The contractor shall be responsible to protect all existing electrical or communications equipment to remain from construction dirt and debris, whether created from this contractor or another contractor. The contractor shall determine the method needed to protect each piece of equipment to remain. Should existing equipment be damaged during demolition it will be the responsibility of the contractor to provide necessary repairs or replacement of the damaged equipment.

1.30 PROTECTION OF SENSITIVE ELECTRONICS

A. During construction activities, the Contractor shall protect all newly installed and existing sensitive electronics, including, but not limited to Data equipment (network electronics, servers, etc.), intercommunications equipment, telephone equipment, CATV equipment, security equipment and CCTV equipment with a method that will keep all construction dirt and debris from the equipment filters, whether generated by this contractor or other contractors.

B. At a minimum, the Contractor shall build wood frames around all equipment housed in freestanding and wall mounted racks when construction occurs within the vicinity of the equipment. Cover housing with minimum 6mil thick reinforced clear plastic sheeting. The enclosure shall include removable access panels to work on equipment and shall be sized to provide sufficient air flow around equipment to avoid excessive heat buildup. The contractor shall provide an exhaust fan at one end and a similar sized framed inlet opening at the other end with a removable MERV 8 filter. Filters shall be replaced within sufficient intervals to avoid excessive heat buildup.

C. The Contractor may propose an alternate protection method prior to construction; however, the Contractor shall be prepared to provide the enclosure if their method is rejected.

D. Should the equipment be damaged during construction, the contractor shall replace the equipment with the same piece at no additional cost to the owner.

1.31 SCAFFOLDING AND HOISTING

A. The Contractor shall provide all lumber and other material required for the erection of all staging, scaffolding, shoring, protective platforms, railings and ladders. Scaffolding shall be removed at the completion of the work.

B. The Contractor shall protect any flooring that is to remain. The Contractor shall inspect the flooring before the scaffolding is installed and report any damage that exists before the start of construction. The Contractor shall be responsible to repair any damage to the flooring after the scaffolding is removed to the acceptance of the owner at no additional cost to the owner.

1.32 PERMITS AND FEES

A. Refer to the Division 1 for Permits and Fee requirements.

B. Unless noted otherwise, all electrical work permits, certificates, tests, and inspection fees required for the electrical work provided under this contract shall be paid by the Contractor, including any electrical licenses required to work on the project.

1.33 UTILITY COMPANY FEES OR CHARGES

A. Unless noted otherwise, all utility company (Electric, Telephone, Cable Television, Leased Fiber) fees or charges will be paid by the Owner directly to the utility companies.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment Specifications in Divisions-2 through -25 for rough-in requirements.

3.2 EXTERIOR AND INTERIOR EXCAVATION

A. Prior to any digging outside and inside the building, the Contractor shall review all available existing documentation and review the excavation path with the owner’s representative to help determine the location of existing utilities and structures. Following review of this documentation, the Contractor shall provide Ground Penetrating Radar (GPR) to ensure there are no utilities in the area of excavation. Should any utilities be found, the contractor shall provide information to the engineer, architect and owner and propose alternate locations for the excavation. If the contractor neglects to perform the research and GPR prior to excavation and destroys any underground utilities, it shall be the responsibility of the contractor to repair the utilities to the engineer, architect and owner's satisfaction without any additional cost to the owner.

3.3 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with Division 1. In addition to the requirements specified in Division 1, the following requirements apply. The Contractor shall be responsible for providing all cutting and patching required to perform his work unless noted otherwise.

B. Perform cutting, fitting, and patching of electrical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.

4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from the Architect, uncover and restore work to provide for Architect observation of concealed work.

C. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

F. Unless noted otherwise, where equipment is being provided on existing roofing systems, the contractor shall provide all roof patching where he penetrates the roof. The roof patching must be performed by an authorized vendor of the roofing system, maintaining all existing roofing warranties. The Contractor must contract with the owner's existing roofing vendor all roofing work.

3.4 PROTECTION OF INSTALLED WORK

A. During construction activities, including cutting and patching operations, protect adjacent installations.

B. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers. For installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.5 ELECTRICAL INSTALLATION

A. Coordinate electrical equipment and material installation with other building components. Verify all dimensions by field measurements. If no dimensions are given, Contractor shall verify with Architect or Engineer before starting work. At no time shall the Contractor scale Drawings for the purpose of locating items.

B. Provide for chases, slots, and openings in other building components to allow for electrical installations. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

C. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

D. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible, or to meet current local, national and ADA codes.

E. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

F. Install systems, materials, and equipment to conform with submittal data, including Coordination Drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.

G. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

H. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

1. Contractor shall also take care to leave access to other systems located behind electrical components being installed as part of this project. Should it be found that access has been blocked to other equipment requiring access (i.e. filters, valves, etc.), the offending system will be required to be removed and reinstalled at no additional cost to the owner.

I. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Division 26 “Common Requirements – Electrical.”

J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

K. Where exterior conduits, duct banks, equipment and pads are installed by this contractor, the contractor shall follow all NEC requirements, as well as those requirements listed on the drawings and in the specifications. Where excavation, both interior and exterior, is indicated to be performed by this contractor, backfill shall also be performed, meeting all requirements of the applicable drawing notes and specifications. Backfill shall include clean earth and/or stone, as specified in the applicable specifications, placed and tamped as indicated in the specifications. Provide all testing as outlined in the applicable specifications.

L. Electrical component installation in spaces where abuse may occur (i.e. gymnasiums, locker areas, exterior areas) shall be provided with vandal covers. Covers shall be provided with a means to be locked. System components include, but are not limited to light switches/dimmers, occupancy sensors, sound system controls, fire alarm devices, clocks, wireless access points, etc.

3.6 LOW VOLTAGE WIRING INSTALLATION

A. All low voltage wiring, installed above ceilings, must be plenum rated, unless noted otherwise. Wiring shall be installed perpendicular to steel, located in j-hooks and/or cable tray as available and allowed. Refer to individual specification and drawings for allowance if cable installation in cable trays.

B. All low voltage wiring, installed in spaces without ceilings, must be installed within conduit or other approved raceway. This requirement shall apply to finished spaces (i.e. gymnasium, etc.) and unfinished spaces (i.e. mechanical rooms, electrical rooms, etc.) Under no circumstances is exposed wiring acceptable.

C. The contractor shall be responsible to provide surge protection for all low voltage systems where copper lines leave and/or enter a building. System shall include, but not be limited to, voice, fire alarm, CCTV, television and security. All surge protection for low voltage systems shall be solid state, unless otherwise noted.

3.7 EXISTING INSTALLED EQUIPMENT

A. Where existing installed equipment (including, but not limited to gymnasium equipment (batting cage, divider nets, etc.), free hanging projection screens, theatrical equipment, etc.) is in the way of construction, the Contractor shall move equipment as required to accommodate their work.

B. During relocation, and work, the Contractor shall take care to no damage the equipment. Should the equipment be damaged prior to work commencing, they shall take photographic evidence, and report, in writing to the Owner, Architect and Engineer, the existing observed damage.

C. Should the existing equipment be damaged during construction activities, the contractor shall repair at no additional cost to the Owner.

3.8 ELECTRICAL REQUIREMENTS FOR EQUIPMENT INSTALLATION

A. Conduit and power wiring of required size and voltage, from a panelboard or similar source, shall be furnished and installed by this Contractor, to the equipment furnished by another Contractor. A junction box or means of disconnect (as required) shall be furnished and installed at the equipment by this Contractor meeting the National Electric Code.

B. Unless noted otherwise, a full complement of electrical control components, required for the intended use and/or operation of specified equipment, including variable frequency controllers, speed controllers and/or other control devices required, whether integral or remote, shall be furnished by the Contractor furnishing the equipment. These control devices as well as power wiring (where required) through these devices shall be installed by this Contractor.

3.9 CONTROL WIRING FOR EQUIPMENT INSTALLED BY ANOTHER CONTRACTOR

A. This Contractor shall be responsible for providing all required control wiring, (except HVAC system control wiring) for any equipment provided by another Contractor which shall include, but not be limited to, motorized backboards, screens, partitions, curtains, motor operated doors, etc, unless noted otherwise.

B. The Contractor shall provide all boxes and conduit required for any equipment provided by another Contractor. Control wiring shall also include any wiring of motion or occupancy sensors for doors, curtains, etc.

C. Coordinate all required work for a complete and functional system with the Contractor supplying the equipment. Make all required connections.

D. Prior to installing any control wiring to any equipment, acquire control wiring diagrams and direction from the installing contractor.

3.10 TEMPORARY ELECTRIC/TELEPHONE

A. Refer to Division 1 "General Conditions."

B. Temporary Electric for Building Construction: Refer to Temporary Facilities for requirements.

C. Temporary Electric for Construction Trailers: Refer to Temporary Facilities for requirements.

D. Temporary Telephone for Construction Trailers: Refer to Temporary Facilities for requirements.

E. Lighting: Provide temporary lighting in accordance with OSHA, (5-footcandles) with local switching to fulfill security requirements and provide illumination for construction operations and traffic conditions.

1. Lamps and Light Fixtures: Provide general service lamps. Provide guard cages or tempered glass enclosures, where exposed to breakage. Provide exterior fixtures where exposed to moisture.

3.11 ELECTRICAL DEMOLITION

A. The Electrical Contractor shall be responsible for all electrical demolition.

B. The Contractor shall be responsible for disconnecting and removing from the site all conduit, wiring, light fixtures, devices, panelboards, switchboards, transformers, disconnect switches, emergency generators, data, intercom, clock, sound, fire alarm, card access, security, CCTV, etc. The Owner shall tag or notify the Contractor as to any devices, equipment or systems which they wish to salvage before start of each phase of construction. See paragraph, "Salvage" for additional information.

C. The Electrical Contractor shall review all demolition drawings, including from other trades, and remove from the site all power wiring and associated electrical equipment, including, but not limited to wire, conduit, boxes, disconnecting means, supports, etc. feeding equipment that is being removed by other trades. This includes within the building, on the roof, attached to the building, and on the site.

D. Where fastened equipment is removed, the contractor shall be responsible to remove the associated lags or bolts that fastened the equipment down. Grind lags or bolts to below exiting surface and patch surface to match existing condition.

3.12 ELECTRICAL EQUIPMENT IN AND ABOVE CEILINGS

A. Where ceilings are being removed to accommodate phasing, the contractor shall tie up all low and line voltage wiring that is resting on the ceiling grid scheduled to remain or feeding a later phase until that wire can be removed.

B. Any wire that is scheduled to remain shall be independently supported from the structure or walls per the applicable specification sections. Low voltage wire shall be installed in cable tray or j-hooks and line voltage wire shall be installed in conduit and supported per NEC.

C. Where ceilings are being removed to accommodate phasing, the contractor shall tie up all lighting, fire alarm equipment (smoke detectors, annunciation devices, etc.), intercom speakers, and other electrical equipment until the new ceiling is installed. Electrical devices shall be removed or reinstalled as scheduled on the documents.

D. All existing MC cable encountered above the ceiling, not supported per the NEC, shall be tied up and supported per NEC requirements when encountered.

E. All wire, conduit, electrical systems or electrical devices, including, but not limited to lighting, power wiring, receptacles, data, fire alarm, security, CCTV, access control, intercom, phone, etc. above or in the ceiling that is abandoned prior to construction or being abandoned as part of the construction shall be removed at no additional cost to the owner. At the completion of the project, there shall be no abandoned wire, conduit, electrical systems or electrical devices in or above the ceiling.

3.13 CONTINUATION OF SYSTEMS DURING PHASED PROJECT

A. The contractor shall include all wiring, accessories, programming, etc. as required to accommodate the following. The contractor shall be responsible to contact the owner's vendor of each system for the necessary programming, and subsequent decommissioning of the existing systems being removed.

B. During the construction process, it is the contractor's responsibility to ensure that all existing site lighting is functional while the building is occupied, until that particular phase is under construction. The contractor shall provide temporary conduit and wiring as required to maintain functionality of site lighting and control.

C. During the construction process, it is the contractor's responsibility to ensure that the building electric and all communications services are maintained during occupied periods. The contractor shall coordinate all downtimes as required per paragraph, "Utility Service Down Time." The contractor shall provide temporary prime generation as required utilizing diesel fuel to ensure that the building has electric service while occupied. The contractor shall be responsible to provide a rented generator and the diesel fuel itself at no additional cost to the owner.

D. During the construction process, it is the contractor's responsibility to ensure that the building life safety and non-life safety emergency systems remain active. The contractor shall provide temporary wiring and possibility additional temporary emergency generator as required to ensure that there is no interruption to the emergency system while the building is occupied outside the construction zone during each phase. It is imperative that the life safety remain active whether the building is occupied or unoccupied to maintain safety for all parties.

E. During the construction process, it is the contractor's responsibility to ensure that the building fire alarm system remain active. At a minimum, audible and visual devices as well as pull station must remain active within the construction zone. All existing fire alarm devices outside the construction zone shall remain active.

F. During the construction process, it is the contractor's responsibility to ensure that the building data network systems remain active. It is this Contractor’s responsibility to coordinate with the Owner, and label wiring to remain prior to demolition activities.

G. In all cases, systems that require programming, including, but not limited to lighting control system(s), occupancy sensors, security system, fire alarm system and area of rescue assistance system, shall be reprogrammed after each phase of construction to ensure that each system is functional. Final programming and training shall occur at substantial completion of the final phase. The warranty period for each system shall commence only after final programming and training.

H. All required night, weekend and holiday time required to ensure that the above requirements are met shall be provided at no additional cost to the owner.

3.14 SALVAGE

A. The Owner reserves the right to salvage any electrical equipment prior to the start of each phase of construction.

3.15 ELECTRICAL ROOM LAYOUTS

A. The contractor shall be responsible for submitting electrical room layouts to the engineer prior to any panel or equipment rough ins. Layouts shall show that all equipment will be installed to meet the N.E.C. Code clearance requirements. The Contractor shall bare all costs associated with any changes required if electrical rough-ins are done prior to layout approval.

B. It shall be the contractor's responsibility to verify all N.E.C. clearance requirements prior to installation, including, but not limited to ductwork, piping, or other equipment above electrical equipment, as well as all horizontal requirements.

END OF SECTION 26 00 10

SECTION 26 00 30 – ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment specified under other Divisions or furnished by Owner.

1.2 REFERENCES

A. NEMA WD 1 - General Purpose Wiring Devices

B. NEMA WD 6 - Wiring Device Configurations.

C. ANSI/NFPA 70 - National Electric Code.

1.3 COORDINATION

A. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other Divisions.

1. Should there be a difference between the design and the installed equipment; change orders shall only be paid for the difference in the rough-ins. If the Division 26 Contractor installs any rough-ins prior to requesting and receiving shop drawings for the equipment to be installed, and the equipment is different than designed, the required rework shall be performed at no additional cost to the owner aside from the difference is cost between the design documents and installed equipment.
2. Should there be a need to install rough-ins ahead of equipment review and final shop drawing, the Division 26 Contractor shall submit a Request for Information, outlining the equipment to be fed, and how the schedule is impacted for review by the Engineer, Architect, Owner and Owner’s Representative.

B. Determined connection locations and requirements.

C. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

D. Sequence electrical connections to coordinate with start-up schedule for equipment.

PART 2 - PRODUCTS

2.1 CORDS AND CAPS

A. Attachment Plug Configuration: Match receptacle configuration at outlet provided for equipment.

B. Cord Construction: Oil-resistant thermoset insulated Type SO multiconductor flexible cord with identified equipment grounding conductor, suitable for hard usage in damp locations.

C. Cord Size: Same as rating of branch circuit overcurrent protection.

PART 3 - EXECUTION

3.1 PREPARATION

A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

B. The Contractor shall be responsible to coordinate all electrical which are installed for roof top equipment. Refer to “Coordination” in Section 260010 for additional requirements.

3.2 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.3 ELECTRICAL CONNECTIONS

A. Electrical connections shall meet equipment manufacturer's instructions.

B. Conduit connections to equipment shall use flexible conduit. Liquidtight flexible conduit with watertight connectors shall be used in damp or wet locations.

C. Wiring connections shall use wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Receptacle outlets shall be used where connection with attachment plug is indicated. Where attachment plug is required, equipment shall have a cord and cap.

E. Suitable strain-relief clamps and fittings shall be used for cord connections at outlet boxes and equipment connection boxes.

F. Disconnect switches, controllers, control stations, and control devices shall be located as indicated and per NEC requirements.

G. Verify proper rotation of three phase equipment.

H. Where applicable, power wiring shall be extended through external disconnect switches, local control switches, remote mounted control panels, etc. and connected to terminals in the equipment.

I. Where applicable, wire and conduit shall be extended between control device (start/stop pushbuttons or lighted handle switch) and combination starter/disconnect switches.

J. Coolers and Freezers: freezer and cooler walls, floors and ceilings shall be cut and sealed around conduit openings.

3.4 MISCELLANEOUS CONNECTIONS

A. Fire alarm, security, data, telephone and other low voltage connections shall be installed as required at equipment.

3.5 CONTRACTOR RESPONSIBILITIES (DIVISION 23 CONTRACT)

A. HVAC Control System Panels & Equipment Controls

1. 120 volt – 1 phase.
2. Division 23 Contractor shall provide power connection to control panel from nearest 120/208 volt electrical panel. Power for control panels for equipment being fed from the emergency generator, including, but not limited to boilers, heating pumps, selected air handling and terminal equipment, etc., shall be derived from the nearest 120/208 volt normal/emergency panel.
3. In addition to HVAC control system panels, where terminal equipment, including, but not limited to shut-off VAV boxes are provided with 120V connection, Division 23 Contractor shall provide power connection to the unit as described above.
4. Division 26 Contractor shall assist the Division 23 Contractor in locating the appropriate panel, ensure there is a spare 20A/1P breaker to feed the control panels and label breaker accordingly.
5. All wiring associated with the unit shall be by the Division 23 Contractor per manufacturer requirements.

B. Duct-mounted Smoke Detector

1. Division 26 Contractor shall furnish duct mounted smoke detector, including detector base and appropriately sized sampling tube for duct being installed.
2. Division 23 Contractor shall install sampling tube and detector base in duct. Coordinate exact location with Division 26 Contractor.
3. Division 26 Contractor shall install detector in base, wire and program into fire alarm system.
4. Division 26 Contractor shall provide relay, and wiring to associated HVAC unit from fire alarm system so that unit shuts down and supervisory signal is provided upon detection of smoke. Refer to Division 28 “Fire Alarm and Detection System” and drawings for additional requirements.
5. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

C. Ductless Air Conditioner (AC)

1. 208 volt – 1 phase.
2. 2-pole toggle switch shall be furnished and installed by the Division 26 Contractor adjacent to unit.
3. Division 26 Contractor shall wire through switch and make one power connection to the line side terminals in the unit.
4. Division 26 Contractor shall power the AC unit from the exterior unit. In systems where indoor unit receives separate power feed, provide junction box adjacent to the disconnect at the outdoor unit and run to the indoor unit for connection so that a single breaker controls both units.
5. All other wiring within the unit and between the unit and associated condensing unit shall be by the Division 23 Contractor per manufacturer requirements.

D. Air Cooled Condensing Unit (CU)

1. 208 volt – 1 phase.
2. Division 26 Contractor shall furnish and install a NEMA 3R fused disconnect switch at unit and shall extend power wiring thru switch to unit and shall make one connection to terminals in unit.
3. Where CU is associated with an indoor AC, power wire for AC unit shall come from the exterior unit. In systems where indoor unit receives separate power feed, provide junction box adjacent to the disconnect at the outdoor unit and run to the indoor unit for connection so that a single breaker controls both units.
4. All other wiring within the unit and between the unit and associated indoor unit shall be by the Division 23 Contractor per manufacturer requirements.

E. Indoor Fans – Manually Controlled (EF)

1. 120 volt – 1 phase
2. Wall switch shall be furnished and installed by the Division 26 Contractor.
3. Division 26 Contractor shall install Division 23 Contractor speed control in space being served by fan. Coordinate location in field for balancing.
4. Division 26 Contractor shall make one power connection thru wall switch and speed control where applicable.

F. Roof Fans – Reverse Acting T-Stat or ATC Controlled (EF)

1. 120, 208, 277 volt – 1 phase.
2. Integral disconnect switch provided by the equipment manufacturer.
3. Division 26 Contractor shall install Division 23 Contractor speed control in space being served by fan. Coordinate location in field for balancing.
4. Division 26 Contractor shall make one power connection through speed control where applicable.
5. Any other connections and/ or equipment required shall be provided by Division 23 Contractor.

G. Fan Powered Variable Air Volume Box (FPV)

1. 120, 277 volt - 1 phase.
2. Division 26 Contractor shall furnish and install a toggle switch for 1 phase units and non-fused disconnect switch for 3 phase units adjacent to unit and shall extend power wiring thru switch to unit and shall make one connection to terminals in units.
3. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

H. Kitchen Ventilation System (KVS-1 & KEF-1)

1. 480 volt - 3 phase.
2. A Demand Control Ventilation control panel, complete with VFD drives, interface screen, controls equipment, etc. shall be provided with the KVS housing drives and local disconnect. The Division 26 Contractor shall install the control panel at the hood. Field verify exact location to ensure ADA heights are maintained to the interface.
3. Division 26 Contractor shall make power connection to the VFD control panel and extend power wiring to rooftop make-up air unit fan and rooftop exhaust fan. Division 26 Contractor shall provide interlock wiring between fans and VFD control panel.
4. Division 26 Contractor shall make additional 120V connection to the KVS disconnect for IBT heaters and provide additional control wiring between the KVS and the VFD control panel per manufacturer requirements.
5. Division 23 Contractor shall furnish and install heat sensors. Division 26 Contractor shall interconnect the heat sensor and hood control panel so that unit starts when heat is sensed per IMC.
6. Division 26 Contractor shall provide wiring from VFD control panel to microswitches and provide 120V power. Division 26 Contractor shall provide interconnecting wiring from microswitches to the fire alarm system, gas solenoid and shunt trip breaker(s). Division 26 Contractor shall provide additional relays as required.
7. Division 26 Contractor shall provide 120V power to the control panel.
8. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

I. Kitchen Dishwasher Exhaust Fan (EF)

1. 120 volt – 1 phase.

2. Integral disconnect switch provided by the equipment manufacturer.
3. Division 23 Contractor shall provide all interlock wiring between exhaust fan and dishwasher machine.
4. Division 26 Contractor shall make one power connection to fan through equipment disconnect switch.
5. Any other connections and/or equipment required shall be provided by Division 23 Contractor.

J. Shut-off Air Terminal Unit (SOV)

1. Control power or 120 volt – 1 phase (contractor discretion).
2. Division 23 Contractor shall provide power to unit. Should 120 volt be selected, Division 23 Contractor shall provide power connection to unit from nearest 120/208 volt electrical panel. Power for units connected to air handling equipment connected to the emergency generator shall be derived from the nearest 120/208 volt normal/emergency panel. An attempt shall be made to minimize the quantity of breakers required by feeding multiple units from the same breaker, not exceeding 20 ampere of load on a single circuit.
3. Division 26 Contractor shall assist the Division 23 Contractor in locating the appropriate panel, ensure there is a spare 20A/1P breaker to feed the unit and label breaker accordingly.
4. Any other connections and/or equipment required shall be furnished and installed by the Division 23 Contractor.

3.6 CONTRACTOR RESPONSIBILITIES (DIVISION 22 CONTRACT)

A. Domestic Water Heater Electric (DWH)

1. 120, 208 volt – 1 phase.
2. Equipment manufacturer shall provide disconnect switch integral to unit.
3. Division 26 Contractor shall provide power wiring to unit disconnect switch and make one power connection.
4. Any other connections and/or equipment required shall be furnished and installed by the Division 22 Contractor.

B. Recirculating Pumps (CP)

1. 120 volt – 1 phase.
2. Thermal overload switch or starter/disconnect switch shall be furnished and installed by the Division 26 Contractor adjacent to the unit. Wire thru switch to pump motor.
3. Any other connections and/or equipment required shall be furnished and installed by the Division 22 Contractor.

C. Electric Water Cooler

1. 120 volt – 1 phase.
2. Division 26 Contractor shall refer to Electric Water Cooler shop drawings and furnish and install a duplex receptacle contained within the enclosure where applicable or provide direct connection where cord and plug is not provided.
3. Any other connections and/or equipment required shall be furnished and installed by the Division 22 Contractor.

3.7 CONTRACTOR RESPONSIBILITIES (GENERAL TRADES CONTRACT(S))

A. Food Service Equipment

1. The food service equipment will be furnished and installed under the Food Service Equipment Contract, but all related electrical work shall be provided by the Division 26 Contractor. Necessary Disconnect switches, starters, thermal switches, and special control devices will be furnished, installed and wired by the Division 26 Contractor. Division 26 Contractor shall install all necessary inter-connecting wiring within the equipment.
2. Division 26 Contractor is required to bring electrical service where required to make final connections. The exact locations for such will be determined by the Food Service Equipment Installer and such information will be furnished to the Division 26 Contractor.
3. Division 26 contractor shall secure roughing-in shop drawings prior to rough-in.
4. Installation of fractional horsepower equipment shall be made by installing a duplex outlet, 3-wire grounding type in wall behind the machine, except where floor outlets are indicated, and making final connection through a 3-wire cap with cord grip. Each machine shall be provided with approved grounding. Flexible feeders from junction boxes shall be provided as required.
5. Interlock wiring for condensing units, evaporative blower units, and lighting in walk-in cooler/freezer units shall be provided by the Division 26 Contractor unless otherwise noted on Food Service Contract drawings and specifications.
6. All work shall be installed in accordance with the standards and requirements of the NSF, DER, and NEC.

B. Powered Furniture

1. Division 26 Contractor shall acquire shop drawings for powered furniture and provide electrical connection per shop drawings. Should shop drawings differ from electrical drawings, contractor shall submit, in writing, changes prior to rough-in.
2. Division 26 Contractor shall provide all wiring, jacks, conduits and boxes for data wiring in furniture. Division 26 Contractor shall coordinate with the Installing Contractor to insure proper placement of jacks.

END OF SECTION 26 00 30

SECTION 26 05 00 – COMMON REQUIREMENTS – ELECTRICAL CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes materials and methods that are common to various Electrical Systems.

1.2 SUBMITTALS

A. Product Data: For the following:

1. Fireproofing
2. Access Doors

1.3 COORDINATION

A. Arrange for conduit spaces, chases and openings in building structure during progress of construction to allow for electrical installations.

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

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

PART 2 - PRODUCTS

2.1 FIRESTOPPING

A. The Contractor shall be responsible for providing permanent, UL approved firestopping systems for all penetrations through fire rated floor or fire rated wall assemblies. For areas that will require future access for the installation of additional cables, repair, or retrofit, the firestopping system shall consist of re-usable intumescent pillows or putty. All firestopping shall meet the requirements of ASTM E-814 and UL 1479.

1. Subject to compliance with project requirements, firestopping materials may be provided by one of the following Manufacturers.

a. Specified Technologies Inc. (STI) Somerville, NJ (800) 992-1180
b. Tremco, Beechwood, OH (800) 321-7906
c. 3M, St. Paul, MN (800) 328-1687

2. Submit for review the following product data.

a. Product data sheets.
b. UL System Drawings for each firestopping application.
c. Manufacturer’s Certificates of Conformance for their products.

2.2 ACCESS DOORS

A. Refer to Division 8, “Access Doors and Frames” for additional requirements. Access doors furnished and installed under this contractor shall comply with Division 8 requirements in addition to the following.

B. Manufacturers: Subject to review, provide access doors manufactured by Milcor, Inc or equal.

C. Description: Steel access doors and frames for installation in masonry and/or drywall/gypsum board assemblies. Provide fire rated access doors when doors are installed in a fire rated assembly.

D. Frames: minimum 16 gage steel with exposed nominal 1” flange around the perimeter of the unit. Where doors are to be installed in drywall/gypsum board assemblies provide frames with a drywall bead. Doors to be installed in masonry shall be furnished with adjustable metal masonry anchors.

E. Flush Panel Doors: minimum 14 gage steel with concealed spring or piano hinge(s) with a minimum swing of 175 degrees. Finish to be a factory-applied primer, suitable for field painting. Provide flush cylinder lock with key. Key all locks alike. Verify keying with owner prior to ordering.

F. Access door schedule: In addition to access door shown on the drawings provide the following access doors to be installed where directed by the architect or engineer:

1. Five 16” x 16” to be installed in drywall/gypsum construction.
2. Five 16” x 16” to be installed in masonry construction.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment Specifications in Divisions-2 through -25 for rough-in requirements.

3.2 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

A. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

B. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

3.3 FIRESTOPPING

A. Comply with manufacturer’s written instructions for install fire stopping. When mechanical system is used, set securely in place in accessible locations.

B. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

C. Firestopping shall be installed in all fire rated walls. Review all drawings, including architectural, and site conditions to determine where fire rated walls are located.

D. Preparation

1. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:

   a. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
   b. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
   c. Remove laitance and form-release agents from concrete.

E. Installation

1. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
2. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

   a. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

3. Install fill materials by proven techniques to produce the following results:

   a. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
   b. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   c. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

F. Identification

1. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375-inch (9.5-mm) strokes.
2. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

G. Cleaning and Protection

1. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
2. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

3.4 ACCESS DOORS

A. Comply with manufacturer's written instructions for installing access doors and frames. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces. Install doors flush with adjacent finished surfaces or recessed to receive finish material.

B. Adjust doors and hardware after installation for proper operation. Remove and replace doors and frames that are warped, bowed or otherwise damaged.

END OF SECTION 26 05 00

SECTION 26 05 19 – WIRES AND CABLES – 600V AND BELOW

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of the wire and cable work is indicated by Drawings and by requirements or other sections of the Specifications for cables used for power, lighting, signal, control and related system rated 600 volts or less. See below article “CABLES” for permitted use of Type MC Cables on this project.

1.2 CODES AND STANDARDS

A. NEC Compliance: Comply with applicable requirements of NEC for construction and installation of wires/cables and connectors.

B. UL Compliance: Comply with UL Stds 44, 83 and 486A, B and C. Provide wiring/cabling and connector products which are UL-listed and labeled consistent with their uses.

C. ICEA Compliance: Insulated Cable Engineers Association Inc., Standard WC-5-86.

D. IEEE Compliance: Institute of Electrical and Electronic Engineers, Standard 82-83.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide all wires and cables of sizes indicated on the Drawings and suitable for the temperature, conditions and location where installed. Install all wire in raceway.

2.2 CONDUCTOR MATERIAL

A. Use copper conductors of 98% conductivity and rated at 600V for all wires and cables, unless otherwise noted.

2.3 INSULATION

A. No conductors smaller than No. 12 AWG shall be used unless noted elsewhere. All wires No. 8 AWG or larger shall be stranded. Wire sizes No. 12 and No. 10 AWG. shall be solid (stranded wire used for No. 12 AND 10 will not be permitted unless otherwise noted).

B. All conductors shall be provided with type THHN/THWN insulation, unless noted otherwise.

C. All switchboard, transformer and panelboard feeder insulation shall be type XHHW-2.

D. Each circuit shall be provided with a dedicated neutral wire. Sharing of neutral wire for multiple circuits shall not be permitted, unless otherwise noted.

2.4 CABLES

A. Provide the following in NEC approved locations and project applications where indicated.

B. Type MC Cable: Provide Metal Clad Cable wiring using two No. 12 or 10 AWG with separate insulated copper ground wire (unless noted otherwise). Where AC (armored cable without separate neutral) is installed, Contractor will be required to remove cable and reinstall with approved cable type at no additional cost to the owner. Metal Clad cable may be used on this project only as follows:

1. For lighting and receptacle branch circuits from panel to device(s) or light fixture(s).
2. Connection to motors (2 feet maximum).
3. Fishing existing walls.
4. Branch circuits in stud walls.
5. Mechanical equipment/miscellaneous branch circuits inside of the building (less than 50amps) where condition warrants.

C. Where MC cables are run in parallel (i.e., down corridors), the Contractor shall bundle the cables and zip tie them together.

D. The Contractor shall bear all costs related for removing MC cable not pre-approved. Support and secure type MC cable at intervals not exceeding 6'-0". In addition, type MC cable must be supported within 12" of every fitting, junction box or outlet box that the cable enters.

E. All other wiring shall be installed in conduit as specified in Division 26 “Raceways,” unless approved otherwise by the Engineer prior to installation.

F. All switchboard, transformer and panelboard feeder wiring shall be run in conduit.

2.5 CONNECTORS FOR CONDUCTORS

A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

PART 3 - EXECUTION

3.1 WIRES AND CABLES

A. General: Install electrical cables, wires, and connectors in compliance with NEC. Coordinate cable installation with other work. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.

B. Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

C. While installing cables, care shall be taken to protect outer coating. If outer coating is damaged, contractor shall remove and reinstall cables.

D. Conceal all cable in finished spaces. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours, where possible. Keep conductor splices to minimum.

E. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor material.

F. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Make terminations so there is no bare conductor at the terminal. Provide wire ties and neatly train and rack wires in all boxes, panels, and other areas as required.

G. Tighten electrical connectors and terminals, including screws and bolts, in accordance with Manufacturer's published torque tightening values. Where Manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

H. Each branch circuit shall be provided with a dedicated neutral wire, unless noted otherwise.

I. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.2 FIELD QUALITY CONTROL

A. Prior to energizing, provide the following tests to all cables, 600 Volt or less and size no. 3 AWG or larger:

1. Inspect exposed sections of Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
2. Test bolted connections for high resistance using one of the following:

    a. A low-resistance ohmmeter.
    b. Calibrated torque wrench.
    c. Thermographic survey.

3. Inspect compression-applied connectors for correct cable match and indentation.
4. Inspect for correct identification.
5. Inspect cable jacket and condition.
6. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration. Use an industry approved meter for all tests.
7. Continuity test on each conductor and cable.
8. Uniform resistance of parallel conductors.
9. All inspection, cleaning and testing procedures shall be in compliance with the recommendations and standards outlined in the "maintenance testing specifications for electrical power distribution equipment and systems", latest edition, published by International Electrical Testing Association (NETA).

B. Prepare test and inspection reports and locate in the O&M manuals at the completion of the project. Test and inspection reports shall be provided to record the following:

1. Procedures used.
2. Results of above tests that comply with requirements.
3. Results that do not apply, corrective action taken, and retesting showing that they comply with the above requirements.

C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.

D. Color-Coding for Phase Identification:

1. Color-code secondary service, feeder, and branch circuit conductors with factory-applied color as follows:

Phase	120/208 Volts	120/240 Volts	277/480 Volts
A	Black	Black	Brown
B	Red	Orange (High-Leg)	Orange
C	Blue	Blue	Yellow
Traveler	Yellow	Yellow	Yellow w/ “T” tag
Neutral	White	White	Gray
Ground	Green	Green	Green w/ Yellow stripe

2. Switch legs shall include an additional “S” tag.
3. Provide visible colored taped as listed above at all termination points for No. 8 and larger wires.

END OF SECTION 26 05 19

SECTION 26 05 26 – GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of electrical grounding and bonding work is indicated by Drawings and Schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.

B. Type of electrical grounding and bonding work specified in this section includes the following:

1. Solidly grounded.

1.2 CODES AND STANDARDS

A. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.

B. UL Compliance: Comply with applicable requirements of UL 467, 486A, and 869, pertaining to grounding and bonding of systems, circuits and equipment. Provide grounding and bonding products which are UL-listed and labeled for their intended usage.

C. NRTL: Connectors shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. General: Except as otherwise indicated, provide electrical grounding and bonding system assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

B. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding system connections that match power supply wiring materials and are sizes according to NEC.

C. Bonding Plates, connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp Manufacturers for indicated applications.

D. Ground Electrodes and Plates:

1. Grounding Electrodes: Solid copper, 5/8" diameter by 10 feet.
2. Grounding Electrodes: Steel with copper welded exterior, 3/4" diameter by 10 feet.

E. Electrical Grounding connection Accessories: Provide electrical insulating tape, heat shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories Manufacturers for type service indicated.

F. Direct Burial Compression Grounding System similar to Panduit's Structural Ground "Direct Burial Compression Grounding System" shall also be acceptable where exothermic connections are specified. Direct Burial System shall meet IEEE Standard 837-2002. System shall also meet UL 467. Contractor shall be responsible for providing all Grounding plates, connectors, cables, hydraulic crimping tool, etc. for a complete system. All other Direct Burial Grounding system manufacturers shall be submitted for approval prior to bidding.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Architect/Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEM

A. General: Install electrical grounding and bonding system as indicated, in accordance with Manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.

B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.

C. Branch Circuits: Install a minimum 12 AWG ground wire in each 20A circuit and conduit run and to connect to each device. Size larger circuit ground wires as per NEC Table 250-122.

D. Exothermically weld grounding conductors to underground grounding electrodes.

E. Ground electrical service system neutral at service entrance equipment to grounding electrodes per NEC Article 250. Grounding conductor shall be 4/0 copper, unless otherwise noted.

F. Direct burial compression grounding system similar to T&B and Panduit shall also be acceptable. System shall meet IEEE Standard 837-2002. System shall meet UL.

G. Ground each separately-derived system neutral to separate grounding electrode.

H. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

I. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.

J. Connect grounding electrode conductors to copper electrodes as per N.E.C., building steel and 1" diameter, or greater, metallic cold-water pipe using a suitably sized ground clamp. Provide grounding electrode connection to concrete slab rebar to meet NEC. Provide 4/0 copper conductor for all connections.

K. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with Manufacturer's published torque tightening values for connectors and bolts. Where Manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

L. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible to minimize transient voltage rises.

M. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory-applied protective coatings have been destroyed, which are subjected to corrosive action.

N. Install clamp-on connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

O. Provide ground wire connection to all electrical boxes and wiring devices.

P. Provide #6 AWG copper ground conductor connection to all cable trays. Cable tray grounding shall be continuous.

Q. Provide minimum #6 AWG ground connection from transformer to building steel. Provide larger conductor as required per NEC and drawings.

R. Bond service ground conduit to grounding conductor if conduit is metallic.

S. The contractor shall be responsible to provide grounding connection on gas piping where an appliance or mechanical piece of equipment has gas and electric circuit run to it. The ground conductor size shall be the same size as the electrical branch circuit run to the appliance or equipment to meet the NEC. article 250.

T. 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. Connect with same size ground as ground feeding circuit.

U. 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. Connect with same size ground as ground feeding circuit.

V. 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.

W. Ground Ring: Install a grounding conductor, when indicated, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install 4/0 AWG, unless noted otherwise, tinned-copper conductor for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building's foundation.

X. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.

2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance of each separately derived system with ground resistance tester. Where tests show resistance-to-ground is over 25 ohms, take appropriate action to reduce resistance to 25 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

1. Provide type-written report in O&M manual documenting test results.

B. Contractor shall coordinate with local inspector to provide tests as required, and provide additional tests as required.

END OF ECTION 26 05 26

SECTION 26 05 29 – SUPPORTING DEVICES

PART 1 - GENERAL

1.1 CODES AND STANDARDS

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical supporting devices.

B. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

C. UL Compliance: Provide electrical components and devices which are UL-listed and labeled.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide supporting devices which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one (1) type of device fulfills indicated requirements, selection is Installer's option.

2.2 SUPPORTS

A. Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

1. Clevis Hangers: For supporting up to 2" rigid metal conduit; galvanized steel; with 2" diameter hole for round steel rod; approximately 54 pounds per 100 units.
2. Riser Clamps: For supporting up to 5" rigid metal conduit; black steel; with 2 bolts and nuts, and 4" ears; approximately 510 pounds per 100 units.
3. Reducing Couplings: Steel rod reducing coupling, 2" x 5/8", black steel; approximately 16 pounds per 100 units.
4. C-Clamps: Black malleable iron; 2"rod size; approximately 70 pounds per 100 units.
5. I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock; 3/8" cross bolt; flanges width 2"; approximately 52 pounds per 100 units.
6. One-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; approximately 7 pounds per 100 units.
7. Two-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.
8. Hexagon Nuts: For 2" rod size; galvanized steel; approximately 4 pounds per 100 units.
9. Round Steel Rod: Black steel; 2" diameter; approximately 67 pounds per 100 feet.
10. Offset conduit clamps: For supporting 2" rigid metal conduit; black steel; approximately 200 pounds per 100 units.

2.3 ANCHORS

A. Provide anchors of types, sizes and materials indicated; and having the following construction features:

1. Lead Expansion Anchors: 2”; approximately 38 pounds per 100 units.
2. Toggle Bolts: Spring head; 3/16" x 4"; approximately 5 pounds per 100 units.
3. Manufacturers: Provide anchors of one of the following (for each type of anchor):

a. Ackerman Johnson Fastening Systems, Inc.
b. Ideal Industries, Inc.
c. Joslyn Manufacturing and Supply Co.
d. McGraw Edison Co.

2.4 SLEEVES AND SEALS

A. Provide sleeves and seals, including armored cable seals, of types, sizes, and materials indicated, with the following construction features:

1. Sleeve Seals: Provide sleeves for piping which penetrated foundation walls below grade, or exterior walls. Caulk between sleeve and pipe with non-toxic, UL-classified caulking material to ensure watertight seal.
2. Wall and Floor Seals: Provide watertight wall and floor seals, or types and sizes indicated; suitable for sealing around conduit, pipe, of tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

B. Fire-Rated Walls and Floors: At all locations where conduits, cables, or ducts penetrate a fire-rated wall or floor, a special fire-retardant caulking compound or other approved device as specified in Division 26 “Common Requirements - Electrical” shall be used.

2.5 CONDUIT CABLE SUPPORTS

A. Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct for 2” rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

2.6 U-CHANNEL STRUT SYSTEMS

A. Provide U-channel strut system for supporting equipment supplied under this contract, 12-ga hot-dip galvanized steel, or types and sizes indicated; construct with 9/16” diameter holes, 8” on center on top surface, with standard green finish, and with the fittings which mate and match with U-channel. The Contractor is responsible to size and install strut to meet properly support its intended load.

B. Auxiliary Steel Supports: Provide all required auxiliary steel to install any equipment supplied under this contract. The design and gauge of steel used shall be as required by the manufacturer's specifications. The Contractor is responsible to size and install auxiliary steel to properly support its intended load.

C. Drop Cords: At Drop Cord locations provide miscellaneous threaded rod, unistrut, steel plates, etc. to vertically and laterally support Drop Cord. Where drop cord is located in ceilings provide proper support to prevent movement and damage to ceiling tile.

D. Manufacturers: Provide U-channel strut systems of one of the following (for each type system):

1. Allied Tube and Conduit Corp.
2. Midland-Ross Corp.
3. OZ/Gedney Div; General Signal Corp.
4. Power-Strut Div; Van Huffel Tube Corp.
5. Unistrut Div; GTE Products Corp.

PART 3 - EXECUTION

3.1 GENERAL

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices. Comply with installation requirements of NECA and NEC pertaining to supporting devices.

B. Coordinate with other mechanical and electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Where supports or anchors are installed after the spray on insulation and/or firestopping is installed, patch the spray on insulation and/or firestopping to match surrounding area.

END OF SECTION 26 05 29

SECTION 26 05 33 – RACEWAYS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of the raceway and work required by this section is indicated by Drawings and requirements of other sections of this Specification.

B. Provide metal and nonmetallic conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated on plans. Where types and grades are not indicated, provide proper selection determined by installer to fulfill wiring requirements and comply with applicable portions of NEC for raceways.

C. It is the intent of these Specifications and Drawings that all feeder wiring be run in a continuous conduit system. Type MC cables are permitted for lighting and power, branch circuits above ceilings and in stud walls, fishing existing walls, and connection to equipment/motors (2 feet max). In areas of exposed structure all wiring shall be run in conduit. At all locations where MC cable cannot be fished in an existing wall, surface (nonmetallic or metallic as specified) raceway shall be used. Finish of raceway shall be verified with the Architect before ordering. Surface raceway shall be screwed into the surface being installed at both ends and every 24” minimum along raceway. All surface raceway shall be run parallel and perpendicular to wall surfaces and run to blend in with surrounding equipment.

D. Refer to Division 26, “Wires and Cables – 600V and Below” for acceptable uses of MC cables.

1.2 CODES AND STANDARDS

A. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems; provide products and components which have been UL-listed and labeled.

C. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of raceway systems.

PART 2 - PRODUCTS

2.1 CONDUITS

A. Rigid Steel Conduit: Provide rigid steel, zinc-coated, threaded type conforming to FS WW-C-581, ANSI C80.1 and UL 6. Provide zinc-coating fused to inside and outside walls.

B. Rigid Aluminum Conduit: Provide rigid aluminum, threaded type conforming to ANSI and UL standards.

C. Intermediate Steel Conduit: Provide rigid intermediate grade (IMC) hot-dip galvanized threaded conforming to FS WW-C-581 and UL 1242.

D. Electrical Metallic Tubing (EMT): FSW-C-563, ANSI C80.3, and UL 797.

E. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit; construct of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with liquid-tight jacket of flexible polyvinyl chloride (PVC).

F. Flexible Metal Conduit: FS WW-C-566 and UL 1. Formed from continuous length of spirally wound, interlocked zinc-coated strip steel.

G. PVC Heavy Wall Conduit: Schedule 40, 90C, UL-rated, constructed of polyvinyl chloride and conforming to NEMA TC-2, for direct burial, UL-listed and in conformity with NEC Article 347. PVC conduit may only be installed above finished grade, where specifically indicated on the drawings or within the specifications.

H. PVC Light Wall Conduit shall not be acceptable under any circumstances. PVC Heavy Wall conduit shall be used when encased in concrete.

I. No other type of conduit shall be used, unless otherwise noted, or prior approval granted by the engineer.

2.2 CABLE IN CONDUIT

A. Cable In Conduit: Similar to “Draka”, CIC (Cable in Conduit) may be used for exterior 20A applications only, including receptacles and area site lighting. Material shall be High Density, Polyethylene, Grade PE33, Class C in accordance with ASTM D3350 (latest addition) Schedule 40 and schedule 80. Duct shall meet the requirements of ASTM D2447 and NEMA standards publication TC7. Must be U.L. listed per standard 1990. The polyethylene duct shall be extruded directly around the cables in long continuous lengths. The single conductors as defined on the plans, shall be placed in parallel during the duct manufacturing process. Cable insulation must meet the intended use. Any other Cable in Conduit product shall be submitted for prior approval before bid.

2.3 CONDUIT FITTINGS

A. Flexible Metal Conduit Fittings: Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type.

B. Straight Terminal Connectors: Contractor shall provide one-piece body, with female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

C. 45-Deg or 90-Deg Terminal Angle Connectors: Two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

D. Rigid Metal Conduit Fittings: Cast-malleable-iron, galvanized or cadmium plated, conforming to FS W-F-408. Use Type 1 fittings for raintight connections, Type 2 fittings for concrete tight connections, and Type 3 fittings for other miscellaneous connections.

E. Rigid Aluminum Conduit Fittings: Provide cast-aluminum conduit fittings and mounting hardware conforming to ANSI and UL standards of types required for the application.

F. Liquid-Tight Flexible Metal Conduit Fittings: FS W-F-406, Type 1, Class 3, Style G. Provide cadmium-plated, malleable-iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated, or non-insulated throat.

G. EMT Fittings: All couplings and connectors shall be of the compression type.

H. PVC Heavy Wall Conduit and Tubing Fittings: Mate and match to conduit or tubing type and material.

I. Conduit and Tubing Accessories: Provide conduit, tubing and duct accessories of types, sizes, and materials, complying with Manufacturers' published product information, which mate and match conduit and tubing.

J. Conduit Bodies: Provide galvanized cast-metal conduit bodies of types, shapes, and sizes as required to fulfill job requirements and NEC requirements. Construct conduit bodies with threaded-conduit entrance ends, removable covers, either cast or galvanized steel, and corrosion-resistant screws.

K. MC Fittings: The Snap2It connector with insulated throat as manufactured by Arlington may be used for MC cable connectors in lieu of the traditional cast fitting. However, these fittings may not be used for any other application.

L. All raceway conduit and fittings above a ceiling shall be plenum rated.

M. Press type fittings may not be used unless specifically specified to be acceptable elsewhere in the specifications or on the drawings.

2.4 WIREWAYS

A. General: Provide electrical wireways of types, grades, sizes, and number of channels for each type of service as indicated. Provide complete assembly of raceway including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other components and accessories as required for complete system.

B. Lay-In Wireways: Provide lay-in wireways with hinged covers, in accordance with UL 870 and with components UL-listed, including lengths, connectors and fittings. Design units to allow fastening hinged cover closed without use of parts other than standard lengths, fittings and connectors. Construct units to be capable of sealing cover in closed position with sealing wire. Provide wireways with knockouts.

C. Connectors: Provide wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached that removal is not necessary to utilize the lay-in feature.

D. Finish: Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage.

E. Raintight Troughs: Construct in accordance with UL 870, with components UL listed.

F. Construction: 16-ga galvanized sheet metal parts for 4" x 4" to 6" x 6" sections, and 14-ga parts for 8" x 8" and larger sections. Provide knockouts only in bottom of troughs, with suitable adapters to facilitate or tear during installation, or would compromise raintight capability of the trough. Do not use cover screws that will protrude into the trough area and damage wire insulation.

G. Finish: Provide 14-ga and 16-ga galvanized sheet metal parts with corrosion-resistant phosphate primer and baked enamel finish. Plate hardware to prevent corrosion.

2.5 SURFACE RACEWAY

A. Provide single or dual channel surface raceway as specified on the drawings. Unless noted otherwise, raceway finish shall be selected at shop drawings from full list of standard and premium finishes.

B. Device plates matching the raceway system shall be utilized. Standard wall mounted device plates shall not be acceptable.

PART 3 - EXECUTION

3.1 GENERAL

A. Low voltage wiring in walls must be run in conduit system rated for 600V, as specified above. the use of flexible innerduct material in walls shall not be acceptable, unless specifically specified elsewhere. In new construction, conduits shall be rigid of appropriate type for the installation. In existing construction, flexible metallic conduit shall be used.

B. Unless noted otherwise, all conduit shall be installed concealed in walls, under slabs, or above ceilings.

C. Type MC cables shall be permitted only as noted.

D. Unless noted otherwise, raceways and cables shall be installed near the structure and be supported independently from the structure. Support systems for other building systems (i.e. ductwork, HVAC equipment, system piping, ceiling supports, etc.) shall not be used to support conduits and cables. When routed from light fixtures and other system connections, raceways and cables shall be routed directly vertical to structure and across. Drop wire supports shall not be used on any ceiling support wires under any circumstances.

E. Use PVC Schedule 40 conduit where circuits, feeders and service conductors are embedded in concrete, masonry, or earth, and use rigid galvanized steel elbows with large sweep elbows wherever turns are needed **(do not use PVC elbows)**. Where PVC conduit is installed below finished floor level within the building pad, contractor shall transition to IMC or rigid galvanized steel at the elbow and rise to above floor slab. Where PVC conduit is used exterior to the building under finished grade, contractor shall transition to galvanized rigid steel conduit at the elbow up, and continue using galvanized rigid steel along the riser to above finished grade.

F. PVC Schedule 40 conduit may be run in CMU wall cavities when originating from below finished grade and terminating at a recessed box no higher than 48” above finished floor or grade. For all other installations within wall cavities, PVC conduit shall not be used.

G. Use rigid aluminum conduit where installed exposed outdoors.

H. Use EMT conduit in mechanical equipment rooms, electrical equipment rooms, penthouses, crawl spaces, walls, and areas above ceiling.

I. Use flexible metal conduit in moveable partitions and from outlet boxes to recessed lighting fixtures, and final 24" of connection to motors, or control items subject to movement or vibration, and in cells of precast concrete panels. Conduit size shall be increased as required to fit wiring per NEC.

J. Use liquid-tight flexible metal conduit in mechanical spaces. Conduit size shall be increased as required to fit wiring per NEC.

K. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean.

L. Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameters.

M. Size conduits to meet NEC, except no conduit shall be smaller than 3/4" on this project.

N. Fasten conduit terminations in sheet metal enclosures by two locknuts, and terminate with bushing. Install locknuts inside and outside enclosure. **Metallic insulating conduit bushings shall be used on all power conduits.** Split bushings shall **not** be acceptable.

O. Conduits are not to cross pipe shafts or ventilating duct openings.

P. Keep conduits a minimum distance of 6" from parallel runs of hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.

Q. Support riser conduit at each floor level with clamp hangers.

R. Use of running threads at conduit joints and terminations is prohibited.

S. Where required, use 3-piece union or split coupling.

T. Complete installation of electrical raceways before starting installation of cables/wires within raceways.

U. For concrete floors-on-grade, install PVC Schedule 40 conduits under concrete slabs.

V. Install underground conduits minimum of 24" below finished grade.

W. Install conduits so as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.

X. Above requirements for exposed conduits also apply to conduits installed in space above hung ceilings, and in crawl spaces.

Y. EMT conduits shall not be installed against roof deck. Allow minimum 3” space between top conduit and roof deck for the possible penetration of roof nails to protrude without damaging conduit.

1. Where conduits are indicated to be installed against roof deck, or where required by construction, IMC or GRS conduits may be used. Unless specifically stated on the documents, prior written approval shall be requested of the Architect/Engineer prior to installation.
2. Where boxes and conduit bodies are installed to accommodate conduits against the roof deck, they shall be cast type.

Z. In finished spaces without ceilings (i.e. gymnasiums, natatoriums, etc.), conduits shall be installed as high as possible, while meeting other requirements within these specifications. Conduits along bottom cord of open joists shall not be acceptable. Where conduits need to be installed along bottom of joists or beams, they shall be installed against walls.

AA. Provide fish wire or pull string in all spare conduits.

BB. Cap all spare conduits installed for future use.

CC. Install surface metal raceways in corners or walls or conceal as much as possible.

DD. There shall be no more than three (3) 20A branch circuits installed in a single 3/4" conduit. Each circuit shall be provided with a dedicated neutral wire. Sharing of neutral wire for multiple circuits will not be permitted.

EE. At locations where conduits are installed after painting is done, the contractor shall be responsible to go back and paint conduit and boxes same color to match. At locations where there is no General Trades painting, this Contractor shall be responsible to paint conduit and boxes to match adjacent surfaces.

FF. Metallic and non-metallic raceway shall be mechanically fastened to surfaces at intervals as recommended by the manufacturer. Under no circumstances shall glue, two-sided tape, or other type of adhesive be the only means of attachment.

GG. For exterior wall or foundation penetrations, seal around conduits/sleeves and annular space between sleeve and conduits to limit water migration.

1. Select seal material to fit the installation location, and ensures no degradation of the sealing material over time due to environmental conditions including, but not limited to continuous ground or rain water, solar impact, temperature changes, freezing, etc. Where exposed, sealing compound shall match adjacent surfaces in texture and color.

HH. Installation through walls:

1. Where conduits are installed to pass through existing walls, the wall shall be cored to allow the conduit to be installed through the wall, and fire calk installed around the conduit.
2. Where MC cable is installed through a wall, an EMT sleeve of sufficient size to fit all of the MC cables shall be installed through a core in the wall, fire calk installed around the sleeve, and fire putty installed around the MC cables.
3. Should the contractor break out blocks, or cut an opening in the wall, not using a properly sized hole saw, he shall provide an appropriately sized lintel to maintain structural integrity of the wall, patch the wall by toothing in new block, new drywall sheet, or other means matching the wall material, and provide fire calk around the conduit or sleeve in the opening.

3.2 CONDUITS IN CONCRETE SLABS

A. Conduits installed in concrete slabs will not be permitted. PVC conduits shall be installed under concrete slabs in stone base minimum 4” below to top of conduit.

B. Conduits installed in elevated slabs will not be permitted. Conduits shall be installed in ceiling plenum spaces below elevated slabs.

3.3 EXPOSED CONDUITS

A. Unless noted otherwise on the documents, or expressly permitted by the Architect/Engineer in writing, Exposed conduits may only be run in open structure, and surface to walls in unfinished spaces (i.e. crawl spaces, mechanical equipment rooms, electrical equipment rooms, etc.) All conduits in finished spaces (i.e. offices, conference rooms, corridors, classrooms, gymnasium, storage, etc.) shall be recessed in the walls, and concealed.

B. Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls of building.

C. Install exposed conduit work as not to interfere with ceiling inserts, lights, or ventilation ducts or outlets.

D. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed following: Up to 1": 6'-0"; 1-1/4" and over: 8'-0".

E. Run conduits for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.

F. Cap all spare and active conduits stubbed up from the floor with secure PVC caps. Caps used for active conduits shall be notched to accommodate the quantity and size of cables installed in each conduit.

G. Where possible, exposed conduits shall be run along walls and at 3” from roof deck. Care shall be given to avoid creating a ledge of conduits along bottom of steel.

H. Where exposed conduits are installed outside of spaces labeled as electrical or mechanical, they shall be prepped and painted with appropriate products to match adjacent surfaces, unless specifically stated, in writing, by the architect/engineer/owner that they may remain unfinished.

3.4 NON-METALLIC CONDUITS

A. Make solvent cemented joints in accordance with recommendations of Manufacturer.

B. Install PVC conduits in accordance with NEC and in compliance with local utility practices. Provide expansion joints as required by Manufacturer and NEC.

3.5 CONDUIT FITTINGS

A. Construct locknuts for securing conduit to metal enclosure with sharp edges for digging into metal, and ridged outside circumference for proper fastening.

B. Bushings for terminating conduits smaller than 1-1/4" are to have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.

C. Install insulated type bushings for terminating conduits 1-1/4" and larger.

D. Bushings are to have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing.

E. Bushing of standard or insulated type to have screw type grounding terminal.

F. Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs to be specifically designed for their particular application.

3.6 RACEWAYS AND WIREWAYS

A. Avoid use of dissimilar metals through system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.

B. Install expansion fittings in all raceways/wireways wherever structural expansion joints are crossed.

C. Make changes in direction to raceway/wireway run with proper fittings, supplied by raceway Manufacturer. No field bends of raceway/wireway sections will be permitted.

D. Properly support and anchor raceways/wireways for their entire length by structural materials. Raceways are not to span any space unsupported.

E. Use boxes as supplied by Manufacturer wherever junction, pull or device boxes are required. Standard electrical "handy" boxes, etc., shall not be permitted for use with surface installations.

END OF SECTION 26 05 33

SECTION 26 05 35 – ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of electrical box and associated fittings work is indicated by Drawings and Schedules.

1.2 CODES AND STANDARDS

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.

B. UL Compliance: Comply with UL Std No.'s 50, 514-series and 886. Provide electrical boxes and fittings which are UL-listed and labeled.

C. NEMA Compliance: Comply with applicable requirements of NEMA Stds/Pub No.'s OS1, OS2 and Pub 250.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS

A. Outlet Boxes: Provide galvanized coated flat-rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated (or as required), suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding. Flush boxes must be mounted flush with finished wall surface.

B. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliant option.

C. Device Boxes: Provide galvanized coated flat-rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated (or as required), suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide cables clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding. Flush boxes must be mounted flush with finished wall plate.

D. Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's codes-compliant option.

E. Surface-Mounted Device and Outlet Boxes: Provide a minimum depth galvanized-coated steel box where indicated on the Drawings, without pre-punched knockouts.

F. Raintight Outlet Boxes: Provide corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, including face plate gaskets and corrosion-resistant plugs and fasteners. Provide raintight outlet boxes where installed outside, and within moisture rich environments (showers, locker areas, natatoriums, etc.)

G. Junction and Pull Boxes: Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers. Provide handles on covers over 4 square feet.

H. Floor Boxes: Provide floor boxes at locations shown on plans. Unless noted otherwise, provide two (2) 1 1/4" conduits from floor boxes to above accessible ceilings for communications cables. Provide duplex receptacles (quantities as shown). Ground level boxes shall be cast type or with on grade finish, elevated slabs shall be stamped steel. Refer to Electrical legend on plans for catalog numbers. All floor boxes must meet mop-tight requirements.

1. Unless noted otherwise, floor boxes shall be recessed type, similar to Wiremold RFBA4 series with 4 gangs. Cover shall be provided with finish, as selected by the architect at the time of shop drawings, and shall be provided with or without flooring insert as selected. No additional cost shall be assessed for any selection of listed cover option.

I. Where surface or recessed boxes are indicated to be blank or with wire leads for future use, they shall be provided with blank covers per Division 26 “Wiring Devices”.

J. All boxes shall be metallic, unless noted otherwise.

K. Under no circumstances shall low voltage rings be used on the project. All outlet boxes used for low voltage system including, but not limited to tele/data, controls, A/V wiring, etc. shall be fully enclosed device boxes, rated for 600V wiring as specified above.

PART 3 - INSTALLATION

3.1 GENERAL

A. Install electrical boxes and fittings as indicated, in accordance with Manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.

B. When installed in stud walls (wood or steel), electrical boxes shall be installed in walls, supported from both sides, bridged between studs, the use of cantilevered supports shall be unacceptable.

C. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

D. Provide weathertight outlets for interior and exterior locations exposed to weather or moisture.

E. Provide knockout closures to cap unused knockout holes where blanks have been removed.

F. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.

G. Position recessed outlet boxes accurately to allow for surface finish thickness.

H. Where devises are shown at casework, contractor shall coordinate exact location and height with casework to ensure usability of devices.

I. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.

J. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.

K. Provide electrical connections for installed boxes.

L. Subsequent to installation of boxes, protect boxes from construction debris and damage.

M. Ground electrical boxes properly upon completion of installation work and demonstrate compliance with requirements. Ground electrical box and wiring device.

N. Floor Boxes:

1. Set floor boxes level and flush with finish flooring material.
2. Verify location of **all** floor boxes with Architect before installation.
3. At locations where floor box depth exceeds floor thickness, contractor shall be responsible to cut floor openings and provide strut or miscellaneous steel to support box flush with top of finished floor. Contractor shall patch concrete around box as required.

O. Where poke-thru's are located, the contractor must core the opening after the floor has been placed to allow the architect/owner exact placement. The use of pre-installation concrete sleeves shall not be acceptable.

P. Where boxes and conduit bodies are installed against roof deck, they shall be cast type.

3.2 INSTALLATION TO MEET ACOUSTICAL PERFORMANCE

A. In order to reduce sound transmission through walls, when back boxes are installed to serve both sides of the wall, they shall be installed in different stud cavities. Where boxes are found to be installed in the same stud cavity, feeding two different sides of the wall, they will be required to be removed and reinstalled at the contractor's expense.

END OF SECTION 26 05 35

SECTION 26 05 53 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 CODES AND STANDARDS

A. UL Compliance: Comply with UL Std 969.

B. NEC and NEMA Compliances: Comply with NEC and NEMA WC-1 and WC-2.

C. ANSI Compliance: Comply with ANSI Std A13.1.

PART 2 - PRODUCTS

2.1 GENERAL

A. Except as otherwise indicated, provide Manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is installer's option, but provide single selection for each application.

B. The Electrical Identification, as outlined in this specification, shall be provided in addition to the labeling requirements listed in other specification sections.

2.2 UNDERGROUND-TYPE PLASTIC LINE MARKER

A. Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.

1. Provide line marker with detectable metallic core for installation above primary power, secondary power and communications service ductbanks.
2. Provide standard plastic line markers for all other installations.

2.3 CABLE/CONDUCTOR IDENTIFICATION BANDS

A. Provide Manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic-coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

2.4 SELF-ADHESIVE PLASTIC SIGNS

A. Provide Manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application areas and adequate for visibility, with proper wording for each application (e.g., “EXHAUST FAN FED FROM PANEL PD1”).

B. Colors: Unless otherwise indicated, or required by governing regulations, provide white signs with black lettering.

2.5 ENGRAVED PLASTIC-LAMINATE SIGNS

A. Provide engraving stock melamine plastic laminate with black face and white core plies (letter color), complying with FS L-P-387, in sizes and thicknesses indicated. Engrave laminate with engraver's standard letter style of sizes and wording indicated, and punch for mechanical fastening except where adhesive mounting is necessary because of substrates.

B. Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.

C. Fasteners: Self-tapping stainless-steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.6 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by Manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

2.7 MANUFACTURER

A. Provide electrical identification products of one of the following (for each type marker):

1. Ideal Industries, Inc.
2. LEM Products, Inc.
3. Markal Company
4. National Band and Tag Co.

PART 3 - EXECUTION

3.1 GENERAL

A. Install electrical identification products as indicated, in accordance with Manufacturer's written instructions, and requirements of NEC.

3.2 COORDINATION

A. Where identification is to be applied to surfaces which require finish, install identification after completion of painting.

3.3 REGULATIONS

A. Comply with governing regulations and requests of governing authorities for identification of electrical work.

3.4 UNDERGROUND CABLE IDENTIFICATION

A. During backfilling/topsoiling of each exterior underground electrical, signal or communication cable, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.

B. Install line marker for every buried cable, regardless of whether direct-buried or protected in conduit.

3.5 CABLE/CONDUCTOR IDENTIFICATION

A. Apply cable-conductor identification where wires of communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, Contract Documents, and similar previously established identification for project's electrical work.

B. Install engraved plastic-laminate tags on new power cables in all manholes and in pullboxes to identify over current device number. Use tie wraps to attach tag to cables. The nameplate shall bear the following information: Building served; voltage, cable size, class of insulation, phase designation.

3.6 CONDUIT IDENTIFICATION

A. Where spare conduits are installed, labels shall be provided at each end clearly identifying destination. Where one end is located in a handhole or manhole, provide label directly above spare conduit.

B. Where spare conduit path includes intermediate pull boxes, conduit bodies, wireways, etc., provide label at each location indicating the next termination point. The label at each end shall identify quantity of intermediate pull boxes, conduit bodies, wireways, etc. as well as location.

C. Where spare conduits are provided above ceilings on either side of an inaccessible area, provide small label on T-bar to indicate location of spare conduit.

D. Where low voltage and conduit sleeves enter floor or below grade, provide label identifying termination point.

3.7 DANGER SIGNS

A. In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work as constituting similar dangers for persons in or about project.

B. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.

C. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.

3.8 ARC FLASH LABELS

A. Provide arc flash labels on equipment per NEC and NFPA. Labels shall be placed in a prominent position that is clearly visible before access to a dangerous area is reached. This includes the front of devices similar to disconnect switches, motor starters, switchboards, etc. and just inside the front cover of panelboards. The labels shall be of sufficient durability to withstand the environment involved.

B. Provide signs for each unit of the following categories of electrical work.

1. Panelboards, electrical cabinets and enclosures.
2. Major electrical switchgear.
3. Combination starter / disconnect switches.
4. Power transfer equipment.
5. Elevator Power module.
6. Disconnect switches.
7. Transformers.
8. Low Voltage Lighting Control Panels.
9. Medium Voltage Switchgear.
10. Unit Substations.
11. Motor control Centers.

3.9 SERVICE ENTRANCE FAULT CURRENT LABELS

A. Provide label at service entrance equipment (switchboard, distribution panelboard, etc.) The label shall be of sufficient durability to withstand the environment involved. The label shall indicate the following information per NEC and NFPA:

1. Nominal system voltage.
2. Maximum available fault current.
3. Clearing time of service overcurrent protective device(s) based on the available fault current.
4. The date the label was applied.

B. The contractor shall coordinate with the utility to determine the available fault current at the point of utility connection, and calculate the maximum available fault current available at the service entrance. All calculations shall be made available at the service entrance gear, as well as being located in the Operations and Maintenance manuals.

3.10 EQUIPMENT/SYSTEM IDENTIFICATION

A. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2" high lettering on 1-1/2" high sign (2" high where 2 lines are required), White lettering in Black field. Provide text matching terminology and numbering of the Contract Documents and shop drawings. Each listed piece of equipment below shall have a sign that has the following: 1. Equipment Name, 2. Where the equipment is fed from. Example: PANEL “PD1" (FED FROM PANEL DPD).

B. Provide signs for each unit of the following categories of electrical work.

1. Panelboards, electrical cabinets and enclosures.
2. Access panel/doors to electrical facilities.
3. Major electrical switchgear.
4. Combination starter / disconnect switches.

5. Power transfer equipment.
6. Elevator Power module.
7. Disconnect switches.
8. Transformers.
9. Low Voltage Lighting Control Panels.

C. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

3.11 DIRECTORIES

A. Provide typed circuit directory cards in all panelboards (both breaker and fuse type) and low voltage lighting control panels indicating the room number or area, and the item or items controlled by each circuit. Provide typed circuit directory cards for all “Existing” panelboards and low voltage lighting control panels where the Contractor has added, deleted or moved circuits with in an “Existing” panelboard.

1. Contractor shall trace existing circuits within existing panelbaords and low voltage lighting control panels to properly identify all circuits within the panelboards and low voltage lighting control panels.

B. Switchboards, unit substations, motor control centers and switchgear shall be provided with plastic-laminate tags similar to those specified in under “Equipment/System Identification”. The tags shall indicate what the circuit feeds and the location of the device.

C. Directories shall use actual room numbers to indicate locations of all devices, including, but not limited to receptacles, lighting, mechanical equipment, etc. When preparing schedule, use a room number schedule generated by the architect and/or the owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, request, in writing, a schedule to reflect the proper room numbers.

D. Provide sufficient information to meet requirements of Article 408 of the National Electric Code. Specifically, location of device fed shall be added to directory cards.

3.12 ADDITIONAL FUSE LABELING

A. At the exterior enclosure of all fused switches, provide additional labeling designating fuse sizes, types and quantity.

3.13 EMERGENCY POWER SOURCE NOTIFICATION

A. Provide a sign at the main service location indicating type and location of emergency power source in accordance with the requirements of Section 700-8 of the National Electrical Code.

3.14 RECEPTACLE CIRCUIT IDENTIFICATION

A. At each receptacle, identify panelboard and circuit number from which receptacle is served. Use machine printed, pressure sensitive, abrasion resistant label tape on **backs and fronts** of the wall plate and durable wire markers or tags within outlet boxes.

3.15 ADDITIONAL EQUIPMENT LABELS

A. Refer to Division 26 “Switchboards,” “Unit Substation,” and “Motor Control Centers” for floor marking requirements.

B. Refer to individual Division 27 and 28 sections for labeling requirements of low voltage systems.

END OF SECTION 26 05 53

SECTION 26 09 23 – OCCUPANCY SENSORS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Contractor's work to include all labor, materials, tools, appliances, control hardware, sensor, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational occupancy sensor lighting control system, as described herein.

B. Contractor/Supplier shall examine all general specification provisions and drawings for related electrical work required as work under Division 26.

C. Contractor shall coordinate all work described in this section with all other applicable plans and specifications, including, but not limited to wiring, conduit, fixtures, HVAC systems and building management systems.

D. Provide factory commissioning as listed in part 3.

1.2 EQUIPMENT QUALIFICATION

A. Products supplied shall be from a single manufacturer that has been continuously involved in manufacturing of occupancy sensors for a minimum of five (5) years. Mixing of manufacturers shall not be allowed.

B. All components shall be U.L. listed, offer a five (5) year warranty and meet all state and local applicable code requirements.

C. Products shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.

D. Wall switch and line voltage products must be capable of withstanding the effects of inrush current. Submittals shall clearly indicate the method used.

1.3 SYSTEM DESCRIPTION

A. The objective of this section is to ensure the proper installation of the occupancy sensor-based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.

B. The occupancy sensor-based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits.

1.4 SUBMITTALS

A. Manufacturer shall substantiate conformance to this specification by supplying the necessary documents, performance data and wiring diagrams. Any deviations to this specification must be clearly stated by letter and submitted.

B. Submit typical room plans clearly marked by manufacturer showing proper product, location and orientation of each sensor. Beam patters shall be marked on plans.

1. Location of doors, windows and typical types of room furniture shall be accounted for in the layouts of the sensors. Provide additional sensors as required on the plans.

C. Submit any interconnection diagrams per major subsystem showing proper wiring.

D. Submit standard catalog literature which includes performance specifications indicating compliance to the specification.

E. Catalog sheets must clearly state any load restrictions when used with electronic ballasts.

1.5 SYSTEM OPERATION

A. Factory Startup: It shall be the manufacturer's responsibility to verify all proper adjustments and train owner's personnel to ensure owner's satisfaction with the occupancy system. This service shall be provided at no additional cost.

B. Adjustments must include setting the proper sensitivity and time delay in the sensors. Simply changing sensitivity to maximum, unless space requires, shall not be acceptable. The sensitivity shall be set appropriately for the space, to detect half step into room, and detecting people working at a desk at the four (4) corners of the room.

1. Automatic sensitivity or time delay settings shall NOT be used. All sensitivity and time delay settings shall be actively set.

C. Provide the appropriate sensor for each room. Simply selecting dual technology sensors for every space shall not be acceptable.

1. Where dual technology sensors are used, initial occupancy shall require both technologies (PIR and ultrasonic), while either technology will maintain and re-trigger occupancy.

D. Microphonics shall be an acceptable alternative technology to ultrasonic technology.

E. Sensors shall be set as vacancy (lights turn on by button, maintain by sensing individuals, and turn off when an individual is no longer sensed). Lights shall not operate automatically, unless noted otherwise.

1. Provide compatible low voltage dimmers and wire with sensor. Digitally addressable sensors, dimmers and room controller may be used, provided sensor meets requirements of this specification. When a digitally addressable lighting control system is installed, manufacturer of the sensors and associated devices shall match the system.

1.6 EXTRA MATERIALS

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

1. Five (5) low voltage ceiling mounted dual technology occupancy sensors.
2. Three (3) dual voltage wall switch sensors.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Watt Stopper.

B. Sensor Switch.

C. Hubbell Building Automation by Current.

D. Greengate.

E. All occupancy sensors on project shall be from one (1) manufacturer.

F. The listing of any manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the electrical contractor to ensure that any price quotations received and submittals made are for sensors which meet or exceed the specifications included herein.

2.2 OCCUPANCY SENSORS

A. Listed products by application shall be Watt Stopper product numbers. Should the contractor choose to use an alternate listed manufacturer, they shall provide the sensor that meets the requirements of the specified sensors. Should an alternate manufacturer require additional sensors due to coverage patterns, they shall be provided at no additional cost to the owner.

1. Instructional and lecture Spaces: Provide, low (24) voltage ceiling mounted dual technology occupancy sensor LMDC-100 series. Provide coverage pattern to accommodate entire room.

    a. Provide isolated relay at all areas for connection to the BAS. This can either be accomplished with the sensor itself, or via relay at the lighting controller.
    b. Where spaces do not have ceilings, provide surface or wall mount version as required.

2. Open Offices, Restrooms, Storage Rooms and Corridors: Provide, low (24) voltage ceiling mounted ultrasonic occupancy sensor LMUC-100 series. Provide coverage pattern to accommodate entire room.

    a. Provide isolated relay at Open Office areas for connection to the BAS. This can either be accomplished with the sensor itself, or via relay at the lighting controller.
    b. Where spaces do not have ceilings, provide surface or wall mount version as required.

3. Private Offices, Cafeteria and Conference Rooms: Provide, low (24) voltage ceiling mounted passive infrared occupancy sensor LMPC-100 series. Provide coverage pattern to accommodate entire room.

    a. Provide isolated relay at all areas for connection to the BAS. This can either be accomplished with the sensor itself, or via relay at the lighting controller.
    b. Where spaces do not have ceilings, provide surface or wall mount version as required.

4. Provide, where indicated, dual (120/277) voltage passive infrared wall switch occupancy sensor PW-300. Set as vacancy so that manual operation is required to turn lights on.
5. Provide, where indicated, dual (120/277) voltage passive infrared 0-10V dimming wall switch occupancy sensor PW-311. Set as vacancy so that manual operation is required to turn lights on.

6. Provide a dual (120/277) voltage power packs/lighting controllers (programmed for manual on when connected with low voltage station) and relay packs compatible with sensors as required.
7. Provide low voltage controls (switches and dimmers), where indicated, compatible with the sensor power pack/lighting controller, from the same manufacturer as the occupancy sensor.
8. Refer to Division 26 “Lighting Sequence of Operations,” for time delay settings. Where no time delay setting is indicated, provide 10-minute time delay.
9. Manufacturer shall be responsible to provide a shop drawing which indicates correct sensor type and location of sensor within each space.

B. Wall switch sensors shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet.

C. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180˚ coverage capability.

D. Wall switch products shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor’s longevity.

E. Wall switch sensors shall have no leakage current to load, in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.

F. Where specified, wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON.

G. Vandal resistant wall switch sensors shall utilize a hard lens with a minimum 1.0mm thickness. Products utilizing a soft lens will not be considered.

H. Passive infrared sensors shall utilize Pulse Count Processing and Digital Signature Analysis to respond only to those signals caused by human motion.

I. Passive infrared sensors shall provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line).

J. Passive infrared sensors shall have a multiple segmented Fresnel lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.

K. Dual technology sensors shall be either corner mounted or ceiling mounted in such a way as to minimize coverage in unwanted areas.

L. Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.

M. Ultrasonic sensors shall utilize Advanced Signal Processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.

N. Ultrasonic operating frequency shall be crystal controlled at 25 kHz within ± 0.005% tolerance, 32 kHz within ± 0.002% tolerance, or 40 kHz ± 0.002% tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.

O. All sensors shall be capable of operating normally with LED lighting, electronic ballasts, PL lamp systems and rated motor loads.

P. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.

Q. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.

R. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.

S. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.

T. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.

U. All sensors shall have UL rated, 94V-0 plastic enclosures.

2.3 CIRCUIT CONTROL HARDWARE – CU

A. Control Units - For ease of mounting, installation and future service, control unit(s) shall be able to externally mount through a 1/2" knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Control unit shall provide power to a minimum of two (2) sensors.

B. Relay Contacts shall have minimum ratings of:

1. 20A – 120 VAC Incandescent
2. 20A – 120 VAC Ballast
3. 20A – 277 VAC Ballast

C. Control wiring between sensors and controls units shall be Class II, 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.

D. Minimum acceptable wire gauge from the circuit control hardware relays shall be #12 AWG.

E. Input voltage shall be dual (120/277) rated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All controls shall be set as vacancy (manual operation required to turn lights on), unless noted otherwise.

B. It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.

C. It is the contractor’s responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at owner's facility, to verify placement of sensors and installation criteria.

D. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The contractor shall also provide, at the owner's facility, the training necessary to familiarize the owner's personnel with the operation, use, adjustment, and problem-solving diagnosis of the occupancy sensing devices and systems.

E. Occupancy Sensors shall be provided with minimum 10’ additional wiring to allow repositioning of the sensor after the fact for poorly positioned sensors. Extra wire shall be coiled and supported adjacent to the power pack.

F. Provide label on ceiling grid for location of occupancy sensor power pack above ceiling.

G. Care shall be used in placing occupancy sensors to ensure proper activation of sensors. Consideration shall be given to HVAC equipment and diffusers, as well as windows and doors. Refer to sensor instruction manual for appropriate placement, in addition to manufacturer submittals.

3.2 FACTORY COMMISSIONING

A. Before wiring between occupancy sensors and lighting control system is started, a pre-installation meeting, lasting a minimum of four (4) hours, shall be scheduled to ensure proper installation and functionality. This meeting shall be performed at the project site between the Distributed Lighting Management System Manufacturer, Occupancy Sensor Manufacturer and installing Contractor. During this meeting, wiring connections and placement of devices shall be discussed and fully coordinated to ease the installation process for the contractor. Meeting minutes shall be composed by the contractor indicating time, personal present and discussion topics.

B. Upon completion of the installation, the system shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system. The factory authorized technician shall enter every space containing an occupancy sensor to verify the locations, sensitivity and delay. Any issues that have been noted previous to this visit shall also be addressed. This meeting shall include, at a minimum, the installing contractor, lighting control manufacturer (when installed) and occupancy manufacturer.

C. Upon completion of the system fine tuning the factory authorized technician shall provide the proper training to the owner's personnel in the adjustment and maintenance of the sensors. This training shall be during an additional visit around substantial completion and last a minimum four (4) hours.

D. Approximately four (4) weeks after substantial completion, a follow-up meeting lasting a minimum four (4) hours shall be scheduled with the Distributed Lighting Management System Manufacturer, Contractor, and Owner to provide any additional technical assistance required and fine tune all occupancy sensors on the project.

E. All commissioning visits shall be scheduled a minimum two (2) weeks in advance, and the Architect, Engineer, Owner and Construction Manager/Clerk of the Work shall be informed of all meetings in addition to parties that are to be present. A factory authorized technician shall be present at all required commissioning meetings. Any additional meetings required for a fully functioning system shall be included at no additional cost to the owner.

END OF SECTION 26 09 23

SECTION 26 09 43 – DISTRIBUTED LIGHTING MANAGMENT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: The following specifications detail the minimum performance and related criteria for the Lighting Management System (LMS). Provide, connect, and furnish all necessary equipment for proper installation and service of the system as indicated on the drawings and specified herein.

B. Division 26 "Lighting Sequence of Operations" shall be referenced for the performance requirements of the Network Lighting Control system.

C. Light fixtures shall be supplied with 0-10V dimming drivers, and the lighting control system shall integrate with these drivers.

1.2 SYSTEM DESCRIPTION & OPERATION

A. The LMS, as defined under this section, shall include remote power supply cabinets with programming software for programming, dimming and switching interface modules, occupant sensors, daylight sensors, wall controls, and related accessories. The system shall also be capable of direct connection into digital ballasts/drivers and daylight sensors. All ballasts/drivers or modules of the system shall be connected by a communication bus configured of Class 1 or Class 2 wiring.

B. While not required for functionality, the lighting system shall include a front-end file server/computer and software to allow for program changes and over-ride functions. The software shall include map of the building.

1. Local programming shall be handled with the use of a Wi-Fi enabled hand-held device utilizing the owner’s Wi-Fi network.
2. All required connections to the Wi-Fi network must be included as part of the project.
3. Where lighting is not being replaced, the areas shall be indicated as such.
4. Software shall be installed on Owner’s virtual server. Coordinate requirements with the Owner, and provide all installation services.
5. It is the intent for the system to be expanded to cover the entire building as lighting renovations occur.

C. All programming of the system shall be handled via the owner’s network. Under no circumstances shall the system require removal of devices or the ceiling to “plug-in” a device. Nor, shall the system utilize proprietary programmers, Bluetooth, RF or IR programmers.

D. **The project shall include all connections into the owner’s network. Coordinate all requirements with the owner’s IT department.**

E. UL 924 listed devices shall be provided to allow control of life safety lighting.

1.3 SUBMITTALS: Submit shop drawings in coordination with the “Lighting Sequence of Operations” shop drawings:

A. Provide a written line-by-line review of the specification.

B. Submit the following according to the Conditions of the Contract, Division 1 and Division 26 Specification Sections.

C. Product data for each of the products specified. Include data on features, components, ratings, and performance. Include dimensioned drawings with isometric projections of components and enclosures and details of the Ballasts and Modules.

D. Sample of the equipment, devices, and device plates for color selection and evaluation of technical features, as required by Architect/Engineer.

E. Wiring diagrams detailing internal and interconnecting wiring for power signal, and control that distinguish between field installed and factory installed wiring.

1. A full single-line diagram for the system shall be provided.

F. Coordination Drawings, Equipment Riser Diagram.

G. Operation and maintenance data for materials and products specified in this Section.

H. When preparing submittals and any required final programming, use a room number schedule generated by the architect and/or the owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, revise the initial submittal, when a schedule is available, to reflect the proper room numbers. Panel directors shall also reflect the final number schedule.

1.4 APPROVALS

A. Prior approval is required for alternate proposals.

B. Complete Catalog data, specifications, and technical information on alternate equipment must be furnished to the Architect and Owner at least ten (10) calendar days in advance of the bid date.

1.5 QUALITY ASSURANCE

A. Manufacturer of LMS shall have a minimum of 5 years of continuous experience in manufacturing lighting control products.

B. Manufacturer of LMS shall have record/history of 5 years of successful lighting control installations.

C. Manufacturer shall be capable of providing on-site service support within 24 hours in the United States.

D. Comply with NFPA 70, "National Electrical Code."

E. LMS, digital ballasts, ballast modules, power supplies, and related accessories shall be UL or CSA marked as appropriate.

F. Manufacturer shall maintain ISO9001 certification and shall provide copy of certificate upon Engineer's request.

G. The contractor/manufacturer shall supply to the owner, a written certification of compatibility, to ensure that all components of the LMS are fully compatible with each other for proper system functionality.

1.6 WARRANTY

A. The manufacturer shall provide a full three-year warranty on all equipment supplied inclusive of system commissioning by a factory employed engineer.

B. Warranty coverage shall begin on the date that the equipment is energized.

1.7 COMMISSIONING

A. Before wiring between occupancy sensors and lighting control system is started, a pre-installation meeting, lasting a minimum of four (4) hours, shall be scheduled to ensure proper installation and functionality. This meeting shall be performed at the project site between the network lighting control manufacturer, occupancy sensor manufacturer and electrical contractor. During this meeting, wiring connections and placement of devices shall be discussed and fully coordinated to ease the installation process for the contractor. Meeting minutes shall be composed by the contractor indicating time, personal present and discussion topics.

B. Upon completion of the installation, the system shall be completely commissioned by factory trained and authorized service personnel. The commissioning will be performed after the electrical contractor ensures the system installation is complete and that all loads have been tested live for continuity and freedom from defects. The system shall be capable of being programmed through the use of a PC with lighting management software. The site visits shall include:

1. Visit site to inspect pre-wiring.
2. Schedule a meeting with the Owner, Engineer, Contractor, and Factory-Employed Engineer to review the lighting control schedule, including but not limited to time limits of each mode, rooms in each group, and control functions per group, as programmed after the initial lighting control meeting.
3. Determine what ballasts are addressed.
4. Determine which sensors, daylight and occupancy, are connected and functioning with the ballasts.
5. Setting lighting zones and device responses to sensor or control input.
6. Upon completion of the installation, the system shall be completely commissioned by a factory-employed engineer. The check-out will be performed after all loads have been tested live for continuity and freedom from defects and that all control wiring has been connected and checked for proper continuity. Commissioning tasks shall include entering each room or space and verifying proper operation of the system as it relates to the lighting control schedule. Issues with the lighting control occupancy sensor placement and sensitivity shall be noted so that they can be addressed by the occupancy sensor manufacturer.
7. A factory-employed engineer shall demonstrate and educate the owner's representative(s) on the system capabilities, operation and maintenance.

C. Upon completion of the system check-out, in a separate site visit, the installer/programmer shall demonstrate the operation of the system to the appropriate owner's representatives during a four (4) hour visit. This demonstration shall present the owner with all of the capabilities of the system, including software features. The visit shall also consist of a walkthrough the building to describe the different functions and user controls.

D. At least 4 weeks after substantial completion, schedule a follow-up minimum four (4) hour meeting with Owner, Occupancy Sensor Manufacturer and Engineer to make adjustments and address any issues regarding the lighting control schedule, and use of the system’s abilities.

E. Project shall include an additional two (2), four (4) hour site visits and changes to the programming after the owner occupies the building within the first year of operation.

F. All commissioning visits shall be scheduled a minimum two (2) weeks in advance, and the Architect, Engineer, Owner and Construction Manager/Clerk of the Work shall be informed of all meetings in addition to parties that are to be present. A factory authorized technician shall be present at all required commissioning meetings. Any additional meetings required for a fully functioning system shall be included at no additional cost to the owner.

1.8 MAINTENANCE

A. The manufacturer shall make available to the end user a method of ordering new equipment for expansions, replacement, or parts to be used as spares twenty-four hours a day, seven days a week. The manufacturer must make available new or remanufactured parts for a minimum period of ten years from the final date of commissioning.

B. The manufacturer shall supply factory service, new or remanufactured replacement parts, and a service contract that extends the factory-limited warranty from three to five years. In addition, this shall allow end user to purchase this coverage on an annual basis for a minimum period of ten years from the date of final commissioning.

1.9 SPARE STOCK

A. Provide a minimum of one (1) remote lighting hub / segment manager

B. Provide a minimum of two (2) 2-zone zone controllers (provide (4) 1-zone zone controllers for systems that do not have 2-zone zone controllers).

C. Provide a minimum of five (5) low voltage control stations used in educational spaces and two (2) low voltage control stations used in the corridors.

D. Provide a minimum of two (2) daylight sensors.

E. Provide a minimum of two (2) emergency lighting control devices.

F. Provide a minimum of two (2) wireless programmers at the completion of the project. The wireless programmers shall come with the necessary software preloaded. Turn over the programmers during the training and retain a receipt and include in the O&M's.

1. If the wireless programmers use apps on tablet devices, coordinate with the owner the purchase of these devices, and install the software on the Owner furnished devices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Wattstopper.

B. Hubbell Building Automation by Current.

C. Acuity nLight.

D. Cooper Controls.

E. Unless otherwise noted, all basic components (ballast/river modules (and/or digital ballasts/drivers), wall controls, bus power supplies, relays (line and low voltage), related accessories and programmers) shall be provided by one manufacturer. The occupancy sensors shall be provided as per the Occupancy Sensor specification section.

2.2 SYSTEM GENERAL PERFORMANCE

A. The system shall be capable of the following performance, regardless of whether a particular feature is installed initially (i.e. if daylight sensors are not part of the system, they shall be capable of being added in the future).

B. Based on integrated control requirements, system will control lighting with the following hierarchy:

1. Emergency (Highest priority): Ignores all other inputs.
2. Programming: During system programming, sensor inputs are ignored. High-end trim shall also be programmable into the system that cannot be overridden locally or by sensors.
3. Occupant sensor: Allows lights to be on/off.
4. Daylight sensor: Imposes a high-end limit for light output.
5. Personal control: Fine tune light levels up to the daylight sensor limit.

C. Response to a single sensor can be unique on fixture by fixture or control zone by control zone basis.

D. Power failure recovery - All devices return to their previous light level prior to power loss.

E. All programmable devices have integral power failure memory to maintain settings during power loss.

F. Wall station and sensor replacement shall be accomplished without programming.

2.3 LIGHTING MANAGEMENT SYSTEM COMPUTER

A. The system shall include a Lighting Management System Computer.

B. The computer shall be used for system setup, monitoring, control, graphics, timeclock operation and data logging.

1. Should the computer be disconnected for any reason, the LMS shall continue to function without issue. It is expected that certain interconnections, override functions and data logging will be interrupted in the event of a disconnection, but the normal function will continue.

C. The LMS shall have lighting control software preinstalled, fully updated and tested prior to shipping.

1. Updates for a minimum of one (1) year shall be furnished and installed by the manufacturer as part of the project.

D. File Server / Computer shall be a virtual machine furnished by the Owner. Provide system specs as required to operate the system to the Owner to ensure the provided machine is capable of running the software.

E. The LMS shall be provided with a client software/web address to provide remote log-in. The client software/web address shall be loaded on the same computer as the mechanical BMS terminal computer. Coordinate with the mechanical contractor to install any required programs to interface with the rack mounted computer with their software.

2.4 LIGHTING MANAGEMENT SYSTEM SOFTWARE

A. Provide system software that is designed, tested, manufactured, and warranted by a single manufacturer.

B. Software Overview:

1. Software includes minimum five (5) Client Access Licenses (CALs).

a. Each CAL allows access to the Software.
b. Each CAL allows that user to operate the system concurrently.

2. Software shall provide the following capabilities

a. Setup and Configuration

1) Automatic discovery of all LMS equipment connected to the system.
2) Assign unique names to all equipment and devices.
3) Create and modify grouping of devices.
4) Create and modify presets.

a) Presets are set per driver (if digital drivers are installed), module, zone, or per group.
b) Set single fade time.

5) Define spaces and assign devices to the space.
6) Graphical Creation Tool for Floorplan Control.

a) Import floorplan background from a standard file type.
b) Add icons and associate to devices.
c) Associate users with a defaulted floorplan.

b. Monitor and Control

1) System summary.
2) Individual device status.
3) Set light levels or shade positions of groups or individual devices.
4) Select presets on groups or individual devices.
5) Average light level and calculated power consumption.
6) Peak power demand control adjusts light levels to reduce peak power demand.

c. Graphical Monitor and Control

1) Floorplan based.

a) Navigation between multiple floorplans.
b) Monitor individual device status.
c) Set light levels of groups or individual devices.
d) Select presets on groups or individual devices.

d. Timeclock

1) Create and modify timeclock events.
2) Time-of-day and astronomic events.
3) Enable or disable individual timeclock events.
4) Set light levels of groups or individual devices.

5) Select presets on groups or individual devices.
6) Enable or disable sensors per lighting bus.

e. Alarms

1) Create and modify alarms.
2) Alarm conditions include:

a) Driver failure (if digital drivers are installed) or module failure.
b) Power threshold by space.
c) Activate an alarm based on occupancy time periods.
d) Execute commands to turn lights on, turn lights off, dim the lights, enable sensors per lighting bus or, disable sensors per lighting bus.

f. Reports/Logs

1) Calculated power consumption.
2) Average light level.
3) Log of user activity in LMS software.
4) Timeclock events.
5) Alarms generated and acknowledgment.

g. User Management

1) Create users and assign access rights.

h. Diagnostics

1) Test and verify device operation.

i. Automatic Reconnect

1) If Ethernet connectivity is lost, the lighting hub will reconnect to the server automatically when connectivity is restored.

2.5 REMOTE LIGHTING HUB / SEGMENT MANAGER

A. For larger systems, to interconnect zone controllers, digital ballasts and provide power to the lighting bus, the systems hall include at least one remote lighting hub / segment manager. The remote lighting hub /segment manager shall be capable of providing at least two lighting loops, provide a network connection, and serving up a graphical user interface via standard web browser over TCP/IP.

1. Where BMS/BAS connection is specified, either the remote lighting hub / segment manager may be used, or a separate device to provide this connection. Refer to interconnection requirements to determine the type of connection required.

B. Provide in a pre-assembled, plenum rated NEMA listed enclosure with terminal blocks listed for field wiring.

C. Enables Light Management software to control and monitor digital dimming driver, interface modules and zone controllers.

1. Remote Lighting Hub / Segment Manager shall be cable of communicating with a central LMS server, should one be installed as part of this project, or in the future, utilizing Ethernet connectivity.

However, the remote lighting hub / segment manager shall also be capable of full operation without a central LMS server.

2. Remote Lighting Hubs / Segment Manager shall be supplied with a programming tool, so that a hand-held programmer. When connected to the building data network, the use of installed application on a handheld smart device (phone or tablet) shall be used, running over the Owner's network.
3. Bus Supply

    a. Connect to:

        1) digital drivers, driver modules, and/or zone controllers.
        2) Occupancy sensors.
        3) Daylight sensors.
        4) Wall stations.

    b. Integral fault protection to prevent bus supply failure in the event of a mis-wire.
    c. Wiring may be via individual pars, or category cabling per manufacturer requirements.
    d. LED status indicators:

        1) Bus supply is powered.
        2) Bus supply operating properly.
        3) Bus communication.

    e. Configuration switches:

        1) Override bus to full light output.
        2) Override bus to low end.
        3) Override bus to off.
        4) Closure inputs normally open/closed.

    f. Each Remote Lighting Hub / Segment Manager shall be connected to a maximum 4 digital loops.

        1) Each remote lighting hub / segment manager shall only provide loops for the floor for which it is installed, with exception to the corridor/stairwells, which shall have one (1) remote lighting hub / segment manager to control all corridors and stairwells.

D. Remote lighting hubs / segment managers shall be installed in panelboard closets, dedicated electric rooms or data closets.

2.6 DRIVER MODULE

A. General

1. Required to provide switching and/or continuous dimming to a driver or load. The module shall provide 0-10 Volt, PWM, forward-phase or reverse-phase dimming as required for the application. Should 3-wire dimming be required, provide interface as needed to accomplish.

    a. Addressing: Module shall be individually addressable vis LMS.

2. Generate digital communication commands to distribute driver and sensor data on the digital bus.
3. If power is interrupted and subsequently returned, lights automatically return to the setting prior to power interruption.

4. Each driver responds independently to occupancy sensors, daylight sensors, personal control inputs or LMS commands.
5. Unique internal reference number visibly displayed on module cover.
6. Electrical: Dimmer to meet limited short circuit test as defined in UL 20.
7. Provide integral fault protection to prevent driver module failure in the event of a mis-wire.

B. Device Specifications:

1. Provide devices rated for the maximum available fixture wattage.
2. Devices shall be universal voltage rated to operate 120 Volt through 277 Volt lighting. 347 Volt devices shall be available as needed.
3. Memory: Retains all system settings in non-volatile memory.

2.7 ZONE CONTROLLER

A. Provide zone controllers as required to control the loads indicated.

1. Zone Controllers shall provide one (1) through four (4) zones of independent control. Provide sufficient quantity of zone controllers to control all zones of lighting indicated on the documents.

B. General Requirements:

1. Delivered and installed in plenum rated enclosure as individual panel, or to attach to an electrical box.
2. Passively cooled via free-convection, unaided by fans or other means.
3. Mounting: Surface.
4. Connection to wired:

    a. Occupancy sensors.
    b. Daylight sensors.
    c. IR receivers for personal control, where required.
    d. Occupant controls.

5. Contact Closure Input:

    a. Communicate with input from a dry contact closure or solid-state output. Interface may be performed without or with interface to:

        1) Activate scenes.

            a) Scene activation from momentary or maintained closure.

        2) Enable or disable after hours.

            a) Automatic sweep to user-specified level after user-specified time has elapsed.
            b) System will provide occupants a visual warning prior to sweeping lights to user-specified level.
            c) Occupant can reset timeout by interacting with the lighting system.

6. Emergency Contact Closure Input (where applicable):

    a. Turn all zones to full output during emergency state via direct contact closure input from UL 924 listed emergency lighting interface, security system or fire alarm system.
    b. Allow configurable zone response during emergency state.

c. Disable control operation until emergency signal is cleared.

7. Supplies power for control link for keypads and control interfaces.
8. Distributes sensor data among multiple lighting control modules.

C. Provide switching and/or continuous dimming to drivers or load per zone. The zone controller shall provide 0-10 Volt, PWM, forward-phase, reverse-phase or 3-wire dimming as required for the application. Provide interface modules as required to accommodate the type of dimming as required.

D. Device Specifications:

1. Provide devices rated for the zone wattage (up to 16 Amp continuous per zone). Less than 16 Amp continuous per zone may be used where the connected zone wattage is less
2. Devices shall be universal voltage rated to operate 120 Volt through 277 Volt lighting. 347 Volt devices shall be available as needed.
3. Memory: Retains all system settings in non-volatile memory.

E. Zone controllers shall be located as follows:

1. Where zone controllers control fixtures in general public areas (hallways, corridors, etc.), they shall be installed in panelboard closets, dedicated electric rooms or data closets.
2. Where zone controllers control fixtures in multiple rooms, they shall be located above accessible ceiling in hallways, directly outside the rooms they control.
3. Where zone controllers control fixtures in a single room, they shall be located above accessible ceiling in that room, near the entrance door, directly above the wall station.
4. The final location for all zone controllers shall be coordinated with the Owner prior to rough-in.

2.8 LIGHTING RELAY PANELS

A. Where more than four (4) zones of switched fixture zones are indicated, or where specifically called out, provide lighting relay panels

B. Mechanical:

1. Panels shall be UL listed, CSA certified, NOM approved, or CE marked (as appropriate).
2. Panels shall be wall or recess mountable. Enclosure shall be NEMA Type 1 and IP-20 rated as specified by IEC 60529. Panel shall be constructed of steel with steel gauge of type required by UL508. Contractor shall reinforce wall as required.
3. Panels shall be completely pre-assembled and factory tested by the manufacturer prior to shipment. The contractor shall be required to provide input feed wiring, load wiring, and control wiring. No other wiring or assembly by the contractor shall be permitted. Panels requiring field assembly are not acceptable.
4. All input feed, load, and control terminals shall be front accessible without the need to remove switching assemblies or other components.
5. Panels shall be passively cooled via free-convection and unaided by fans. Systems that are fan dependent or fan assisted for cooling of components are not acceptable. Systems that require or recommend regularly scheduled maintenance for air filtration components are not acceptable.

C. Electrical:

1. Panel shall contain the number of switched outputs as per the drawings. Each output may be controlled independently or in combination with any other output within the panel or with outputs from other panels within the system.

2. The panels shall be dedicated feed-through-type without the use of branch circuit protection or main lug with rated breakers as indicated on the documents.
3. Panels shall be rated for 120/240 volt, or 277/480 volt as dictated by the feeding circuit breakers.
4. Panel should have minimum UL listed short circuit current rating (SCCR) of 14,000A.
5. Panels shall be equipped with an electronic module BYPASS feature which electronically switches outputs to ON by toggling the individual branch circuit breakers (for individual circuits) or main breaker (for all circuits) when there is no data available from the control system.
6. Panel shall be capable of operating from a normal feed, an emergency feed, or a normal/emergency feed.

    a. Normal/Emergency Panels

        1) Upon the loss of normal input power, a panel operating from a normal/emergency feed shall immediately turn all circuits within that panel to full-on condition when emergency input power is present.
        2) During the presence of normal power, circuits designated as emergency circuits shall be controlled via the same controls as circuits designated normal.
        3) Emergency power feed may be provided by an emergency generator. Alternatively, the generator can be turned on only under emergency conditions.
        4) Normal/Emergency loads shall be fed by Normal /Emergency feeds through the use of a line side (upstream) normal/emergency power transfer switch supplied by others.
        5) Under Emergency input power feed, all local control stations shall be inoperable. Once normal power is restored, all lighting circuits shall revert back to their status prior to the emergency condition without requiring any action on the part of the user.
        6) Use of a separate UL 924 listed emergency relays shall be an acceptable alternative to Normal Emergency panel; however, the emergency relays shall be located directly above or adjacent to the relay panel, be clearly labeled and be wired to match the above sequences. Individual emergency relays shall be provided for each individual circuit, plus spares as specified on the drawings.

    b. 3 Phase detection/sensing device shall:

        1) Be UL924 listed as Emergency Lighting and Power Equipment.
        2) Have two dry contact closure inputs (normally open and "supervisory" normally closed). The normally open input requires a maintained dry contact closure to activate the Emergency mode. The "supervisory" normally closed input will activate the Emergency mode when a dry contact closure is opened. A status indicator will indicate when this closure is activated.
        3) Have a function test switch with status indicator to simulate a phase failure.
        4) Have a phase status indicator.

    c. 1 Phase detection/sensing device shall:

        1) Have two dry contact closure inputs (normally open and "supervisory" normally closed). The normally open input requires a maintained dry contact closure to activate the Emergency mode. The "supervisory" normally closed input will activate the Emergency mode when a dry contact closure is opened. A status indicator will indicate when this closure is activated.
        2) Have a function test switch with status indicator to simulate a phase failure.
        3) Have a phase status indicator.

D. Switching Module:

1. A positive air gap switch shall be employed by each switched output in the panel to ensure that the load circuits are open when the "off" function is selected from the control system. If the manufacturer

is not utilizing an air gap style switch (i.e. standard latching relay), the rating of the relay shall be of a higher rating.

2. Switched output shall be capable of withstanding inrush current of 75 times operating current typically generated by a full circuit of switching electronic non-dim ballasts.
3. Each switched output shall be rated for 16A continuous duty for the following load types: resistive (incandescent/tungsten), inductive (magnetic low voltage (MLV), electronic low voltage (ELV), neon/cold cathode, magnetic and electronic fluorescent lamp ballasts, high intensity discharge (HID), LED and Motor Loads (1/3HP at 100-127V, 1/2Hp at 220-347V). Relays rated only for resistive loads shall not be acceptable.

    a. Should the relays not utilize an air gap style switch (i.e. standard latching relay), the relay shall be rated for 30A to ensure a long life.

4. Switching modules shall be tested to 300,000 cycles.

E. Lighting relay panels shall be installed directly adjacent to the panelboard that is feeding the loads being controlled by the lighting relay panel.

2.9 LOW-VOLTAGE WALL STATIONS

A. Product: Provide low-voltage wall station controls as indicated.

B. General:

1. Class 2 (low voltage).
2. Integral IR receiver for programming where required for system programming.
3. Wall station buttons shall be programmable in their feature (on/off, raise/lower, scene, etc.)
4. Removable buttons for field replacement with engraved buttons and/or alternate color buttons.
5. Immediate local LED response upon button activation to indicate that a system command has been requested.
6. Wall stations can be replaced without reprogramming.
7. Provide finish as selected by architect from manufacturer's full list of standard finishes (not metal finish).
8. Wall stations shall be wired into the system utilizing low voltage wring. If the remote lighting hub / segment manager is disconnected from the lighting system for any reason, this shall not restrict the use of the wall stations.
9. **Wall stations shall be provided with inset style, fitting a Decora style wall plate. Wall plates shall match those as specified in Division 26 "Wiring Devices."**

C. Standard room stations shall be provided as follows, unless noted otherwise:

1. Offices and educational spaces (including cafeteria, gymnasium, etc.) shall be provided with stations as follows:

    a. LEED Projects: Three (3) button + raise lower station to provide the following functions: 'on', 'off', 'AV mode', 'raise' and 'lower'.

        1) Four (4) button station where there is a combined ‘on/off’, ‘AV mode’, ‘raise’ and ‘lower’ buttons shall be acceptable.

b. Non-LEED Projects: Two (2) button + raise lower station to provide the following functions: 'on', 'off', 'raise' and 'lower'.

1) Three (3) button station where there is a combined ‘on/off’, ‘raise’ and ‘lower’ button shall be acceptable.

c. The use of a single button that combines ‘on’ and ‘raise’, ‘off’ and ‘lower’, or any other function, other than described above shall not be acceptable.

2. Where indicated, corridors shall be provided with single button or key type stations, as indicated, to provide simple on/off control.

D. Two Button Control

1. Provide 2 button, ‘on’, ‘off’ stations where indicated (storage rooms and other spaces).

E. Station Engraving:

1. Stations shall be intuitively engraved with the use of word or graphics for example:

a. “ON,” lit light bulb, etc.
b. “OFF,” unlit light bulb, etc.
c. “Raise,” up arrow.
d. “Lower,” down arrow.

2. Where stations are controlling scenes, or areas/zones not directly obvious (i.e. corridor and stair stations), they shall be engraved with the scene or area/zone being controlled.

2.10 SENSORS

A. General:

1. Use Class 2 wiring for low voltage communication.
2. Can be replaced without reprogramming.
3. Sensors shall be wired into the LMS. If the remote lighting hub / segment manager is disconnected from the lighting system for any reason, this shall not restrict the use of the sensors.

B. Interior Daylight Sensors

1. Open-loop or closed-loop basis for daylight sensor as per manufacturer recommendations.
2. Stable output over typical interior temperature range.
3. Partially shielded for accurate detection of available daylight to prevent fixture lighting and horizontal light component from skewing sensor detection.
4. Provide linear response along entire range of detection.
5. Integral IR receiver for programming as required.
6. Constructed with plastic meeting UL94 HB.

C. Occupancy Sensors

1. Provide occupancy sensor types as per Division 26 “Occupancy Sensors.”
2. Connect occupancy sensors to the network lighting control system as per manufacturer’s recommendations.
3. Digital sensors directly connected to the bus shall be utilized where feasible and available. Low voltage (24V) with interface shall be used where required to meet the document requirements.

2.11 EMERGENCY LIGHTING CONTROL DEVICES

A. UL924 listed voltage sensing units that monitors unswitched side of switched/dimmed circuit providing normal lighting to an area. The unit shall provide normal ON/OFF control of emergency lighting in concert with the normal lighting. Voltage sensing units may be provided in the following manner:

1. As an integral part of the remote lighting hub / segment manager, tied in with the zone controllers. Provide all components and the system entirely is listed as UL924, the control components may provide the functionality. A UL 924 sensing unit must be used, and connected to the normal circuits feeding the applicable area. Both single phase and three phase units may be used in this application.
2. As an independent control unit, connected to the normal/emergency circuits, after the zone controller. In this instance, upon power failure, the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored.

B. Emergency lighting control devices shall be provided with auxiliary contacts for remote testing as well as connecting to the fire alarm system in order to meet current building codes.

C. Emergency lighting control devices shall be provided as required to accommodate the indicated emergency circuits.

D. Diagnostics and Service: Replacing emergency lighting control devices shall not require re-programming of system or processor.

2.12 ACCESSORIES

A. Tamper Proof Covers:

1. Locking covers for preset control units and wall stations: Reversible to allow lock to be located on either side of control.
2. Compatible with IR controls.
3. Provide tamper proof covers in locker areas, gymnasiums and other areas where damage will occur.

2.13 SOURCE QUALITY CONTROL

A. Perform full-function testing on all completed assemblies at end of line. Statistical sampling is not acceptable.

B. Diagnostics and Service - Tiered control scheme for dealing with component failure that minimizes loss of control for occupant.

1. Bus failure: Lights go to emergency level for safety.
2. Failure of one sensor type: Driver still controllable via other sensors.
3. Driver failure: Only impacts one fixture - remainder of system operates as programmed.

C. Equipment shall be 100% tested for proper operation at three different levels—printed circuit board, end of line, and for two hours at 40°C (104°F) ambient—prior to shipment from the factory. Manufacturers sampling at end-of-line shall not be acceptable.

2.14 CONTROL INTERFACES

A. Contact Closure Interface(s)

1. Control shall provide two-way interface between controls and dry contact closure devices such as from Timeclock Inputs, Building Management Systems, Fire Alarm Systems, Security Systems, and Occupancy Sensors. Control shall provide a minimum of five input and five output terminals. Input terminals must be able to accept maintained or momentary inputs with a minimum pulse time of 40msec. Inputs must have an on-state saturation voltage less than 2.0VDC and an off-state leakage current less than 10mA. Outputs must be capable of controlling other manufacturers' equipment. Customer provided output indicators must not exceed 200mA at 30VDC. Following functions shall be available and shall be set up in software: scene selection, panic mode, occupancy response, sequencing, zone and scene lockouts, and partitioning.

B. BACnet Interface

1. Control shall provide the ability to communicate via BACnet IP communication to the LCS from a user supplied 10/100BaseT Ethernet network.
2. The control shall provide override control for occupied/unoccupied modes throughout the controlled area.
3. Provide points list to HVAC contractor for interface between the systems.
4. Refer to Division 23 specifications for additional information on the interface.

2.15 INTERCONNECTIONS TO OTHER SYSTEMS

A. Provide contact closure inputs from the fire alarm system to determine when the fire alarm system is initiated. All necessary contact closures shall be furnished as part of the system and be programmed as required.

B. Refer to Division 26, “Lighting Sequence of Operations” for additional interconnection requirements. Provide all devices, accessories, wiring and programming required to meet these requirements.

2.16 ADDITIONAL EQUIPMENT

A. **Furnish and install all necessary data wiring and hardware, including, but not limited to, data cable, terminations, data switches, etc. to provide a fully functioning lighting control system.**

B. Furnish and install all necessary power connections for relay panel, dimming panels, lighting control power supplies, etc. Power shall be derived from spare 20A/1P breakers in the nearest 120/208V normal power panel. Provide any additional breakers as required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Communication wiring between ballasts may be either Class 1 or Class 2 wiring as required. If wiring is run separate from power, provide plenum rated Class 2. If run with power, the wiring shall be Class 1 rated.

B. Contractor shall furnish all equipment, labor, system setup, and other services necessary for the proper installation of the devices as indicated on the drawings and specified herein. System setup shall include

defining and setting all control functions, installation of hardware and software, and instructions to the owner or owner representative.

C. Contractor shall install lighting hubs on wall in data closets, electrical closets or as directed on the drawings. Provide cord and plug on lighting hubs and connect to dedicated receptacle located on wall adjacent to remote lighting hubs.

D. **The project shall include all connections into the owner's network. Coordinate all requirements with the owner's IT department.**

3.2 LABELING

A. Provide self-adhesive label with software identification on all connected devices.

B. Provide self-adhesive label with data jack identification on all data network connected devices.

C. Where devices are located above the ceiling, provide self-adhesive label on ceiling T-bar with device identification and the words "Lighting Control System Device."

3.3 FIELD QUALITY CONTROL

A. Manufacturer shall be capable of providing on-site service support within 24 hours of a service call in the USA, + within 72 hours anywhere in the world, except where special visas are required.

B. Manufacturer shall provide toll-free technical support 24 hours per day, 7 days a week.

C. Manufacturer shall offer upgraded warranty based upon successful field commissioning.

D. Manufacturer shall offer a renewable service contract on a year-to-year basis, which will include parts and factory labor as well as annual training visits.

E. Service Contracts will be available for up to ten years from date of system commissioning.

3.4 MANUFACTURER'S FIELD SERVICES

A. Provide services as listed under Commissioning in Part 1 of this section.

END OF SECTION 26 09 43

SECTION 26 09 50 – LIGHTING SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes control sequences for building lighting systems and equipment. Sequence of operation is hereby defined as the manner and method by which various controls and systems function. Initial requirements for the operation of each type of space are specified in this section and/or on the contract drawings. Provide all necessary materials and labor to supply a complete and fully operational system.

B. The system shall include a completely distributed control system with no required front-end computer. Programming shall be handled via the Wi-Fi network using a hand-held device should a front-end computer be provided or not. Refer to Division 26 “Distributed Lighting Management System” for additional information.

C. Provide connections to other systems as listed in part 3.

D. Light fixtures shall be supplied with 0-10V dimming drivers, and the lighting control system shall integrate with these drivers.

1.2 SHOP DRAWINGS: Submit shop drawings in coordination with the “Distributed Lighting Management System” shop drawings:

A. Provide a description of how the building will be initially programmed as a whole, including the control of and afforded to any and all interconnecting systems.

B. Provide a description of how each space will be initially programmed including the hierarchy of control sequences, whether the space is listed within this specification or not.

C. Provide a full single-line diagram showing all control devices and the connection points. Diagrammatically show the associations of these control devices with the applicable spaces. The single-line shall also show connections to other systems, indicating method and communications protocol.

D. Provide layout drawings indicating the proper location of daylight sensors.

E. Coordinate the connection of occupancy sensors with the occupancy sensor supplier. Show these connections in detail.

F. Coordinate the connection of other lighting control systems and control devices, including, but not limited to remote architectural control systems, remote theatrical control systems and touchscreens. Review drawings and specifications for additional information.

G. Maintenance Data: Include copy of shop drawings in each maintenance manual; in accordance with requirements of Division 1.

H. When preparing submittals and programming, use a room number schedule generated by the architect and/or the owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, revise the initial submittal, when a schedule is available, to reflect the proper room numbers.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 LIGHTING MANAGEMENT SYSTEM (LMS)

A. The LMS shall include all hardware, software and programming required to fully execute all control sequences and monitor all control points described in this specification. The LMS shall have the capabilities to perform the control strategies, energy management functions, and lighting management functions listed. LMS software to perform override commands and backup of remote-control unit(s) shall reside on a rack mounted server to be located and the Main Data Room, or as indicated elsewhere in the specifications or on the drawings.

B. Set Point Control: The LMS software shall have full editing capabilities of the control sequences for all set point control logic residing in remote control units and the lighting management software. In the Event of a communication low between the LMS server and any remote-control unit(s), all local control sequences must remain active, including, but not limited to local occupant control, occupancy sensing and daylight harvesting. Once connection is reestablished, normal operation shall be reenacted.

C. Operating Mode Control: The LMS shall have full 24 hr./ 365-day scheduling capabilities for occupied/unoccupied modes of operation for all systems regardless of whether sequencing logic resides in a remote-control unit or the lighting management software. The control system shall be capable of fully executing all schedule sequences listed to be stored within the remote-control unit(s) in the event of a communication loss between the LMS server and any remote-control unit(s).

D. Alarm Management: The LMS shall monitor, buffer, and direct alarm reports to operator devices and memory files. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three (3) priority levels shall be provided.

1. The conditions under which alarms need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date shall be definable by the user.
2. Report Routing: Alarm, reports, messages, and files will be directed to a user-defined list of operator devices for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
3. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to display or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.
4. Auto-Dial Alarm: The user shall define which critical alarms shall initiate a call to a remote operator device.

E. Historical Data and Trend Analysis: The LMS software shall be capable of automatically sampling, storing, and displaying system data in all of the following ways:

1. Continuous Point Histories: A point history routine shall continuously and automatically sample the value of all analog and binary inputs and outputs at fifteen-minute intervals. Samples shall be stored for the past 72 hours to allow the user to immediately analyze equipment performance and all problem-related events. History files shall include a continuous record of the last ten status changes or commands for each point.
2. Data Storage and Archiving: Trend data shall be uploaded from local unit controllers to the LMS software at pre-determined intervals or when the trend buffers become full.

F. Totalization: The LMS software shall be capable automatically accumulating, storing, and displaying totals as follow:

1. Runtime: Automatically accumulate, store, and display runtime hours for binary input and output points as specified in sequence of operations specifications. The totalization routine shall have a sampling resolution of 1-minute or less. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
2. Event: Automatically count, store, and display event occurrences (such as the number of times the lights in a space is turned on and off) on a daily basis for user selected events.

3.2 GENERAL LIGHTING CONTROL SEQUENCES

A. Scheduled Control

1. Each remote lighting hub shall be capable of being provided with a predetermined scheduled control via the following methods:

    a. Scheduled time of day through the use of a timeclock or front-end computer.
    b. Indication from any connected system (i.e. BMS).
    c. Indication from a contact closure connected to a system or device (i.e. photoelectric cell).

2. Should a front-end file server/computer be added in the future, scheduled control shall be capable of being set independently for each space and/or relay based on the above control methods.

B. Occupancy Sensors

1. The occupancy sensors in each space shall be programmed to control, at a minimum, the lighting within that space.
2. Occupancy sensors that are connected with the system shall be capable of controlling any lighting fixture and/or relay connected within the system through programming.
3. The front-end computer shall be capable of sending an alarm signal when an occupancy sensor connected into the system detects a person during “Unoccupied” mode. The alarm signal shall be sent to a connected security system, building management system and/or as an alarm input as part of the front-end computer.

C. Occupant Control

1. In addition to the use of occupancy sensors, each indicated space shall have local occupant controls.
2. Unless otherwise stated, local occupant controls shall be used to activate the local lighting, and connected occupancy sensors to maintain lighting, and provide automatic off (i.e., vacancy sensor setting).
3. The local occupant controls shall be capable of turning the local lighting off.
4. The local occupant controls shall be capable of dimming the local lighting.
5. Through programming, the local occupant controls shall be capable of being a local override to the scheduled control. Override shall last a maximum of 2 hours without additional intervention.

    a. If the scheduled control is via connection with another system, the front-end computer shall send a signal indicating that the building is occupied. If the connection is via digital link (Bacnet or ModBus), the signal shall also indicate the space sending the override signal.

D. Daylight Harvesting

1. Each space indicated with a daylight sensor shall be programmed with daylight harvesting.

2. Each row parallel with the window wall shall be set with individual gains according to the amount of daylight that enters the room proportional to each other row.
3. Where an average amount of light is not indicated elsewhere for each space, it shall be assumed that an average of 40 foot-candles for direct lighting and 35 foot-candles for indirect lighting shall be maintained.
4. Lighting shall reach a minimum level of lighting without turning off. Any changes to the lighting shall happen at such a rate that the occupants are not aware of any dimming of the light fixtures.

E. General Order of Operations

1. Each space/relay shall follow the following order of operations, where applicable, unless noted otherwise in the specifications or drawings:

a. On-Off Control:

1) Local Occupant Control.
2) Local Occupancy Sensors.
3) Override control of connected systems.
4) Time-of-day schedule.

b. In spaces with dimming control, the lowest value shall always take precedence.

F. Normal/Emergency lighting:

1. In spaces where normal/emergency lighting is indicated along with normal lighting that is controlled via the system, the normal/emergency lighting shall function with the normal lighting so that the occupancy has no idea that there are two (2) different lighting circuits in the space.
2. If the building loses power, the control for the lighting shall fail, and the normal/emergency lighting shall operate at 100% light output from the emergency generator.
3. In spaces where normal/emergency lighting is indicated, but the normal lighting is controlled outside of the system (i.e., occupancy sensor with power pack, or just a wall switch), the normal/emergency lighting shall operate at 100% 24 hours per day.
4. Unless noted otherwise, in spaces where normal/emergency lighting is indicated, and controlled outside of the system (i.e., switch type occupancy sensor in private restroom), the normal/emergency lighting shall operate via control device only, with no UL listed relay. These spaces have been designed with emergency lighting for convenience.

3.3 INITIAL SPACE SPECIFIC CONTROL SEQUENCES

A. Exterior Lighting:

1. Provide for newly installed exterior lighting.
2. All building entrance lighting, security building mounted lighting (when indicated), approx. 1/3 of the area lighting and flag pole lighting shall be control with photoelectric cell on / photoelectric cell off.
3. All other exterior lighting, including, but not limited to, non-security building lighting, remainder of the area lighting, building/site sign lighting, etc. shall be controlled as follows:

a. ‘ON’ From dusk to 11:00pm.
b. ‘OFF’ From 11:00pm to 5:00am.
c. ‘ON’ From 5:00am to dawn.
d. Schedule shall be adjustable, and times verified with owner prior to programming.

4. When the photoelectric cell reads that it is dark, and the building is in “Occupied” mode, including when an occupant presses an override control, all exterior lighting shall remain on.

B. Corridor Lighting:

1. Provide wall switches where indicated throughout the building. These wall switches shall change the corridor lighting between "Unoccupied" and "Occupied."

    a. In lieu of using wall switches, a schedule shall be able to be programmed into the system. The corridor system shall be broken down into floors and wings to provide a level of control throughout the building. All times and areas shall be coordinated with the owner prior to system programming. When a schedule is provided, the wall stations shall be used as 2-hour override control.
    b. In addition to the programmed schedule, the BMS shall be capable of providing override commands and the schedule. Coordinate with the Owner the preference in programming.

2. During "Unoccupied" mode, all of the light fixtures in the corridor shall be set to a minimum level as directed by the owner. Initially, the lighting shall be programmed to be set to 10% light output. Should the owner choose, the lights may be set to turn off.
3. During "Occupied" mode, all of the light fixtures in the corridor shall be set to a minimum occupied light level as set by the owner. Sufficient light to provide an average light level of 10 foot-candles as measured throughout the corridor with a calibrated light meter at the floor shall initially be used, unless directed otherwise by the owner. When an occupancy sensor in the corridor senses an individual, the lights shall ramp up to a high level as set by the owner. Sufficient light to provide an average light level of 30 foot-candles as measured throughout the corridor with a calibrated light meter at the floor shall initially be used, unless directed otherwise by the owner. The occupancy sensors shall control the corridor lighting within the visible area of the occupancy. Coordinate the lighting areas with the Owner/Engineer during shop drawing submittals. Where daylight sensors are indicated in the corridor, the light fixtures within the daylight zone as identified by the currently adopted version of the International Energy Conservation Code (IECC) shall be programmed to be controlled via the daylight sensor.
4. When the occupancy sensors do not detect a person for a period of 5 minutes, the lights shall reduce back to the low level.
5. The display cases shall function on the unoccupied/occupied signal. They shall be “off” during unoccupied and “on” during occupied. An additional low voltage dimmer shall be installed at each display case to allow control of the light output.
6. In addition to the above description, a building management system connection shall be provided to allow the building management system to override the lights on during a predetermined set time. This override shall override the pre-scheduled events. Coordinate with the owner the exact programming of this override.
7.

C. Stairwell Lighting:

1. The corridor control shall be used for associated stairwells to set between "Unoccupied" and "Occupied" modes.
2. Where fixtures in the stairwell have uplight and downlight components, these components shall be controlled independently. During the initial programming, a question shall be asked of the design team regarding the uplight component of the stairwell to ensure the visual impact of the building is realized.
3. During "Unoccupied" mode, all of the light fixtures in the stairwell shall be set to a minimum level as directed by the owner. Initially, the lighting shall be programmed to be set to 10% light output.
4. During "Occupied" mode, all of the light fixtures in the stairwell shall be set to a minimum occupied light level as set by the owner. Sufficient light to provide an average light level of 10 foot-candles as measured throughout the stairwell with a calibrated light meter at the floor shall initially be used, unless directed otherwise by the owner. When an occupancy sensor in the stairwell senses an individual, the lights shall ramp up to a high level as set by the owner. Sufficient light to provide an average light level of 30 foot-candles as measured throughout the stairwell with a calibrated light

meter at the floor shall initially be used, unless directed otherwise by the owner. The occupancy sensors shall control the entirety of the stairwell as a single group. Coordinate the lighting areas with the Owner/Engineer during shop drawing submittals. Where daylight sensors are indicated in the stairwell, all of the light fixtures within the daylight zone as identified by the currently adopted version of the International Energy Conservation Code (IECC) shall be programmed to be controlled via the daylight sensor.

5. When the occupancy sensors do not detect a person for a period of 5 minutes, the lights shall reduce back to the low level.

D. Instructional Space (including classrooms, training rooms, etc.), Office and Conference, Meeting Space Lighting:

1. Occupancy sensors connected with the lighting system shall be set as vacancy sensors, so that to turn the lights on, a person has to manually activate the wall control. When a person uses the local occupant control, the lights shall turn on to the level indicated. As long as the occupancy sensor detects a person, the lights shall remain on. The lights shall turn off when the occupant turns off the lights via the local occupant control. If the occupancy sensor stops detecting a person for 10 minutes, the lights shall turn off.
2. Where there is under cabinet lighting, they shall be controlled by the indicated control station, only in an on/off manner (i.e., if the station is on, the undercabinet lighting is on; however, when the station indicates dimming, the undercabinet lighting does not dim.). Undercabinet lighting shall be supplied with its own line voltage switch so that it can be switched off independent of the room lights (although the undercabinet lighting cannot be turned on without the room lights being on).
3. In addition to the lighting controls, these spaces shall have an additional connection to the local HVAC terminal unit (fan powered VAV, VAV, blower coil, fan coil unit, etc.) to provide occupancy status. The Occupancy sensors are specified with a relay to allow this connection; however, should the controls manufacturer elect to use a system connected relay, that shall be an acceptable alternative.

E. Multi-User Restroom Lighting:

1. The corridor control shall be used for associated multi-gang restrooms to set between "Unoccupied" and "Occupied" modes.
2. During “Unoccupied” mode, all of the light fixtures in the restrooms shall be set to 10%.
3. During "Occupied" mode, all of the light fixtures shall be at 10%. When a person is detected by the occupancy sensor, the lights shall rise to a predetermined light output as directed by the owner. The lighting shall initially be set to 90% output, unless directed otherwise by the owner.
4. When the occupancy sensors do not detect a person for a period of 5 minutes, the lights shall reduce to 10%.

F. Storage and other space Lighting:

1. Occupancy sensors connected with the lighting system shall be set as vacancy sensors, so that to turn the lights on, a person has to manually activate the wall control. When a person uses the local occupant control, the lights shall turn on to the level indicated. As long as the occupancy sensor detects a person, the lights shall remain on. The lights shall turn off when the occupant turns off the lights via the local occupant control. If the occupancy sensor stops detecting a person for 5 minutes, the lights shall turn off.

3.4 INFORMATION TO BE DISPLAYED AT THE FRONT-END COMPUTER

A. The front-end computer shall display a full graphical display of the building showing all light fixtures and control devices, including, but not limited to, occupant control devices, occupancy sensors and daylight sensors.

B. For all connected dimmable drivers with a digital interface, the front-end computer shall display the lighting output of each fixture. With this information, the front-end computer shall be able to provide a graph showing what the light level was over time. This information shall be able to be put together with multiple spaces to give the information over an entire area of the building. The front-end computer shall also provide an indication when the local occupant control overrides the occupancy sensor or daylight sensor and track the estimated saving due to this override.

C. For each occupancy sensor connected to the system, the front-end computer shall be capable of displaying when the last person was detected. Through this detection, the front-end computer shall be able to provide when the space was occupied over a period of time.

D. For each relayed control area, the front-end computer shall display whether the relay is closed (on) or open (closed).

3.5 CONNECTION TO OTHER SYSTEMS

A. UL924 listed voltage sensing units shall be provided at each remote power supply and be connected to the lighting panel associated with the lighting in the area. Connect to the breaker indicated in the lighting panelboards.

B. Provide a connection with the mechanical building automation system via Bacnet over IP to control the exterior lighting and provide schedule programming in lieu of using the lighting system timeclock. Coordinate with the mechanical building management system provider and provide all required programming for facilitate all previously stated information to be passed between the mechanical building automation system and the relay panels.

1. The gateway shall interface all exterior lighting relays, including building mounted, landscape and area lighting.

C. Provide a connection with the fire alarm system via contact closure. When the fire alarm system goes into alarm, all of the connected lighting shall go to full output. When the fire alarm system is reset, the lights shall go to their preset level. This connection shall be 1-way.

END OF SECTION 26 09 50

SECTION 26 24 16 – PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:

1. Lighting and appliance branch circuit panelboards.
2. Distribution panelboards.

1.2 DEFINITIONS

A. GFCI: Ground fault circuit interrupter.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and Manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short circuit current rating of panelboards and overcurrent protective devices.
d. UL listing for series rating of installed devices.
e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between Manufacturer installed and field installed wiring.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

D. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," 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.

1.4 CLOSEOUT SUBMITTALS

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

1. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:

a. Routine maintenance requirements for switchboards and all installed components.
b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

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

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D Company. Base Bid

B. Siemens. Alternate Bid

C. GE by ABB. Alternate Bid

D. Eaton (Cutler Hammer). Alternate Bid

E. No Other Manufacturers Will Be Considered.

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush and surface mounted cabinets. Refer to panel Schedules on Drawings to determine flush or surface. NEMA PB 1, Type 1 for interior locations and Type 3R for exterior locations, unless noted otherwise in the documents.

B. Front: See panelboard, Hinged Trim Covers.

C. Finish: Manufacturer's standard enamel finish over corrosion resistant treatment or primer coat.

D. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

E. Bus Material (Main, Neutral & Ground): Hard drawn copper, 98 percent conductivity.

F. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.

G. Equipment Ground Bus: Adequate for feeder and branch circuit equipment ground conductors; bonded to box.

H. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches. Provide when indicated on the panel Schedules.

I. Skirt for Surface Mounted Panelboards: Provide skirts with same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor. Skirts shall be provided for all surface mounted panels in all rooms with exception of rooms labeled on plans “Electric or Mechanical.”

J. Feed through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

2.3 PANELBOARD SHORT CIRCUIT RATING

A. Panelboards shall be fully rated to interrupt symmetrical short circuit current as indicated on the schedules. All breakers within panelboards shall be fully rated to the panel AIC rating. Series ratings of branch breakers or bus shall not be acceptable.

2.4 ARC ENERGY REDUCTION

A. For any circuit breaker rated for 1200A, or can be adjusted to 1200A or higher, an electronic circuit breaker must be used, and the following shall be provided:

1. Documentation shall be made available, at the switchboard, regarding the Arc Energy Reduction methodology.
2. The applicable breaker shall be provided with an energy-reducing maintenance switch setting with local status indicator.

2.5 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: See Panelboard Hinged Trim Covers.

2.6 DISTRIBUTION PANELBOARDS

A. Doors: Front mounted secured with latch and lock; keyed alike.

B. Main Overcurrent Protective Devices: Circuit breaker or Main Lugs Only. Refer to panel Schedule.

C. Branch Overcurrent Protective Devices: Bolt on circuit breakers.

2.7 OVERCURRENT PROTECTIVE DEVICES

A. Lighting and Appliance Branch Circuit Panelboards:

1. Molded Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

a. Thermal Magnetic Circuit Breakers: Inverse time current element for low level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breaker frame sizes 250 A and larger.
b. GFCI Circuit Breakers: Single pole configurations with 5mA trip sensitivity.

2. Molded Case Circuit Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.

a. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
b. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air conditioning, and refrigerating equipment.
c. Ground Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time delay settings, push to test feature, and ground fault indicator.
d. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

B. Distribution Panelboards, 600A main lug and larger

1. 100A and larger, provide electronic trip units with LSI (Long time, Short time and Instantaneous) protection, size as specified on the drawings. Interrupting rating shall be available up to 200 kAIR RMS without fuses. Under 100A, provide thermal magnetic trip units, size as specified on the drawings.

a. Circuit Breakers

1) Circuit breakers shall have voltage and interrupting ratings that meet the application requirements.
2) Circuit breakers shall be constructed using glass reinforced insulating material.
3) Current carrying components shall be completely isolated from the handle, and the accessory mounting area.
4) Circuit breakers shall have an over center, trip-free, toggle-operating mechanism which shall provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.
5) Up to 600 A rating frame, MCCBs breaking unit shall be made with a double rotary contact to limit let-through energy on the installation.
6) MCCBs shall be designed to trip the circuit breaker in the event of high-level short-circuit currents. This design shall be independent of the trip unit.
7) The circuit breaker handle shall reside in a tripped position between ON and OFF to provide local trip indication. Circuit breaker escutcheon shall be clearly marked ON and OFF in addition to providing international I/O markings.
8) The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on the face of the circuit breaker.
9) Each circuit breaker shall be equipped with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit breaker tripping mechanism for maintenance and testing purposes.
10) Circuit breakers shall be factory-sealed with a hologram quality mark or a tamper evident label and shall have a date code.

11) MCCB's shall be able to receive a device for locking in the isolated position.
12) Electronic components shall withstand temperatures up to 221 °F (105 °C).
13) Circuit breakers shall be UL-listed to accept field installable/removable mechanical type lugs. Lugs shall be UL-listed to accept solid and/or stranded copper and aluminum conductors. Lugs shall be suitable for 194 °F (90 °C) rated wire, sized according to the 167 °F (75 °C) temperature rating in the NEC.
14) Circuit breakers shall be capable of accepting bus connections.
15) For frame ratings, higher than 250 amperes, MCCBs shall be fitted with metallic filters to reduce effects perceptible from the outside during current interruption.
16) For a given MCCB rated frame, MCCBs dimensions shall be the same whatever the AIR.
17) 1200 amperes frame shall be provided in electrically operated version. The operation shall use stored-energy type only and will be equipped with anti-pumping function.
18) Circuit breakers, 600A and larger, shall be equipped with a safety interlock which keeps the circuit breaker open if the trip unit is not installed.

b. Trip Units

1) MCCB's, 100A and larger shall be equipped with electronic trip units. MCCB's less than 100A shall be equipped with thermal magnetic trip units.
2) Circuit breakers with permanent trip units shall be UL-listed for reverse connection without restrictive line and load markings and be suitable for mounting in any position.
3) MCCBs with field interchangeable trip units (600A and larger) shall have trip units that are easily interchangeable and easily secured to the MCCB.
4) The trip units shall not augment overall circuit breaker volume.
5) Thermal Magnetic (less than 100A):

a) Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true RMS sensing and thermally responsive to protect circuit conductor(s) in a 104 °F (40 °C) ambient temperature.
b) Where indicated on drawings, circuit breakers shall be equipped with a ground fault module (GFM) with 20 to 200 amperes sensitivity level or earth leakage module (ELM) with sensitivity ranges between 30 mA and 3 amperes, or approved equivalent.

6) Electronic Trip Circuit Breakers (100A and larger):

a) Trip unit shall be true RMS sensing.
b) Air core current transformers shall be used to ensure accurate measurements from low currents up to high currents.
c) Electronic trip unit shall be fitted with thermal imaging to protect intermittent short circuits or ground-faults.
d) The following monitoring functions shall be integral parts of electronic trip units:

i) A test connector shall be installed for checks on electronic and tripping mechanism operation using an external device.
ii) LED for load indication at 105 percent.
iii) LED for load indication at 90 percent of load for applications 600 amperes and smaller.
iv) LED for visual verification of protection circuit functionality for applications 600 amperes or smaller.
v) LED for trip indication for applications above 600 amperes.
vi) Trip unit functions shall consist of adjustable protection settings with the capability to be set and read locally by rotating a switch.

vii) Long-time pickup shall allow for adjustment to nine long-time pickup settings. This adjustment must be at least from 0.4 to 1 times the sensor plug (In), with finer adjustments available for more precise settings to match the application.

viii) Adjustable long-time delay shall be in nine bands. At six times Ir, from 0.5 to 24 seconds above 600 amperes, and 0.5 to 16 seconds for 600 amperes and below.

ix) Short-time pickup shall allow for nine settings from 1.5 to 10 times Ir.

x) Short-time delay shall be in nine bands from 0.1-0.4 I^2t ON and 0-0.4 I^2t OFF.

xi) Instantaneous settings on the trip units with LSI protection shall be available in nine bands.

1. Above 600 amperes, from 2 to 15 times In
2. 600 amperes, from 1.5 to 11 times In
3. 400 amperes from 1.5 to 12 times In
4. 250 amperes and below, from 1.5 to 15 times In

xii) Four-pole devices shall be equipped for neutral protection with a three-position setting; neutral not protected, neutral tripping threshold equal to half the phase value, and neutral threshold equal to the phase value.

xiii) Ground fault settings for circuit breaker sensor sizes 1200 amperes or below shall be in nine bands from 0.2 to 1.0 times In. The ground fault settings for circuit breakers above 1200 amperes shall be nine bands from 500 to 1200 amperes.

e) It shall be possible to fit the trip unit with a seal to prevent unauthorized access to the settings in accordance with NEC Section 240-6(b).

f) Trip unit shall provide local trip indication and capability to locally and remotely indicate reason for trip, i.e., overload, short circuit, or ground fault.

g) Measurement chain shall be independent from the protection chain.

h) The measurements shall be displayed on the breaker itself.

2.8 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: To test functions of solid-state trip devices without removal from panelboard.

C. Provide top and bottom panel skirts for all surface mounted lighting and power panels.

2.9 HINGED TRIM COVERS

A. Provide Hinged Trim Panelboard covers for lighting and power panelboards. Entire Trim Hinged to one side of the box with a piano type hinge to access panel gutter space. Front door of panel shall be keyed to lock.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mounting Heights: Top of trim 74 inches above finished floor, unless otherwise indicated.

C. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Refer to Section 260553 for more information.

E. Install filler plates in unused spaces.

F. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub two 1-inch empty conduits below slab not on grade into suspended ceiling cavity.

G. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Provide panel and circuit identification as outlined in Division 26 “Electrical Identification”.

3.3 CONNECTIONS

A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to Manufacturers’ 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. Test continuity of each circuit.

B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:

1. Measure as directed during period of normal system loading.
2. Perform load balancing circuit changes outside normal occupancy/working Schedule of the facility and at time directed. Avoid disrupting critical 24 hour services such as on line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 10 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 PROTECTIVE SHIELDS

A. Provide metal protective shield(s) under all piping located within 3’-0” of the panelboard to defect a pipe leak away from the electrical equipment. Shield(s) shall be sized as required to cover the required pipe to prevent water from reaching the panelboard.

3.6 ADJUSTING

A. Set field adjustable switches and circuit breaker trip ranges.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 DEMONSTRATION AND START-UP

A. Adjust all adjustable settings. When a coordination study is performed, adjust breakers and ground fault circuit interrupters as required per the study.

END OF SECTION 26 24 16

SECTION 26 27 26 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes receptacles, connectors, switches, dimmers, finish plates and cord reels.

1.2 DEFINITIONS

A. GFCI: Ground fault circuit interrupter.

1.3 SUBMITTALS

A. Product Data: For each product specified.

B. Shop Drawings:

1. Legends for receptacles and switch plates, where indicated on the drawings.
2. Cord Reels.

C. Samples: For devices and device plates for color selection and evaluation of technical features, when requested by the Architect-Engineer and/or Owner.

D. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

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

B. Comply with NEMA WD 1.

C. Comply with NFPA 70.

D. Compliance with Federal Specifications – identified by the federal specifications mark (capital letters ‘F’ and ‘S’ each in a wing on either side of the UL Listing mark):

1. Receptacles and GFCI’s: Federal Specification number WC596.
2. Switches: Federal Specification number WS896.

1.5 COORDINATION

A. Receptacles for Owner Furnished Equipment, or Equipment furnished by other trades: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

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. Deliver extra materials to Owner.

1. Extra Keys: Provide minimum ten (10) keys for each type of key.
2. GFCI Receptacles: Five (5).

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers

1. Hubbell HBL1221 Series.
2. Leviton 1221-2 Series.
3. Pass & Seymour PS20AC1 Series.

B. Description: NEMA WD 1, heavy duty industrial grade, binding screw type for back and side wiring, AC only snap switch with grounded mounting strap, and grounding terminal with green screw.

C. Toggle Color: As selected by Architect.

D. Types: Switch shall be single pole, double pole, three-way, or 4-way, as required by the drawings.

E. Voltage Rating: 120/277 volts, AC.

F. Current Rating: 20 amperes.

G. Prewired and plug-in devices shall be acceptable provided device matches specifications and plug-in devices are crimped and welded.

2.2 ANALOG 0-10V WALL DIMMERS

A. Manufacturers

1. Lutron Diva 0-10V Series Control.

a. For loads exceeding 8A, provide PP-DV power pack. Locate power pack above ceiling, directly above dimmer.

2. Hubbell Rocker Slide Dimmer with appropriate power pack when required.
3. Leviton Decora Slide Dimmer with appropriate power pack when required.
4. Pass & Seymour Radiant Paddle Slide Dimmer with appropriate power pack when required.

B. Description: Decora style rocker/paddle switch with 0-10V LED compatible slide dimmer.

C. Toggle Color: As selected by Architect.

D. Types: Single pole, or three-way as required by the drawings.

E. Voltage Rating: 120/277 volts, AC.

F. Current Rating: as required for load. If load exceeds dimmer rating, provide compatible power pack.

2.3 RECEPTACLES

A. Duplex Convenience Receptacle

1. Manufacturers

   a. Hubbell HBL5362 Series.
   b. Leviton 5362 Series.
   c. Pass & Seymour PS5362 Series.

2. Description: Heavy-Duty Federal Industrial Spec Grade with nylon face (smooth), brass strap, brass contacts for side and back wiring, and nylon base.
3. Provide with WR (weather resistant) label when installed in exterior applications per code.
4. Where indicated on the drawings, or per current version of NEC, provide the tamper resistant version with internal shutter system.
5. Color of receptacles shall be as selected by the Architect.
6. Prewired and plug-in devices shall be acceptable provided device matches specifications and plug-in devices are crimped and welded. Provide similar to Pass & Seymour “Plug Tail” type receptacles.

B. Tamper Resistant Duplex Convenience Receptacle

1. Manufacturers

   a. Hubbell HBL5362TR Series.
   b. Leviton 5362-SG Series.
   c. Pass & Seymour TR63 Series.

2. Description: Heavy-Duty Federal Industrial Spec Grade tamper resistant with nylon face (smooth), brass strap, brass contacts for side and back wiring, and nylon base.
3. Provide with WR (weather resistant) label when installed in exterior applications per code.
4. Provide the tamper resistant with internal shutter system.
5. Color of receptacles shall be as selected by the Architect.
6. Prewired and plug-in devices shall be acceptable provided device matches specifications and plug-in devices are crimped and welded. Provide similar to Pass & Seymour “Plug Tail” type receptacles.

C. Tamper Resistant Duplex USB Charger Receptacle

1. Manufacturers

   a. Hubbell USB8300C5 Series.
   b. Leviton T5835-HG Series.
   c. Pass & Seymour TR20HUSBCC6 Series.

2. Description: **Hospital Grade** tamper resistant with high-impact resistant thermo plastic construction.
3. Provide with WR (weather resistant) label when installed in exterior applications.
4. Provide the tamper resistant with internal shutter system.
5. Provide with two USB type C ports.
6. USB charging shall comply with USB BC1.2 battery charging and 3.0 power delivery specifications.
7. USB charging shall supply minimum 5 amp.
8. Color of receptacles shall be as selected by the Architect.

9. Prewired and plug-in devices shall be acceptable provided device matches specifications and plug-in devices are crimped and welded. Provide similar to Pass & Seymour "Plug Tail" type receptacles.

D. Tamper Resistant Ground Fault Circuit Interrupter (GFCI) Receptacle

1. Manufacturers

   a. Hubbell GFTR20 Series.
   b. Leviton X7899 Series.
   c. Pass & Seymour 2097TR Series.

2. Description: Federal Specification Grade tamper resistant with high-impact-resistant thermoplastic construction, brass contacts for side and back wiring and LED trip indicator light.
3. GFCI receptacles shall not be connected to protect downstream devices, unless noted otherwise on the drawings. Provide unit designed for installation in a 2-3/4" deep outlet box without adapter, grounding type, Class A, Group 1, per UL 943.
4. Device shall comply with Federal Specification WC596. Devices shall have protection so that if critical components are damaged and ground fault protection is lost, power to receptacle shall be disconnected.
5. Provide with WR (weather resistant) label when installed in exterior applications per code.
6. Provide tamper resistant with internal shutter system.
7. Prewired and plug-in devices shall be acceptable provided device matches specifications and plug-in devices are crimped and welded.

E. Weatherproof Receptacle

1. Consisting of a GFCI receptacle as specified above in an outlet enclosure that is UL listed for wet locations, and meet NEC and OSHA requirements while in use.
2. Exterior-mounted receptacles installed in existing walls and on mechanical units shall have a self-closing weatherproof (in use) cover **with locking hasp** similar to Pass & Seymour WIUCAST series. Exterior-mounted receptacles installed in new walls shall have a self-closing weatherproof (in use) and be mounted over a recessed box similar to Arlington Industries DSBVR1W series. Paint cover to match adjacent surface with appropriate type of paint. Coordinate color with Architect prior to ordering.

2.4 CORD REELS

A. Manufacturers

1. Heavy Duty Plastic: KH industries CRK series with black finish.

   a. Provide at locations with finished ceilings (science, STEM, kitchen, etc.) and where indicated.
   b. Provide cord and plug on reel, and receptacle at ceiling.
   c. Description: Retractable reel with 20’ of wire, rated at 15 amps using #12 AWG wire.
   d. Provide heavy duty thermos plastic reel with strain relief. Provide triple-tap 15 amp receptacle at end of cord. **Modified payout option in lieu of standard.**

2.5 SPECIAL PURPOSE RECEPTACLES

A. Manufacturers

1. Hubbell.

2. Leviton.
3. Pass & Seymour.

B. Description: Polarized, grounding type

C. Device Body: Black nylon

D. Configuration: As required by the amperage and voltage of the equipment to be connected on the drawings.

E. Provide equipment cord and caps as required for equipment.

2.6 WIRING DEVICE ACCESSORIES

A. Wall Plates: Provide wall plates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as indicated. Provide plates which mate and match with wiring devices to which attached. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates.

B. Wall Plates: Provide 302 satin finished stainless steel wall plates throughout the building.

C. Provide galvanized steel wall plates in unfinished spaces.

D. Floor Service Outlets: Provide duplex receptacles as required and specified under receptacles.

2.7 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. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.

B. Verify all receptacle mounting heights before roughing in unless noted. If an outlet is installed in such a location as to be out of proper relation to beams, walls, or finish details of the building, its location shall be corrected by and at the expense of the Contractor under direction of the Architect/Engineer.

C. Install devices and assemblies plumb and secure only in electrical boxes which have been cleaned of excess building materials, dirt, and debris. Device to be secure tight against wall box and flush with wall plate.

D. Install switches on latch side of doorways.

E. Install wall plates when painting is complete.

F. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

G. Do not share neutral conductor on load side of dimmers.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

I. Protect devices and assemblies during painting.

J. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings.

K. Analog Dimmers: Provide the required low and/or line voltage wiring shall be provided to control the fixture. Any and all additional accessories required, including power packs, shall be provided in their entirety.

L. Coord reels shall be installed at structure or in ceiling (where architectural drawings indicate a ceiling). Provide all miscellaneous steel as required to support cord reel, both vertically and laterally. When installed in ceiling:

1. Support cord reel so that ceiling is not impacted from pulling cable.
2. Provide power connection to cord reel at ceiling plane to meet NEC.

3.2 INSTALLATION TO MEET ACOUSTICAL PERFORMANCE

A. In order to reduce sound transmission through walls, when devices boxes are installed to serve both sides of the wall, they shall be installed in different stud cavities. Where boxes are found to be installed in the same stud cavity, feeding two different sides of the wall, they will be required to be removed and reinstalled at the contractor's expense.

3.3 IDENTIFICATION

A. The requirements listed below are in addition to the requirements listed in Division 26 “Electrical Identification”.

B. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.

C. Receptacles: Identify panelboard and circuit number from which served. Use machine printed, pressure sensitive, abrasion resistant label tape on backside of the wall faceplate and durable wire markers or tags within outlet boxes.

3.4 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

C. Tighten electrical connectors and terminals according to manufacturers published torque tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.6 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 26 27 26

SECTION 26 28 13 – FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, controllers, and motor control centers; and spare fuse cabinets.

1.2 SUBMITTALS

A. Product Data: Include dimensions and Manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.

1.3 QUALITY ASSURANCE

A. Source Limitations: Provide fuses from a single Manufacturer.

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

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

1.4 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.

1.5 COORDINATION

A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.

1. Fuses: Quantity equal to one (1) set for every five (5) installed sets, but not fewer than one set of three of each kind.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Eaton Bussmann Series
2. Mersen (Ferraz Shawmut) by Powerfuse.
3. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Main Service: Class L, time delay (601 to 6000A) or Class J, time delay (0 to 600A).

B. Main Feeders: Class L, time delay (601 to 6000A) or Class J, time delay (0 to 600A).

C. Combination Starter/Disconnect Switches: Class RK1, time delay.

D. Disconnect Switches: Class RK1, time delay (30-600A).

E. Other Branch Circuits: Class J, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. The requirements listed below are in addition to the requirements listed in Division 26 “Electrical Identification”.

B. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 26 28 13

SECTION 26 28 16 – DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Disconnect Switches.

B. Molded-Case Circuit Breakers and Switches.

C. Enclosures.

1.2 REFERENCES

A. FS W F 870 Fuse Holders (For Enclosed Cartridge Fuses).

B. FS W S 865 Switch, Box, (Enclosed), Surface Mounted.

C. NEMA KS 1 Enclosed Switches.

1.3 SUBMITTALS

A. Include outline Drawings with dimensions, and equipment ratings for voltage, capacity, horsepower, and short circuit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D Company. Base Bid

B. Siemens. Alternate Bid

C. Eaton (Cutler Hammer). Alternate Bid

D. General Electric by ABB. Alternate Bid

E. No Other Manufacturers will be considered.

2.2 HEAVY DUTY TYPE FUSED AND NON-FUSED DISCONNECT SWITCHES

A. All switches shall have switch blades which are visible when the switch is OFF and the cover is open.

B. Lugs shall be mechanical type, front removable and UL listed for 60°C or 75°C conductors in switches rated 30 through 100 ampere, 75°C conductors in switches rated 200 through 1200 ampere, copper conductors.

C. Switches rated over 1200 amperes shall be provided as switchboard sections, with all applicable accessories.

D. All current carrying parts shall be plated to resist corrosion.

E. Switches shall have removable arc suppressors to facilitate easy access to line side lugs.

F. Switches shall have provisions for a field installable electrical interlock.

G. Switch operating mechanism shall be quick make, quick break such that, during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started.

H. The operating handle shall be an integral part of the box, not the cover.

I. The handle position shall travel at least 90 degrees between OFF and ON positions to clearly distinguish and indicate handle position.

J. All switches shall have a dual cover interlock mechanism to prevent unintentional opening of the switch cover when the switch is ON and prevent turning the switch ON when the cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

K. The enclosure shall have ON and OFF markings on the cover to clearly identify the position of the switch.

L. All switches shall have provisions to lock the operating handle in the OFF position.

M. Switches shall be horsepower rated for ac and/or dc as indicated on the plans.

N. The UL listed short circuit current rating of the switches shall be: 200,000 rms symmetrical amperes when used with or protected by Class R fuses (30 through 600 ampere switches employing appropriate fuse rejection schemes).

O. Switch Accessories:

1. Provide the following where required/indicated on the documents:

a. Where switches are designated to be used as service entrance, the switch shall be labeled for such use.
b. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
c. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
d. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
e. Where fused switches are designated to have type "R" fuses, the switch shall be provided with rejection clips.
f. Provide fuse clip adaptors as required to accommodate smaller fuses when required.
g. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Provide contact rating as required to accommodate application.

2.3 MOLDED-CASE CIRCUIT BREAKERS AND SWITCHES

A. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

B. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

C. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.

D. MCCBs shall be equipped with a device for locking in the isolated position.

E. Lugs shall be suitable for 60 deg C 125 ampere circuit breakers and below and 75 deg C over 125 ampere.

F. Switches rated over 1200 amperes shall be provided as switchboard sections, with all applicable accessories.

G. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

H. 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-squared t response, when ground-fault is required or indicated.

I. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip). Provide where indicated or required by code.

J. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip). Provide where indicated.

K. Features and Accessories:

1. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
2. Ground-Fault Protection: Comply with UL 1053; integrally mounted 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.
3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
4. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
5. Electrical Operator: Provide remote control for on, off, and reset operations.

2.4 ENCLOSURES

A. Switch and breaker enclosure shall be NEMA 1 unless otherwise on the Drawings or required by the NEC in accordance with the project conditions.

1. Exterior switches and breakers shall be rated NEMA 3R, unless noted otherwise.
2. Kitchen and wash-down areas shall be provided with NEMA 4X with stainless steel enclosure, unless noted otherwise.

B. The enclosure shall be finished with Gray baked enamel paint which is electrodeposited on cleaned, phosphate pretreated steel (Type 1), or Gray baked enamel paint which is electrodeposited on cleaned, phosphate pretreated galvannealed steel (Type 3R).

C. Tangential knockouts shall be provided to facilitate ease of conduit entry for switches rated 30 through 200 amperes.

D. Enclosures for Type 3R switches through 200 amperes shall have provisions for interchangeable bolt on hubs in the top end wall.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches to meet N.E.C. working clearance requirements.

B. Install fuses in fusible disconnect switches.

3.2 IDENTIFICATION

A. The requirements listed below are in addition to the requirements listed in Division 26 “Electrical Identification.”

B. Provide labeling on the exterior of each disconnect switch Stating the following:

1. What the piece of equipment is fed from the switch.
2. Where the piece of equipment is fed from the switch.
3. Size, type and quantity of fuses within cabinet.

3.3 FIELD QUALITY CONTROL

A. Subsequent to completion of installation of disconnects, energize circuits and demonstrate capability and compliance with requirements. Demonstrate switch operation through six (6) opening/closing cycles with circuit unloaded. Open each switch enclosure to display interior, mechanical and electrical connections and fuse installation, and for verification of type and rating of fuses installed. Where possible, correct deficiencies at project site, then retest or demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 26 28 16

SECTION 26 29 13 – ENCLOSED MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Manual motor controllers.

B. Combination magnetic motor controllers.

1.2 REFERENCES

A. NFPA 70 – National Electrical Code.

B. NECA "Standard of Installation," published by National Electrical Contractors Association.

C. NEMA ICS 2 – Industrial Control Devices, Controllers, and Assemblies.

D. NEMA ICS 6 – Enclosures for Industrial Controls and Systems.

E. NEMA KS 1 – Enclosed Switches.

1.3 SUBMITTALS

A. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

B. Test Reports: Indicate field test and inspection procedures and test results.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years' experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D Company. Base Bid

B. Siemens. Alternate bid

C. Eaton (Cutler Hammer). Alternate Bid

D. General Electric by ABB. Alternate Bid

E. No Other Manufacturers will be considered.

2.2 MANUAL MOTOR CONTROLLER (Thermal Switch)

A. Description: NEMA ICS 2, AC general purpose Class A manually operated, full voltage controller for fractional horsepower induction motors, with thermal overload unit. Where indicated on the Drawings, provide red pilot light.

B. Provide with lock-off handle guard.

C. Enclosure: ANSI/NEMA ICS 6, Type 1.

D. Provide with Lock-off handle guard.

2.3 DISCONNECT SWITCH TYPE COMBINATION MAGNETIC MOTOR CONTROLLERS – NON-REVERSING

A. Description: Combine magnetic motor controllers with fusible switch disconnect in common enclosure. Switch shall have a color coded externally operated handle. Operating handle shall give positive visual indication of ON-OFF with red and black color coding.

1. Fusible Switch Assemblies:

a. NEMA KS 1, enclosed knife switch with externally operable handle.
b. Fuse clips: Designed to accommodate Class R fuses and visible blades.
c. Operating handle shall give positive visual indication of ON-OFF with a color-coded operating handle.

B. Switch shall have fuse clips to accept dual element, time delay, 600 volt, UL 198E, Class RK 5.

C. Interrupting Rating: 200,000 rms amperes.

D. Magnetic Motor Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

E. Coil operating voltage: 120 volts, 60 Hz. Verify voltage with HVAC Contractor prior to ordering equipment.

F. Coil: Be of encapsulated type.

G. Poles: Three.

H. Size: Minimum size 1. Provide larger size as required by motor or as otherwise indicated.

I. Contacts: Totally enclosed, double-break, silver- cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring.

J. Wiring: Straight-through wiring with all terminals clearly marked.

K. Overload: Provide thermal overload type with overload unit rated for the motor current.

L. Phase Loss Relays: Provide additional phase loss relays so that the overloads trip in the event of the loss of a single phase on any motor 10 horsepower or larger.

M. Enclosure: ANSI/NEMA ICS 6, Type 1, unless noted otherwise.

1. Provide NEMA Type 3R at exterior locations.
2. Provide NEMA Type 4X stainless steel at kitchens and other wet locations.

2.4 PRODUCT ACCESSORIES

A. Auxiliary Contacts: NEMA ICS 2, 2 each normally open, field convertible contacts in addition to seal-in contact.

B. Cover Mounted Pilot Devices: NEMA ICS 2, standard duty type.

C. Pilot Device Contacts: NEMA ICS 2, Form Z.

D. Push buttons: Unguarded type. Provide “RESET” button.

E. Indicating Lights: Incandescent type. Provide “RUN” light.

F. Selector Switches: Rotary type. Provide “H-O-A” switch.

G. Control Power Transformers: 120 volt secondary. Provide fused secondary, and bond un-fused leg of secondary to enclosure. Verify voltage with HVAC Contractor prior to ordering equipment.

H. Provide fuse clip adaptors as required to accommodate smaller fuses when required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install enclosed controllers where indicated, in accordance with Manufacturer's instructions.

B. Install enclosed controllers plumb.

C. Mounting Height: 5'-0" to operating handle.

D. Install fuses in fusible switches.

E. Select and install overload heater elements in motor controllers to match installed motor characteristics.

F. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.2 IDENTIFICATION

A. The requirements listed below are in addition to the requirements listed in Division 26 “Electrical Identification.”

B. Provide labeling on the exterior of each Enclosed Motor Controller Stating the following:

1. What the piece of equipment is fed from the enclosed motor controller.
2. Where the piece of equipment is fed from the enclosed motor controller.
3. Size, type and quantity of fuses within cabinet.

3.3 FIELD QUALITY CONTROL

A. Inspect and test each enclosed controller to NEMA ICS 2.

B. Adjust trip settings for proper motor operation.

END OF SECTION 26 29 13

SECTION 26 33 53 – STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes a continuous duty, three-phase, on-line, double conversion, IGBT, solid state Uninterruptible Power System, hereafter referred to as the UPS. The UPS shall operate in conjunction with the building electrical systems to provide high quality power conditioning, back-up power protection and distribution for electronic equipment loads. The system shall consist of a solid-state inverter, power factor corrected rectifier, a 100% rated for continuous duty static switch, an internal maintenance bypass switch, battery plant, graphical status/control panel, Emergency Power Off (EPO) and synchronizing circuitry as described herein.

B. The UPS shall be of a modular design to allow for n+1 class redundancy of the UPS electronics.

C. The new UPS shall be mated up to the existing distribution cabinet. Provide adaptor plates, wiring, and other connections and equipment as required. Existing cabinet is a 50kVA MGE Galaxy 5000 unit. The auxiliary cabinet model no. is G5TAA#815076.

D. Provide interconnections as listed in part 2.

E. Provide product startup and training as listed in part 3.

1.2 SUBMITTALS

A. Submittals shall contain the following documentation:

1. Installation Package: Complete electrical characteristics and connection requirements, including, but not limited to overcurrent protection requirements, wire size limitation at lugs, etc. Provide detailed equipment outlines with cabinet dimensions and spacing requirements; location of conduit entry/exit paths; location of floor/seismic mounting; available battery types/sizes; all cabinet weights; heat rejection and air flow requirements, including clearance requirements; single-line diagram; control, and external wiring.
2. Product Data: Provide catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.
3. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product. Include equipment installation outline and connection details.

1.3 STANDARDS

A. The UPS has been designed in accordance with, and complies to, the following standards:

1. UL 1778 and CSA 22.2 (cUL equivalent).
2. IEC, 1000 (801) Level 4.
3. FCC Rules and Regulations of Part 15, Subpart J, Class A.

4. The UPS shall be designed in accordance with the applicable sections of the documents published by:

   a. National Fire Protection Association (NFPA)
   b. National Electrical Manufacturers Association (NEMA)
   c. Occupational Safety and Health Administration (OSHA)

1.4 QUALITY ASSURANCE

A. Manufacturer's Certification: The manufacturer shall specialize in manufacturing of on-line, double conversion three phase UPS modules specified in this document with a minimum of twenty years documented experience, and with a nationwide first party service organization. The manufacturer shall be ISO 9001 certified and shall design to internationally accepted standards.

B. Factory Testing: Prior to shipment the manufacturer shall complete a documented test procedure to test all functions of the UPS module and batteries (via a discharge test), when supplied by the UPS manufacturer, and guarantee compliance with the specification. The factory test shall be performed in the presence of the customer providing the manufacturer receives adequate prior notice. The manufacturer shall provide a copy of the test report upon request.

C. Materials and Assemblies: All materials and parts comprising the UPS shall be new, of current manufacture, and shall not have been in prior service, except as required during factory testing. All active electronic devices shall be solid state and not exceed the manufacturer's recommended tolerances for temperature or current to ensure maximum reliability. All semiconductor devices shall be sealed. All relays shall be provided with dust covers. The manufacturer shall conduct inspections on incoming parts, modular assemblies and final products.

1.5 DELIVERY, STORAGE, AND HANDLING

A. All products shall be packaged in a manner to prevent penetration by debris and to allow safe delivery by all modes of ground transportation and air transportation where specified.

B. Prior to shipping all products shall be inspected at the factory for damage.

C. Equipment shall be protected against extreme temperature and humidity and shall be stored in a conditioned or protected environment. Contractor shall coordinate with the manufacture exact requirements to ensure equipment is maintained for proper operation.

D. Equipment containing batteries shall not be stored for a period exceeding three months, or as otherwise directed by the manufacturer, without powering up the equipment for a period of eight hours, or as directed by the manufacturer, to recharge the batteries. Contractor must coordinate with the manufacturer exact requirements to ensure batteries are maintained and provide power as directed by the manufacturer. Should batteries be destroyed due to improper storage, contractor shall replace at no additional cost to the owner.

1.6 WARRANTY

A. Manufacturer and Installer agree to repair or replace UPS system and/or storage batteries that fail in materials or workmanship within the warranty period.

B. Warranty Period: Two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Vertiv Liebert APM2 series shall be basis of design.

B. No other manufacturer shall be acceptable.

2.2 SYSTEM DESCRIPTION

A. UPS Design Requirements

1. Output Power Continuous Rating: The continuous output power rating of the UPS shall be 30 kVA at a 0.9 lagging power factor.

    a. UPS shall be of a module design consisting of inverter modules of at least 10kVA.
    b. Sufficient modules shall be provided to achieve n+1 redundancy at the output power rating (i.e., if modules are rated at 20kVA, to achieve 60kVA with specified redundancy, four (4) modules shall be provided).
    c. Each UPS module output current shall differ by no more than 5% of the rated full load current of one UPS module.
    d. Modules shall be hot swappable, and shall share the battery, so that a failure of a module does not reduce the backup time.

2. Input Voltage: 480 VAC – 15% / +15%, 3 phase, 3 wire plus ground. A transformer shall be provided to generate the output voltage (transformer may be before or after UPS inverter).
3. Output voltage: 120/280 VAC 3 phase, 4 wire plus ground.
4. Battery Autonomy: The UPS shall be capable of operating at full load for a minimum of **40** minutes at 0.9 PF output on battery power. Internal batteries shall be used as much as possible; however, external cabinets shall be provided as required.
5. Primary & secondary overcurrent protection:

    a. Breakers MUST be provided integral to the UPS. The existing UPS is a 50kVA unit, and the existing feed and overcurrent protection shall remain.

B. Modes of Operation:

1. The UPS shall be designed to operate as an on-line, double-conversion, IGBT system with the following operating modes:

    a. Normal: The critical AC load is continuously supplied by the UPS inverter. The rectifier/charger derives power from an AC source and supplies DC power to the inverter while simultaneously float-charting the reserve battery.
    b. Emergency: Upon failure of utility AC power, the critical AC load is supplied by the inverter, which obtains power from the battery. There shall be no interruption to power to the critical load upon failure or restoration of the utility AC source.
    c. Recharge: Upon restoration of utility AC power after a utility AC power outage, the rectifier/charger shall automatically restart, gradually ramp up output voltage and assume the inverter and battery recharge loads.
    d. Bypass: If the UPS must be taken out of service for maintenance or repair or if the inverter overload capacity is exceeded, the static transfer switch shall perform a reverse transfer of the load from the inverter to the bypass source with no interruption in power to the critical AC load.

C. AC Input Characteristics

1. Voltage: 480 VAC, ±15%, 3 phase, 3 wire plus ground.
2. Frequency: 60 Hz (+/- 10%).
3. Power Factor: > .98 lagging at 50% and 100% load.
4. Inrush Current: UPS inrush current not to exceed 1.5 times rated input current. Maintenance bypass and distribution cabinet inrush current not to exceed 8 times rated input current.
5. Current Limit: 140% of nominal AC input current maximum.
6. Current Distortion: Less than 3% reflected THD maximum at full load.
7. Input Surge Protection: The UPS is equipped with input MOVs to withstand sustained input surges per IEC 1000-4-5.

D. AC Output Characteristics

1. Voltage: 120/208, VAC, 3 phase, 4 wire plus ground.
2. Voltage Regulation:
    a. +/- 1% three-phase RMS average for balanced three-phase load for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature and load power factor.
    b. +/- 5% three-phase RMS average for a 100% unbalanced for the combined variation effects of input voltage, connected load, battery voltage, ambient temperature and load power factor.
3. Frequency:
    a. Free running frequency (asynchronous): 60 Hz +/- 0.01%.
    b. Minimum frequency slew rate adjustment: 1 - 3 Hz/second (selectable).
4. Voltage Regulation:
    a. Less than 1% THD for linear loads.
    b. Less than 5% for 100% nonlinear loads (3:1 crest factor) without kVA/kW derating.
5. Load Power Factor Range: 0.7 lagging to 0.9 leading without derating.
6. Output Power Rating: 0.99 full load, 0.98 half load.
7. Overload Capabilities:
    a. 125% for 60 seconds
    b. 150% for 30 seconds
8. Voltage Transient Response: 100% load step, +/- 5%.
9. Transient Recovery Time: To within of steady state output voltage within half a cycle.

E. Battery

1. Provide batteries to meet specified back-up inverter time when UPS is supplying 100% rated load. Use manufacturer standard technology.
2. **ALTERNATE BID:** Under the applicable alternate bid, provide lithium-ion batteries in lieu of the manufacturer standard technology. Provide sufficient batteries to supply 100% of the rated load.

2.3 FABRICATION

A. Materials:

1. All materials of the UPS shall be new, of current manufacture and high grade and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state. All power semi-conductors shall be sealed. Control logic and fuses shall be physically isolated from power train components to ensure operator safety and protection from heat. All electronic components shall be accessible from the front without removing sub-assemblies for service access.

B. Wiring

1. Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code, OSHA and applicable local codes and standards. All bolted connections of busbars, lugs and cables shall be in accordance with requirements of the National Electrical Code and other applicable standards. All electrical power connections shall be torqued to the required value and marked with a visual indicator.
2. Provisions shall be made in the cabinets to permit installation of input, output and external control cabling, using raceway or conduit. Provision shall be made for top and bottom access to input, output, bypass and DC connections. In conformance with NEC, connection cabinets shall provide for adequate wire bend radius. All copper busbars for customer power connections shall be tin plated for connection integrity.

C. Construction and Mounting

1. The UPS shall be in NEMA Type 1 enclosures, designed for floor mounting. The UPS shall be structurally adequate and have provisions for hoisting, jacking and forklift handling.

D. Cooling

1. Cooling of the UPS shall be by forced air using a redundant fan configuration. Fan power shall be provided by the UPS.
2. The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded. Air filters shall be located at the point of air inlet and be changeable.

E. Cabinet Access

1. All pieces of the cabinet shall be front and/or top access only. Where rear access is required, the UPS shall be mounted to wheels, and sufficient flexible cable shall be provided to allow the UPS to be wheeled out from the wall.

2.4 COMPONENTS

A. Rectifier/Charger

1. General: The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert AC to regulated DC for input to the inverter and for charging the battery.
2. AC Input Current Limiting: The rectifier/charger unit shall be provided with AC input current limiting whereby the maximum input current shall be limited to 140% of the full input current rating.
3. DC Filter: The rectifier/charger shall have an output filter to minimize ripple current into the battery. The AC ripple voltage of the rectifier DC output shall not exceed 1% RMS of the float voltage. The

filter shall be adequate to ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter without the battery connected.

4. Automatic Rectifier Restart: Upon restoration of utility AC power, after a utility AC power outage and prior to a UPS automatic end-of-discharge shutdown, the rectifier/charger shall automatically restart, walk-in and gradually assume the inverter and battery recharge loads.
5. Battery Recharge: In addition to supplying power for the inverter load, the rectifier/charger shall be capable of producing battery charging current sufficient to replace 95% of the battery discharge power within ten (10) times the discharge time. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.
6. Overvoltage Protection: DC overvoltage protection shall be provided so that if the DC voltage rises to the preset limit, the UPS will shut down automatically and initiate an uninterrupted load transfer to the static bypass line.

B. Inverter

1. General: The term inverter shall denote the equipment and controls to convert DC from the rectifier/charger or battery to precise AC to power the load. The inverter shall be solid-state, capable of providing rated output power, and for increased performance the inverter shall be a pulse-width-modulated design and utilize insulated gate bipolar transistors (IGBTs).
2. Overload Capability:

    a. The inverter shall be capable of supplying current and voltage for overloads exceeding 100% as previously specified.
    b. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.

3. Fault Clearing and Current Limit: The inverter shall be capable of supplying an overload current of 150% of its full-load rating as previously specified. For greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The critical load will be transferred to the static bypass automatically and uninterrupted. The inverter shall be self-protecting against any magnitude of connected output overload. Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement to clear protective fuses.
4. Step Load Response: The inverter shall be capable of the step load response as previously specified.
5. Voltage Distortion: The total harmonic distortion in the output voltage shall be as previously specified.
6. Phase Balance: Electronic controls shall be provided to regulate each phase so that an unbalanced loading will not cause the output voltage to go outside the specified voltage unbalance or phase displacement. With 100% load on one phase (and 0% load on the other two phases) or 100% load on two phases (and 0% load on the other phase), the voltage balance is to be as previously specified.
7. Inverter Shutdown: For rapid removal of the inverter from the critical load, the inverter control electronics shall instantaneously turn off the inverter transistors. Simultaneously, the static transfer switch shall be turned on to maintain continuous power to the critical load.
8. Inverter DC Protection: The inverter shall be protected by the following disconnect levels:

    a. DC Overvoltage Shutdown
    b. DC Under voltage Warning (Low Battery Reserve)-pre-warning time is adjustable
    c. DC Under voltage Shutdown (End of Discharge)

9. Output Frequency: The output frequency of the inverter shall be controlled by a high-speed DSP capable of holding the inverter output frequency as previously specified during steady state and transient conditions. Total deviation from the rated frequency, including short time fluctuations and drift, shall not exceed previously specified levels.

C. Display and Controls

1. Monitoring and Control: The UPS shall be provided with a microprocessor-based unit status display and controls section designed for convenient and reliable user operation. A graphical liquid crystal display (LCD) shall be used to show a single-line diagram of the UPS and shall be provided as part of the monitoring and controls sections of the UPS. All operator controls and monitors shall be located on the front of the UPS cabinet. Monitoring functions such as metering, status and alarms shall be displayed on the graphical LCD. Additional features of the monitoring system shall include:

    a. Menu-driven display with pushbutton navigation
    b. Real-time clock (time and date)
    c. Alarm history with time and date stamp
    d. Memory with battery backup

2. Metering: The following parameters shall be displayed:

    a. Input AC voltage line-to-line
    b. Input AC current for each phase
    c. Input frequency
    d. Battery voltage
    e. Battery charge/discharge current
    f. Output AC voltage line-to-line
    g. Output AC current for each phase
    h. Output frequency
    i. Apparent power
    j. Active power
    k. Battery time left during battery operation

3. Alarm Messages: The following alarm messages shall be displayed:

    a. Mains Voltage Abnormal
    b. Mains Under voltage
    c. Mains Freq. Abnormal
    d. Charger Fault
    e. Battery Reversed
    f. No Battery
    g. Control Power 1 Fail
    h. Parallel Comm. Fail
    i. Bypass Unable to Track
    j. Bypass Abnormal
    k. Inverter Asynchronous
    l. Fan Fault
    m. Control Power 2 Fail
    n. Unit Over Load
    o. System Over Load
    p. Bypass Phase Reversed
    q. Transfer Time-Out
    r. Load Sharing Fault
    s. Bypass Over Current
    t. Output Ground Fault

4. Status Messages: The following UPS status messages shall be displayed:

    a. Rectifier (Off / Soft Start / Main Input On / Battery Input On)
    b. Input Supply (Normal Mode / Battery Mode / All Off)

c. Battery Self-Test (True / False)
d. Input Disconnect (Open / Closed)
e. EPO (True / False)
f. Charger (On / Off)
g. Output Disconnect (Open / Closed)
h. Maint. Disconnect (Open / Closed)
i. Bypass Disconnect (Open / Closed)
j. Inverter (Off / Soft Start / On)
k. Bypass (Normal / Unable to Trace / Abnormal)
l. Output Supply (All Off / Bypass Mode / Inverter Mode / Output Disable)
m. Inverter On (Enable / Disable)

5. Controls: UPS startup, shutdown and static bypass operations shall be accomplished through pushbutton controls on the front panel. Menu-driven user prompts shall be provided to guide the operator through system operation without the use of additional manuals. Pushbuttons shall be provided to display the status of the UPS and to test and reset visual and audible alarms. A mimic screen shall be available on the LCD to depict a single-line diagram of the UPS with switch positions and power flow.
6. On-Line Battery Test: The UPS shall be provided with a menu-driven On-Line Battery Test feature. The test shall ensure the capability of the battery to supply power to the inverter while the load is supplied power in the normal mode.

D. Static Transfer Switch

1. General

a. A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be a naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously. The switch shall have an overload rating to clear a 20-ampere load branch circuit breaker.
b. The static transfer switch control logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS or to bypass the UPS for maintenance.

2. Uninterrupted Transfer

a. The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:

1) Inverter overload capacity exceeded
2) Critical AC load overvoltage or under voltage
3) UPS fault condition

b. The transfer control logic shall inhibit an automatic transfer of the critical load to the bypass source if any of the following conditions are present:
c. Bypass frequency out of limits
d. Bypass out-of-synchronization range with inverter output

3. Uninterrupted Retransfer

a. Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall

inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:

1) Bypass out of synchronization range with inverter output
2) Inverter/bypass voltage difference exceeding preset limits
3) Overload condition exists in excess of inverter full load rating
4) UPS fault condition present

E. Battery Power Pack: The battery power pack shall include valve-regulated, lead-acid battery cells housed in a separate cabinet that matches the UPS cabinet styling to form an integral system lineup. Battery cells shall be mounted on slide-out trays for ease of maintenance. A battery disconnect circuit breaker shall be included for isolation of the battery pack from the UPS module. Casters and leveling feet shall also be provided with the battery power pack cabinet for ease of installation. When the application calls for the battery cabinet to be bolted to the UPS cabinet, an interconnecting cable kit will be available, precut and pre-lugged.

2.5 OPTIONAL ACCESSORIES

A. Web Card Interface

1. Provides communication outputs to indicate a change of status of the UPS. Outputs are provided for:

   a. SNMP
   b. HTML - Web page
   c. Allow use of network management systems

2. UPS shall be provided with the Web Card Interface, and provide all programming as required to provide full functionality.
3. In addition to the communications adapter, remote server shutdown sequence shall also be included in the system and be connected as directed by the owner to their servers. The shutdown sequence shall be orderly, unattended, and sequential to conserve critical systems.
4. Provide dual data jack at the UPS (one used and one spare) and patch cables as required to make the connection.

B. Modbus TCP Interface Card

1. Provide Modbus TCP communications to communicate with the BMS. Provide gateways, wiring, accessories and programming as required to provide this interface. Coordinate the interface with the BMS installer.

   a. Provide dual data jack at the UPS (one used and one spare) and patch cables as required to make the connection.

2. Information to be displayed at the BMS shall be as follows:

   a. Nominal Input Voltage
   b. Nominal Input Frequency
   c. Nominal Output Voltage
   d. Nominal Output Frequency
   e. Nominal VA Rating
   f. Nominal Output Power
   g. Nominal Battery Life

h. The Following Alarms (at a minimum):

1) Temperature
2) Overload
3) UPS Shutdown
4) Charger Failure
5) System Off
6) Fan Failure
7) Fuse Failure
8) Shutdown Pending
9) Shutdown Imminent
10) General Fault

C. Matching Maintenance Bypass Cabinet

1. A make-before-break maintenance bypass with Solenoid Key Release Unit interlock shall be available in a cabinet that matches and may be bolted up to the right side of the UPS. Installation of the cabinet shall not affect the cooling ability of the UPS. Thermal-magnetic breakers shall be provided for bypass and maintenance isolation.
2. UPS shall be provided with Bypass allowing for single input, single output, while bypassing the UPS for maintenance operations.

D. Existing Distribution Cabinet

1. The existing distribution cabinet shall remain and be reused. Provide all parts pieces, labor, wiring, etc. to interconnect with the existing cabinet.

2.6 EMERGENCY POWER OFF

A. The UPS shall be connected to a remote emergency power off device. Provide any additional relays, contacts, etc. required for this interconnection. The emergency mushroom type shut-down button shall be located at the entrance into the room and be provided with a cover to prevent accidental activation. The cover shall be connected to the fire alarm system. The emergency power off button shall shut down the UPS and any HVAC equipment located in the room, provide additional contactor/relays and wiring as required. This contractor shall be responsible for all wiring, transformer, contacts, relays, etc. for a fully functioning system.

2.7 INTERCONNECTIONS

A. Provide a Modbus BAS interconnection utilizing an IP connection. Provide a data jack at the UPS and wire back to the nearest MDF/IDF, and connection. Coordinate all programming requirements with the BAS installer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Maintain minimum clearances and workspace at equipment according to manufacturer’s written instructions and NFPA 70.

B. Connections: Interconnect system components. Make connections to supply and load a circuit according to the manufacturer's wiring diagrams, unless otherwise indicated.

C. When installed on raised floors, provide miscellaneous steel of sufficient capacity to support UPS from concrete floor below the raised floor.

3.2 GROUNDING

A. Comply with NFPA 70 requirements for connecting to grounding and bonding.

B. Provide minimum #6 AWG ground, or same size as secondary ground wire of UPS, whichever is larger, and bond to local building steel.

3.3 ADDITIONAL CONNECTIONS

A. Contractor shall provide all wiring and connections to connect UPS to BAS and Data Network Systems where applicable.

B. The manufacturer shall include an additional minimum 8 hours with a manufacturer representative to assist the owner in programming auto shutdown of their servers.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect and adjust equipment installation including connections. Report results in writing and include in final project O&M manual.

B. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each UPS component:

1. Inspect interiors of enclosures, including the following:

    a. Integrity of mechanical and electrical connections.
    b. Component type and labeling verification.
    c. Ratings of installed components.

2. Test manual and automatic operational features and system protective and alarm functions.
3. Test communication of status and alarms to remote monitoring equipment.

C. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each UPS component:

1. Inspect interiors of enclosures, including the following:

    a. Integrity of mechanical and electrical connections.
    b. Component type and labeling verification.
    c. Ratings of installed components.

2. Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated, within the previous six months according to NIST standards.

    a. Simulate malfunctions to verify protective device operation.
    b. Test duration of supply on emergency, low-battery voltage shutdown, and transfers and restoration due to normal source failure.
    c. Test harmonic content of input and output current less than 25, 50, and 100 percent of rated loads.
    d. Test output voltage under specified transient-load conditions.
    e. Test efficiency at 50, 75, and 100 percent of rated loads.
    f. Test battery-monitoring system functions.

D. Retest: Correct deficiencies and retest until specified requirements are met.

E. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

3.5 STARTUP AND TRAINING

A. The manufacturer shall provide a minimum 8 hours of training and start-up services in two (2) 4-hour visits. The manufacturer shall provide an overview of UPS operation and UPS maintenance during the training. In addition to the training, the manufacturer shall provide startup services to ensure all requirements are met, wiring is proper, etc. to ensure the owner is granted full warranty of the product. Finally, the startup visit must coincide with the generator startup visit to ensure proper operation between the UPS and generator.

B. The manufacturer shall provide an additional 8 hours of assistance to the owner in programming the auto shutdown of their servers in the event of an emergency.

C. The previously specified requirement to provide support to the owner for shutdown of their servers shall be in addition to the startup and training.

3.6 MAINTENANCE & SERVICE CONTRACTS

A. The manufacturer shall offer additional preventative maintenance and service contracts covering both the UPS and the battery bank. Accredited professional service engineers employed exclusively in the field of critical power systems service shall perform all maintenance and service. The manufacturer shall also offer extended warranty contracts.

END OF SECTION 26 33 53

SECTION 26 43 13 – TRANSIENT VOLTAGE SURGE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. The Surge Protection Devices (SPD) covered under this section includes all service entrance type surge protection devices suitable for use as Type 1 or Type 2 devices per UL1449 4rd Edition, applied to the line or load side of the utility feed inside the facility.

B. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to finish and install surge protection devises.

C. The unit installed at the electrical service entrance shall be designed for parallel connection to the facility's wiring system and be multi-listed as a TVSS device, a noise filter, and as a Secondary Surge Arrester. The suppression filter system shall be designed and manufactured in the USA by a qualified manufacturer of suppression filter system equipment.

D. The units installed at the electronic panelboards shall be designed for parallel connection to the facility’s wiring system and be multi-listed as a TVSS device and noise filter.

E. Provide product startup as listed in part 3.

1.2 STANDARDS

A. The specified unit shall be designed, manufactured, tested by an approved National Testing Lab (i.e. UL, ETL, Metalab, etc.) and installed in compliance with the following standards:

1. Underwriters Laboratories UL 1449 4th Edition 2014 Revision
2. Underwriters Laboratories UL 1283
3. Underwriters Laboratories UL 96A
4. IEEE C62.41
5. IEEE C62.45
6. IEEE 1100 Emerald Book
7. National Fire Protection Association (NFPA 70 [NEC])

1.3 SUBMITTALS

A. Package must include shop drawings complete with all technical information, unit dimensions, detailed installation instructions, maintenance manual, recommended replacement parts list and wiring configuration.

B. Copies of Manufacturer’s catalog data, technical information and specifications on equipment proposed for use.

C. Copies of documentation stating that the Surge Protection Device is listed by UL to UL1449 4th Edition, category code VZCA.

D. Copies of actual let through voltage data in the form of oscillograph results for both ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (Ring wave) tested in accordance with ANSI/IEEE C6245.

E. Copies of Noise Rejection testing as outlined in NEMA LS1-1992 (R2000) Section 3.11. Noise rejection is to be measured between 50kHZ and 100MHz verifying the devices noise attenuation. Must show multiple attenuation levels over a range of frequencies.

F. Copies of test reports from a recognized independent testing laboratory, capable of producing 200kA surge current waveforms, verifying the suppressor components can survive published surge current rating on a per mode basis using the ANSI/IEEE C62.41 impulse waveform C3 (8 x 20 microsecond, 20kV/10kA). Test data on an individual module is not acceptable.

G. Copy of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.

1.4 WARRANTY

A. The manufacturer of the TVSS shall provide a Warranty against failure for the following durations from the date of shipment.

1. Service Entrance Unit: Fifteen (15) years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Current Technology

1. Service Entrance Model TG3-150- (See Chart below, provide voltage as shown on drawings)-MNx-M2-F-HPI.

B. Thor equivalents.

C. Asco by Schneider equivalents.

2.2 GENERAL

A. Refer to drawing for operating voltage, configuration and surge current capacity per mode for each location, or you may list locations and information here.

B. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449, section 37.7.3. MCOV values claimed based on the component’s value or on the 30-minute 115% operational voltage test, section 38 in UL1449 will not be accepted.

C. Unit shall have no more than 10% deterioration or degradation of the UL1449 4th Edition Voltage Protection Rating (VPR) when exposed to a minimum of 14,000 repeated category C3 (20kV/10kA) surges. The SPD manufacturer must provide a test report validating the repetitive surge test was performed.

D. Protection Modes UL1449 4th Edition VPR(6kV, 3kA) for grounded WYE/delta and High Leg Delta circuits with voltages of (480Y/277), (208Y/120), 3-Phase, 4 wire circuits, (120/240) split phase shall be as follows and comply with test procedures outlined in UL1449 3rd Edition section 37.6:

TG3-150			B3 Ringwave	C3 Comb. Wave	UL 1449 4th Ed
Voltage	Mode	MCOV	6kV, 500A	20kV, 10kA	VPR Rating
277/480	L-N	320	450	1420	1200
	L-G	320	540	1540	1200
	N-G	320	570	1600	1000
	L-L	552	530	2600	2000

E. High Frequency Extended Range Power Filter. The unit shall include a high frequency filter and shall be listed to UL 1283 as an Electromagnetic Interference Filter. The unit's EMI-RFI noise rejection or attenuation values shall be in compliance with test and evaluation procedures outlined in MIL-STD-220B.

Attenuation Freq.	10KHz	100KHz	1MHz	10MHz	Max at 142KHz
TG3-150	18.1dB	44dB	22.8dB	15.3dB	54.6dB

NOTE: Standardized insertion loss data obtained utilizing MIL-STD-220B 50-ohm insertion loss methodology. Noise source path = 100' to model maximum average circuit distance, filter connection distance = 6".

2.3 ENCLOSURE AND MOUNTING

A. The unit shall be supplied in a NEMA 4 metallic enclosure for mounting external to switchgear. Products required to be mounted integral to switchgear will not be accepted.

2.4 FEATURES/OPTIONS

A. On-Line Diagnostic Monitoring (all units):

1. LED/phase and audible alarms.
2. Surge Counter.
3. 2 Form 'C' contacts to provide alarm indication to remote system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The specified service entrance unit shall be installed on the wall adjacent to the switchboard and connected to the designated breaker in the switchboard utilizing a cable similar to Current Technology HPI-6Y series cable. Cable leads shall be kept to a minimum.

B. System shall not require removal and replacement for warranty or other repairs. All internal component replacements shall be capable of being completed by a licensed electrician.

C. Other materials and equipment shall comply with applicable Sections of this Division.

3.2 QUALITY ASSURANCE

A. Diagnostic Signature Card. Each unit shall be factory tested before shipment. A copy of the start-up test results and the factory benchmark testing results shall be supplied to the engineer and the owner for confirmation of proper system function. These results shall also clarify that the integrity of all neutral-to-

ground bonds were verified through testing and visual inspection, and that all grounding bonds were observed to be in place.

3.3 STARTUP

A. Startup: A manufacturer's representative shall visit the site verify installation and submit to Contracting Officer a letter stating equipment and installation meets intent of Contract Documents, and manufacturer's warranties and guarantees are in effect.

END OF SECTION 26 43 13

SECTION 26 51 00 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes interior LED lighting fixtures, LED lighting fixtures mounted on exterior building surfaces, emergency lighting units, and accessories.

1.2 SUBMITTALS

A. Product Data: For each type of lighting fixture indicated, provide typical cutsheets. Include data on features, accessories, and the following:

1. Light output in lumens, color temperature (CCT), color rendering index (CRI) and energy efficiency data.
2. Lighting fixture accessories.
3. Dimensions of fixtures.

B. Exterior Fixture Performance

1. Site lighting is based on the manufacturers and distribution patters specified. It shall be the Contractor's responsibility to review all "approved substitute" manufacturers to match the lighting levels achievable with the basis of design.
2. If requested, the Contractor shall supply the Engineer with a 10'x10' lighting level plot plan of the site using the proposed approved alternate manufacturer for review. If the alternate manufacturer cannot meet light levels within Engineer acceptable limits, the Contractor will be required to select another manufacturer from the approved substitute list.

C. Coordination: The electrical contractor shall be responsible to coordinate all light fixtures with ceiling installer before installation of ceiling grid. The electrical contractor shall also coordinate light fixture installation with HVAC and plumbing contractor for installation of piping and ductwork. Should there be any conflicts, they should be brought to the attention of the Architect/Engineer prior to the installation of the ceiling grid. Any conflicts not brought to the attention of the Architect/Engineer before installation of ceiling, the electrical contractor shall bare all costs associated with rework to install light fixtures, piping, ductwork, ceiling grid, etc.

1.3 QUALITY ASSURANCE

A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with NFPA 70.

C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.4 COORDINATION

A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.

B. Lighting Control: Verify compatibility of lighting controls (analog dimmers and digital systems) with lighting fixtures to be installed. Where controls are not compatible with the lighting to be installed, bring to the attention of the Architect/Engineer in writing prior to ordering lighting fixtures or controls.

1.5 FIELD CONDITIONS

A. Mark locations of exterior luminaires for approval by Architect/Engineer prior to the start of luminaire installation.

B. Where aimable fixtures are specified (i.e. flood lights), fixtures shall be aimed at night, and presented to the Architect/Engineer for review prior to final approval.

1.6 WARRANTY

A. Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within the project specified warranty period.

B. Manufacturer warranty: Contractor shall ensure manufacturer published warranty furnished with the luminaires remain in-tact through the project as well as the project warranty period. Any luminaires that are damaged during the project shall be replaced at no additional cost to the owner in order to ensure maintenance of the product warranty.

1.7 EXTRA MATERIALS

A. Exit Signs: Provide two (2) 2-sided exit signs, matching the units being specified for the project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide from manufacturers as specified in the Lighting Fixture Schedules or on the drawings.

2.2 LUMINAIRE REQUIREMENTS

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

B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI.

C. Recessed luminaires shall comply with NEMA LE 4.

2.3 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

D. Reflecting Surfaces: 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.

E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
2. Lens Thickness: 0.156 inch minimum, unless greater thickness is indicated.

F. Metal Finishes: Variations in finishes are unacceptable in the same piece, or in adjacent fixtures.

1. Exterior luminaires shall be provided with the same finish, regardless of manufacturer. Custom finishes must be provided were required to ensure same finish.
2. Pole light heads and poles shall match. Color chips and custom finishes shall be applied to ensure they match, regardless of manufacturer.

2.4 LED DRIVERS

A. Provide low-energy LED drivers, capable of operating the LEDs indicated. Drivers shall operate at an input voltage between 120 to 277 VAC at an input frequency of 60 Hz +/- 10%. Light output shall remain constant for line voltage fluctuations within the range described. Drivers shall comply with EMI and RFI limits set by the FCC (CFR 41 Part 18) for non-residential applications and not interfere with normal electrical equipment. Drivers shall meet applicable ANSI standards and must be UL listed with the fixtures. In order to maximize combability, drivers shall provide 0-10V dimming operation, unless noted otherwise.

1. Where fixtures are connected to a switching device on the drawings, the 0-10V terminations shall remain unconnected.

B. Compatibility: Certified by manufacturer for use with specific dimming system indicated for use with each dimming ballast.

2.5 BATTERY POWERED EMERGENCY LIGHTING UNITS

A. Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.

1. Emergency Connection: Operate lamp(s) continuously upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Test Push-Button and Indicator Light: Visible and accessible when fixture installed in final location.

a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Provide type as specified.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.6 EXIT SIGNS

A. General Requirements: Comply with UL 924 and the following:

1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.
2. Internally Lighted Signs: As follows:

a. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.

2.7 LAMPS

A. LED lamps shall comply with the LM-79 and LM-80 standards and be provided to meet the following minimum specifications:

1. Recessed 1'x4', 2'x2' and 2'x4'fixtures: minimum 50,000 hours at 70% lumen output.
2. Recessed downlights: minimum 50,000 hours at 70% lumen output.
3. Linear pendant fixtures: minimum 70,000 hours at 80% lumen output.
4. Exterior fixtures: minimum 50,000 hours at 70% lumen output.

B. LED lamps shall be rated as follows, unless specified otherwise:

1. Interior luminaires:

a. CCT: 4100K nominal.
b. CRI: 80% minimum.

2. Exterior luminaires:

a. CCT: 4100K nominal.

b. CRI: 70% minimum.

2.8 FIXTURE SUPPORT COMPONENTS

A. Single-Stem Hangers: ½-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, ½-inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

C. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.

D. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

E. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

F. Independent Support Anchors: Anchors shall be on every fixture at the four (4) opposite corners. The contractor is required to independently support all recessed 1'x4', 2'x2', 2'x4', 4'x4', 2' diameter or larger fixture from all four corners. Circular fixtures smaller than 2' diameter, linear slot fixtures, etc. shall be support from at least two (2) opposite corners. Provide additional supports as recommended by the manufacturer.

G. Ceiling support steel for light fixtures: Support steel (unistrut) shall be installed to provide additional support for light fixtures from ceiling grid. Unistrut shall be installed above ceiling grid T-bars where the weight of the light fixtures require additional ceiling supports. Unistrut shall be supported independently from ceiling system.

2.9 FINISHES

A. Fixtures: Manufacturer's standard, unless otherwise indicated.

B. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.

C. Metallic Finish: Corrosion resistant.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

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

3.2 TEMPORARY LIGHTING

A. The use of permanent lighting shall not be used for temporary lighting, unless approved, in writing, by the Architect/Engineer.

3.3 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials.

B. Support for Fixtures in or on Grid-Type Suspended Ceilings. Fixtures shall be independently supported from building structure from all four corners of recessed fixtures including 2x4, 1x4, 2x2, 4x4, etc. and from opposite corners from recessed downlight and 1x1 fixtures to building steel. Wire shall be galvanized steel and rated for fixture, but not less than 14 gauge. Braided wire shall be acceptable.

1. Fixtures must be tied to structure so that failure of a single wire does NOT constitute failure of the independent support (i.e. at least two (2) wires must be tied to structure independently).

C. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.

D. Fixtures of Sizes Less Than Ceiling Grid: Arrange 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.

E. Suspended Fixture Support: As follows:

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. Chain Hung: Suspend with jack chain from structure.
4. Continuous Rows: Suspend from cable installed according to fixture manufacturer's written instructions and details on Drawings.
5. Do no support suspended fixtures from grid. Fixtures must be supported from building structure.

F. Light fixtures shall be installed over junction boxes so they can be removed at a later date to access the wiring in the junction box.

G. Undercabinet Lighting: When installing undercabinet lighting, take care to hide all wiring. If there is a valance under the cabinet, wiring may exit the wall below the cabinet, and be run tight to the backside of the valance. If there is no valance, wiring shall exit the wall within the cabinet at a lower corner, run along the edge of the bottom shelf to the front of the cabinet to feed the end of the undercabinet light fixture. All exposed wiring shall be MC cable, and be tightly trained using straps and mechanical fasteners.

H. Where digital or analog dimming devices are indicated to control light fixtures, the required low and/or line voltage wiring shall be provided to control the fixture. Any and all additional accessories required shall be provided in their entirety.

3.4 CONNECTIONS

A. Ground equipment.

B. Furnish and install code compliant fixture disconnecting devices.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Tests: As follows:

1. Verify normal operation of each fixture after installation.

a. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

C. Corrosive Fixtures: Replace during warranty period.

3.6 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities. Inform Architect/Engineer when aiming fixtures.

END OF SECTION 26 51 00

SECTION 27 15 00 – COMMUNICATIONS CABLING

PART 1 - GENERAL

1.1 DESCRIPTION

A. **Alternate Bid:** Under the applicable alternate, all communications cabling work shall be performed by Berks-Western Telecom, Inc. of Sinking Spring, PA. The contractor shall contact and contract with Coral Communications, inc.

B. Provide a complete, tested, cable distribution system for data network system (local area network). The data distribution system shall include fully terminated UTP station cables.

C. UTP Cables: UTP cables shall be routed to each data outlet location.

D. Provide specific details consistent with the contract documents as required to complete shop drawings for data cable systems including detailed documentation for Owner review and detailed documentation of as-built conditions.

1.2 APPLICABLE STANDARDS

A. TIA/EIA-569-A: "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. TIA/EIA-568.2-D: "Commercial Building Telecommunication Standard" with all addendums.

C. ISO/IEC 11801 Ed. 2.0 (Class E)

D. TIA/EIA-TSB 67: "TIA/EIA Telecommunications Systems Bulletin, Additional Transmission Specifications for Unshielded Twisted-Pair Cabling Systems."

E. IEEE 802.3: "Carrier Sense Multiple Access with Collision Detection."

F. IEEE 802.3ab: Gigabit transmission over UTP

G. TIA/EIA-606: "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."

H. TIA/EIA-607: "Commercial Building Grounding and Bonding Requirements for Telecommunications."

1.3 REGULATORY REQUIREMENTS

A. All work shall be performed in accordance with the latest revisions of the following standards and codes:

1. Uniform Construction Code (UCC)
2. National Electrical Code (NEC)
3. Standards as previously listed
4. The supplied manufacturers structured cabling system installation guidelines.

B. Governing Codes and Conflicts: If the requirements of this section or the Project Drawings exceed those of the governing codes and regulations, then the requirements of this section and the Drawings shall be construed to permit work not conforming to all governing codes and regulations.

1.4 SUBMITTALS

A. Documentation:

1. The name of the person who will act as the Contractor's official contact with the Owner/Engineer.
2. A copy of an RCDD certificate from a full-time staff member.
3. Complete manufacturer's product literature for all cable, patch panels, cable supports, cable labels, outlet devices, and other products to be used in the installation. Cabling and outlets must show compliance with the performance criteria specified herein. In addition, whenever substitutions for recommended products are made (pre-approved prior to bid by Owner/Engineer), samples and the manufacturer's supporting documentation demonstrating compatibility with other related products shall be included.
4. Shop Drawings:

    a. The Contractor shall submit scaled drawings of all IDF/MDF rooms with backboard layouts showing hardware frame placements and rack locations with wire management. The name/number of the room shall be included. The contractor must show dimensions for LAN network equipment.
    b. The Contractor shall submit individual rack layouts for Owner review indicating all hardware as well as Owner furnished network electronics and servers. Coordinate with Owner network electronic and server dimensions, etc.

5. Proposed TIA/EIA Category cable matching specified test result forms. Provide complete product information on proposed meter to be used and verification that meter is acceptable for use to provide warranty as specified.
6. Certifications: Contractor must be pre-certified by the manufacturers of the products that comprise a partnership guaranteeing 20-year performance. Submit copy of certifications and 20-year performance warranty. Contractor must show record of at least five (5) previous projects of this type with required warranties.
7. Warranty: Warranty must guarantee all performance values in accordance with proposed TIA/EIA Category cable matching specified. The warranty shall include application assurance beyond Gigabit Ethernet.
8. 3rd party certification of Channel and component compliance meet or exceeding the performance criteria herein.

B. Labeling:

1. The Contractor shall work with the Owner’s IT department to verify the labeling to be used throughout the building. Once the labeling has been determined, the Contractor shall submit the labeling scheme to the Engineer for review. The submittal shall include a sign-off by the Owner’s IT department.
2. Racks and cabinets shall be labeled with closet designation with self-adhesive labels.

C. Rack Layouts:

1. The Contractor shall work with the Owner’s IT department to verify the rack layouts to be used throughout the building. Once the layouts have been determined, the Contractor shall submit the layout drawings to the Engineer for review. The submittal shall include a sign-off by the Owner’s IT department.

D. When preparing submittals and any required final drawings/labeling, use a room number schedule generated by the architect and/or the Owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, revise the initial submittal, when a schedule is available, to reflect the proper room numbers.

1.5 FUNCTION AND OPERATION

A. The intended function of the data communications cable system is to transmit data signals from a central location to the individual data outlet locations. Upon completion of the work outlined in this specification, the system shall be capable of transmitting data signals at a rate of 1Gbps, and future applications.

B. Work station cable, from the MDF/IDF to the work area, shall be installed in accordance with TIA/EIA-568.2-D specified installation practices, TIA/EIA-TSB-67 recommended installation practices, TIA/EIA-569, and the manufacturer specified installation practices.

C. The Permanent Link shall be tested for TIA Category standards. Channel Manufacturer or Partners must submit 3rd party verification of category performance using “WORST CASE” 4 connector model. “Typical” or “Average” measurements will NOT be accepted.

1.6 PROJECT COMPLETION

A. As a condition for project acceptance, the Contractor shall submit the following for review and approval:

1. Inspection and Test Reports: During the course of the Project the Contractor shall maintain an adequate inspection system and shall perform such inspections to ensure that the materials supplied and the work performed conform to Contract requirements. The Contractor shall provide written documentation which indicates materials acceptance testing was conducted as outlined Part 3 below. The Contractor shall also provide documentation which indicates that all cable termination testing was completed and that all irregularities were corrected prior to job completion for Owner/Engineer analysis.
2. A manufacturer warranty shall be provided by the Communication Systems installer. This warranty shall include defects in material and workmanship. Warranty shall also cover applications assurance beyond 1000BaseT. The warranty period shall begin at the date of Substantial Completion. Quality and workmanship evaluation shall be solely by the Owner/Engineer and designated representatives.

B. Acceptable Cable Tester

1. Refer to part 3 for tester information.

1.7 SYSTEM INSTALLER

A. The Owner reserves the right to exercise its discretion to require the contractor to remove from the project any such employee of the contractor to be incompetent, careless, or insubordinate.

B. Where applicable, the installer must be licensed and bonded in the state.

C. Installer must have RCDD on staff as a full-time employee.

D. Prior to bid date, the installer must be certified by the manufacturer of the cabling components he intends to use.

E. All clean up activity related to work performed will be the responsibility of the Contractor and must be completed daily before leaving the facility.

1.8 ABBREVIATIONS AND DEFINITIONS

A. MDF/MCF – Main Distribution Frame/Main Cross-Connect Frame.

B. IDF/ICF – Intermediate Distribution Frame/Intermediate Cross-Connect Frame consisting of station wire terminals, riser cable terminals, and various equipment.

C. UTP – Unshielded Twisted Pair (telecommunications station cable).

1.9 MINIMUM WARRANTY

A. The Cabling System shall meet the performance requirements of the ANSI/TIA/EIA-568.2-D standard and TIA/EIA Telecommunications Systems Bulletin 67. The warranty on the material, services, and operation of the cabling system to this specification must be for a period of at least 20 years.

B. The warranty must include the following statements regarding the cabling system:

1. "will support and conform to TIA/EIA-568.2-D specifications covering ANY CURRENT OR FUTURE APPLICATION which supports transmission over a properly constructed horizontal cabling system premises network which meets the channel and/or basic link performance as described in TIA/EIA-568.2-D and TIA/EIA TSB67 for category cable systems."
2. "will be free from defects in material or faulty workmanship."

C. The warranty must be provided by the hardware manufacturer and must be fully executed prior to project closeout.

PART 2 - PRODUCTS

2.1 GENERAL WIRING

A. The cabling shall be installed per requirements of these specifications utilizing materials meeting all applicable TIA/EIA standards for Category cable specified.

B. Materials shall meet the TIA/EIA 568A category specification matching specified. Must supply 3rd party verification of this performance as specified herein. In some cases, specific materials are called out to maintain a uniformity of application across all installations.

C. All installed wire shall be tested and labeled 100% good after installation by the installer.

D. All cabling, outlets, and termination patch panels used for the Category cable specified data system may be provided by a single manufacturer and shall be certified as part of the 20-year minimum warranty. Where the installer chooses to use one (1) manufacturer for cabling and a different manufacturer for the outlets and termination patch panels, the two (2) manufacturers must prove to have compliant interconnecting hardware and shall be certified as part of the 20-year minimum warranty. The components manufacturer shall take responsibility for the end-to-end system performance certification.

E. All components, modules, adapters, and fittings required for a complete and first-class installation shall be provided whether or not enumerated herein. Model numbers given are meant to set a standard for performance criteria and general style of device. It is the contractor’s responsibility to verify the completeness and proper fit of devices including depth and necessary cable bend radius within raceways, and compatibility of outlets in surface raceway or floor boxes before installation.

F. All device colors shall be as per the TIA/EIA Standards and as approved by the Owner and/or Engineer before installation.

G. All products shall be new, and brought to the job site in original manufacturer's packaging. Electrical components (including innerduct) shall bear the Underwriter's Laboratories label. All communications cable shall bear flammability testing ratings as follows:

1. For Copper Cable

a. CM: Communications Cable
b. CMP: Plenum Rated Communications Cable
c. CMR: Riser-rated Communications Cable

H. Initial Cable Inspection: The Contractor shall inspect all cable prior to installation to verify that it is identified properly on the reel identification label, that it is of proper gauge, containing the correct number of pairs, etc. Note any buckling of the jacket which would indicate possible problems. Damaged cable, or any other components failing to meet specifications shall not be used in the installation.

2.2 CATEGORY 6A HORIZONTAL CABLING

A. Manufacturers - ISO 9001 Certified – must be compliant with Category 6A.

1. Leviton
2. Belden
3. Belden Mohawk
4. Berk-Tek
5. Prysmian General Cable
6. CommScope Systimax
7. Hubbell Nextspeed
8. Superior Essex

B. Description: Unshielded twisted pair cable, Category 6A, CMP listed, for use with IEEE Std. 802.3 network, and TIA/EIA-568 compliant using 4 pairs, 23 AWG solid copper conductors all 4 pairs FEP insulated, colored plenum rated jacket, meeting or exceeding the category 6A requirements, tested to at least 500MHz. Provide color jacket as directed by the Owner, different colors for different systems. Verify with Owner colors prior to ordering.

C. All 4-pair station cables shall:

1. Conform to TIA/EIA-568.2-D.
2. Be part of the UL LAN Certification and Follow-up Program.
3. Tested and approved by ETL or similar independent testing facility.

D. The copper cabling provided for each data outlet shall be one 4-pair UTP Category 6A cable per jack. For example, where multiple jacks are indicated at a single location, each jack shall have its own dedicated 4-pair UTP cable.

E. The Category 6A 4-pair UTP cable, must be UL Performance Level Tested and 3rd party verified that the cable meets or exceeds these specifications.

2.3 CATEGORY 6A STATION HARDWARE (Outlets)

A. Manufacturers - ISO 9001 Certified - must be compliant with Category 6A.

1. Hubbell
2. No other manufacturer will be acceptable.

B. Data Outlets - Category 6A modular jack with single gang 4-port angled faceplate for “gravity-feed” outlets at wall mounted locations. Provide quantity of data outlets at the locations as indicated on the drawings. Provide blank inserts for unused openings in faceplate. Flush type outlets shall be provided at floor boxes.

C. Data Outlets - Category 6A modular jack with single gang 4-port faceplate for outlets as specified for category 6 locations.

D. Jacks shall be high quality Category 6A 8-position modular jack with mechanical stress relief for cable. Jacks shall provide dual color code to allow both T568A and T568B wiring on the same jack. Jacks shall be terminated using TIA/EIA-568.2-D requirements for Category 6A connecting hardware.

E. Faceplates shall match manufacturer style for modular jack outlets at all locations. Color and material (nylon or stainless steel) shall match wiring devices in the area being installed. Faceplates shall accommodate color-coded icons for different applications and a separate location for labeling.

F. All terminating hardware for 4-pair Category 6A cabling shall:

1. Conform to TIA/EIA-568.2-D - Commercial Building Telecommunications Cabling Standard, Horizontal Cable Section.
2. Be part of the UL LAN Certification and Follow-up Program.
3. Meet or exceed the specifications for Category 6A Channel.

G. Additional electrical and mechanical specifications are:

1. Insulation resistance: 500 MW minimum.
2. Dielectric withstand voltage: 1,000 VAC RMS, 60 Hz minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.
3. Contact resistance: 20 mW maximum.
4. Current rating: 1.5 A at 68 deg F (20 deg C) per IEC Publication 512-3.

2.4 CATEGORY 6A CHANNEL – PERFORMANCE REQUIREMENTS

A. The Channel performance levels shall not be less than the minimum values shown in the following table.

Frequency MHz	Pair-To-PairNEXT Loss(dB)	Pair-To-PairELFEXT Loss(dB)	Power SumNEXT Loss(dB)	Power SumELFEXT Loss(dB)
1	74.3	67.8	72.3	64.8
10	59.3	47.8	57.3	44.8
31.25	51.9	37.9	49.9	34.9
100	44.3	27.8	42.3	24.8
200	39.8	21.8	37.8	18.8
250	38.3	19.8	36.3	16.8

B. The Channel performance levels shall not be less than the minimum values shown in the following table.

Frequency MHz	Attenuation (dB)	Pair-To-PairACR(dB)	Power SumACR(dB)	Return Loss(dB)
1	2.1	72.2	70.2	20.0
10	5.9	53.4	51.4	25.0
31.25	10.5	44.0	39.4	23.6
100	19.1	25.2	23.2	20.1
200	27.6	12.2	10.2	18.0
250	31.1	7.3	5.3	17.3

C. The channel performance shall be based on a 4 connector, worst pair, independently tested solution.

2.5 PATCH CORD ASSEMBLIES

A. Copper patch cord assemblies must meet the requirements of the Category cable specified performance criteria, and shall be factory-manufactured in 3-foot, 5-foot, 7-foot, 10-foot, 15-foot, and 25-foot lengths. The cables shall be manufactured by the selected connectivity manufacturer.

B. Contractor shall provide patch cords ONLY for components installed by the Contractor. All other patch cords will be provided by the Owner.

2.6 PATCH PANELS - Copper Cables

A. Manufacturer - ISO 9001 Certified - shall match the manufacturer of the data outlets.

B. Provide patch panels separated by system (do not mix different systems on the same patch panel), unless directed otherwise by the Owner.

C. All patch panels shall be of the channel manufacturer or partner. Keystone style, unloaded patch panels shall be provided at the MDF/IDF locations. Provide 48 port panels, 2-rack unit high (single rack unit high density shall not be acceptable) in quantities required for the number of data outlets. Load panels with keystone style jacks matching the station hardware. Provide a minimum of 25% spare ports in each closet (including spare keystone jacks). Existing unloaded patch panels may not be used. Provide jacks matching the wire color.

1. **Only 48 port patch panels shall be provided as part of this project. 24 port, or fewer patch panels shall not be acceptable.**

2.7 EQUIPMENT RACKS

A. Existing equipment racks, wire management, etc. shall be reused.

2.8 VOICE OUTLETS

A. Voice Outlet - Same as data outlets.

B. Wall Mount Type – Provide jack without plate for connection to phone. System warranty MUST be maintained.

2.9 LABELING REQUIREMENTS

A. Refer to Division 26 “Electrical Identification” for additional labeling requirements.

B. Cable Ties:

1. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

a. Minimum Width: 3/16 inch.
b. Tensile Strength at 73 deg F according to ASTM D638: 7000 psi.
c. UL 94 Flame Rating: 94V-0.
d. Temperature Range: Minus 50 to plus 284 deg F.
e. Color: Black.

C. Provide manufacturer jack labeling inserts, etc. at patch panels and jacks.

D. All data devices, installed by the contractor, including, but not limited to CCTV cameras, WAPs, IP speakers, etc., shall be provided with labels match jack label. Verify location of label with owner prior to adhering.

E. All labeling must be typewritten or engraved.

2.10 NETWORK ELECTRONICS

A. Network Electronics will be furnished and installed by Owner, unless noted otherwise.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall provide minimum 1” conduit sleeves or as indicated on the drawings above ceilings between corridors and areas where data outlets are located, and elsewhere where required to install data cabling, avoiding penetration of fire rated walls.

B. Any penetration through fire rated walls (including those in sleeves) will be resealed with an Underwriter Laboratories (UL) approved sealant. Use fire stop material as specified in Division 26 “Common Requirements – Electrical.” Contractor shall also seal all floor, ceiling, and wall penetrations in fire or smoke barriers and in the wiring closets.

C. Cable Lubricants: Lubricants specifically designed for installing communications cable may be used to reduce pulling tension as necessary when pulling cable into conduit. After installation, exposed cable and other surfaces must be cleaned free of lubricant residue.

D. Recommended Products:

1. Twisted-pair cable: Dyna-Blue, American Polywater

E. The Contractor shall replace or rework cables showing evidence of improper handling including stretches, kinks, short radius bends, over tightened bindings, loosely twisted and over twisted pairs at terminals, and sheath removed too far (over 2").

F. All low voltage cabling, run in walls, shall be installed in minimum 1” rigid conduit. Back boxes must be full 3.5” deep backboxes (low voltage rings shall not be acceptable). Refer to applicable Division 26 sections for additional requirements.

G. J-Hooks:

1. J-hooks shall be galvanized, comply with TIA-569-D, and be listed for the use.
2. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
3. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
4. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
5. Space hooks no more than 5 feet (1.5 m) o.c.
6. Provide a hook at each change in direction.

3.2 LABELS

A. The labeling plan shall be developed by the Contractor and approved by Owner/Engineer. The Contractor will label all outlets following the detailed shop drawing design, using permanent/legible typed or machine engraved labels. Terminals in the data closets shall be labeled by the Contractor using designation strips as applicable to terminal hardware. All copper terminal for riser cables in the data closets shall correspond to terminal numbering in the MDF. All voice outlets will be installed together on a patch panel at the top of the racks.

B. The labels on IDF station terminals shall be labeled in accordance with TIA/EIA standards. Outlets shall be labeled to match the labels on the corresponding terminal position. The room number component shall reflect the final room numbering system utilized for door labels or room numbers when the Owner occupies the building. **Should the actual final room numbers not be used, the contract will be required to re-label all jacks and wiring, and retest the entire system.**

C. A floor plan clearly labeled with all outlet jack numbers shall be included in the as-built plans. Plans shall be the size of the construction documents.

1. An additional copy of the floor plans, laminated, shall be posted in each data room. Plans shall be the size of the construction documents.

D. All labels shall correspond to as-built and to final test reports.

E. The cables themselves shall also be labeled at each end of the cable matching the labeling method.

F. Where jacks are installed above the accessible ceiling, labels shall be applied to the T-Bar. The label shall match the jack label.

G. All devices, installed by the contractor, including, but not limited to wireless access points, IP speakers, etc. shall receive a label with the jack information. Verify with owner, location of label (exposed, or behind device).

H. Racks and cabinets shall be labeled with closet designation with self-adhesive labels.

I. Where jacks are installed above ceilings, labels shall be provided on T-bar of ceiling to identify location of jack. Label shall match jack label.

3.3 WIRING INSTALLATION

A. All copper horizontal data cables shall be installed by individuals trained and certified in data cable system installation.

B. All Category (4) pair UTP cable must be handled with care during installation so as not to change performance specifications. The Contractor shall not over tighten fasteners or over bend the Category UTP cable. Creased or kinked cables will not be accepted and will be replaced. Tie wraps are NOT permitted to organize or bundle cables. Contractor must use velcro wraps to bundle cables. Velcro wraps shall be UL rated for installation above plenum ceilings.

C. **Should the Engineer/Owner find tie wraps on cables, the contractor shall be responsible to remove the tie wraps and all cables housed within the tie wraps will be assumed to be damaged and will require replacement.**

D. All wiring and associated hardware shall be placed so as to make efficient use of available space in coordination with other uses. All wiring and associated hardware shall be placed so as to not impair the use or capacity of other building systems, equipment, or hardware placed by others (or existing).

E. All cabling installed in ceiling areas must be supported or installed in cable tray. Cable tray will be provided by this Contractor as indicated on the drawings. Where cabling is installed in ceiling areas or other non-exposed areas without cable tray, supports shall be placed by the Contractor at random intervals no greater than 60 inches and preferably on 48-inch centers. Cable sag between supports shall not exceed 12 inches. Attaching wire to pipes or other mechanical items is not permitted. At all runs of twenty or more cables, provide J-hooks at 60-inch (maximum) centers to hang cable.

1. Where cables are installed in exposed areas (exposed structure, etc.) they shall be installed in conduit. Conduit shall be sized for 40% fill, but shall be no smaller than 1”. **Should any cable be installed exposed, the cable will be required to be replaced and retested at no additional cost to the Owner.**

F. All low voltage cable shall be routed to avoid light fixtures (18 inches minimum spacing), sources of heat (12 inches minimum spacing) power feeder conduits (12 inches minimum spacing). Low voltage cabling must be spaced a minimum 120 inches (10 feet) from bus duct.

G. Use Brandy type labels on cable ends in the data racks and in the outlet boxes.

H. An additional minimum ten (10) foot of slack shall be provided at both ends of all cables. The slack shall be wrapped in Velcro straps supported from the steel, walls or cable tray. The cables shall not touch the ceiling.

3.4 STATION HARDWARE

A. Eight (8) position modular jack Pin Assignments:

1. Pin connections for data station 8 position modular jacks and patch panels shall match TIA/EIA-568.2-D.
2. Pin connections at data jacks and panels shall be TIA 568A or 568B as directed by the Owner.

3.5 BACKBOARD CABLING/EQUIPMENT RACK CONFIGURATION

A. All cabling shall be routed so as to avoid interference with any other service or system, operation, or maintenance purposes such as access boxes, ventilation mixing boxes, network equipment mounting,

access hatches to air filters, switches or electrical panels, and lighting fixtures. Avoid crossing areas horizontally just above or below any riser conduit. Lay and dress cables to allow other cables to enter the conduit/riser without difficulty at a later time by maintaining a working distance from these openings. Provide a minimum of 36 inches for a service loop to the patch panel.

B. Cable shall be routed as close as possible to the ceiling, floor, or corners to ensure that adequate wall or backboard space is available for current and future equipment and for cable terminations. Cables shall not be tie-wrapped to existing electrical conduit or other equipment. Minimum bend radius shall be observed.

C. Lay cables via the shortest route directly to the nearest edge of the backboard from the mounted equipment or block. Lace or tie-clamp all similarly routed cables together, and attach by means of clamps screwed to the outside edge(s) of the backboard vertically and/or horizontally, then route via "square" corners over a path that will offer minimum obstruction to future installations of equipment, backboards, or other cables.

D. Do not over tighten cable ties or binding on data station cable. Observe data cabling bend radius, and IEEE and NEC conduit fill ratios (40%).

E. Use cable tray or runway to support cables from walls to rack or crossing the data closets.

3.6 CABLE TESTING

A. This contractor shall submit to the Owner/Engineer the proposed testing procedure and testing report form. The test report shall include the test equipment operator’s name, date, time, test equipment manufacturer’s name, model number, and software version.

B. The Owner/Engineer shall be notified one week prior to any testing so that the testing may be witnessed.

C. Before requesting a final inspection, the Contractor shall perform a series of end-to-end installation performance tests. The Contractor shall submit for approval a proposal describing the industry standard test procedures, test result forms, and timetable for all copper plant wiring.

D. Acceptance of the sample test procedures discussed below is predicated on the Contractor's use of the recommended products (including but not limited to twisted pair cable, patch panels, and outlet devices specified in the Products paragraph) and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation will be evaluated in the context of each of these factors.

E. Test Criteria: The system shall be tested to Category Level III compliance matching specified cable. The test path shall include workstation jacks, station cables, patch panels, and adapter cables. Test shall be performed with a MicroTest Omniscanner, Fluke, or equivalent product. Tester must have minimum dynamic range of 87dB and scan to at least 400MHz.

F. The Contractor shall test:

1. All station drop cable pairs from termination patch panels to outlet device 8 position modular jacks.

G. Each wire/pair shall be tested at both ends for the following up to 400MHz in accordance to Category cable specified:

1. Termination order
2. Polarity (pair reversals)
3. Continuity
4. Shorts
5. Grounds
6. Power-Sum NEXT (near end cross talk) from both directions

7. Cable length (record all length)
8. Attenuation
9. Power-Sum Return Loss
10. Power-Sum ELFEXT from both directions
11. Impedance

H. When errors are found, the source of each error shall be determined, corrected, and the cable re-tested. All defective components shall be replaced and retested. Defective components not corrected shall be reported to the Owner/Engineer with explanations of the corrective actions attempted.

I. Test records shall be maintained using the test results forms outlined below. The form shall record closet number, riser pair number or outlet ID, outcome of test, indication of errors found (e.g., a, b, c, d, or e) cable length, re-test results after problem resolution and signature of the technician completing the tests.

J. Test results for each (4) pair UTP cable must be submitted with identification to match labels on all patch panel ports and 8 position modular jacks, and identification to match as-builts associated with that cable.

K. Owner will observe and verify the accuracy of test results submitted, and reserves the right to randomly check any connection prior to acceptance.

L. The results of the work station cable tests shall be provided in the form of print-outs from the test equipment and USB disk with PDFs.

3.7 DOCUMENTATION

A. Contractor shall provide documentation to include test results and as-built drawings.

B. As-built drawing showing data outlets (with labels) of area served by each data closet shall be laminated and attached a wall in each respective data closet. Coordinate location in field with Engineer and Owner.

3.8 ACCEPTANCE

A. Acceptance of the Data Network System shall be based on the results of testing, functionality, and the receipt of documentation. With regard to testing all copper cables must meet the criteria established above. With regard to functionality, Contractor must demonstrate to Owner that 1000BaseT data signals can be successfully transmitted, bi-directionally, from the MDF to and from some number of individual data outlets by using OmniScanner testing IEEE 802.3ab for 1000BaseT. The number of outlet locations to be tested shall be determined by Owner/Engineer. With regard to documentation, all required documentation shall be submitted to Owner/Engineer.

END OF SECTION 27 15 00

SECTION 27 51 31 – EMERGENCY RESPONDER RADIO SIGNAL SURVEY

PART 1 - GENERAL

1.1 SUMMARY

A. Provide a site survey for bi-directional emergency responder radio signals to determine radio coverage throughout the building. The installation of an amplification system shall not be included as part of this project.

B. The site survey shall comply with the requirements the locally adopted versions of:

1. NFPA 72.
2. NFPA 1221.
3. IBC (International building Code).
4. IFC (International Fire Code).

C. The site survey shall meet with the approval of the Fire Department, the Building Department and all other agencies and authorities having jurisdiction (AHJ).

D. The work in this section shall include the responsibility for all filings with the AHJ. Where filings require engineer's review, documents shall be submitted for his review. This responsibility shall include furnishing of required quantities of floor plans, descriptive notes and/or specifications, wiring diagrams, shop drawings and amendment forms.

E. Early completion of the site survey will be required as to permit the installation of a bi-direction emergency responder radio amplification system prior to acquiring a Certificate of Occupancy.

F. Any specialty permits (general work permits covered elsewhere in these specifications) necessary for the installation of the work shall be obtained prior to the commencement of the work. All permit costs and inspection fees shall be included as the part of the required work.

1.2 DESIGN REQUIREMENTS

A. It is critical that the site survey be tested, and documentation be provided as early as practical, but after the building is fully enclosed, to allow a system be designed and installed, if needed, prior to building occupancy. Refer to Part 3 for additional information on site survey test requirements.

B. The site survey shall be performed by a qualified and approved vendor. Contact the AHJ to ensure the Vendor is acceptable to the AHJ to perform the test.

C. The site survey shall be conducted, documented, and signed by a person in possession of an FCC General Radio Telephone Operators License. Personnel qualifications must be acceptable to the AHJ.

D. An overall pass/fail indication shall be provided for areas, and shall meeting the following:

1. Critical areas, as identified in part 3, must have 100% coverage.
2. General building areas shall have 95% radio coverage, or as specified by the AHJ.
3. The following signal strengths are required to pass the tests:

a. Downlink - Minimum signal strength of -95 dBm throughout the coverage area.
b. Uplink - Minimum signal strength of -95 dBm received at the AHJ Radio System.

1.3 SUBMITTALS

A. Qualification Requirements:

1. Provide a copy of a valid FCC issued general radio operators license of a full-time employee
2. Provide a certification of in-building system training issued by a nationally recognized organization, school or a certificate issued by the manufacturer of the equipment being submitted.

B. Additional Submittal Requirements:

1. Once the survey is complete, provide drawings, at original scale, and other documents showing all survey points and test points, including their tested values.

C. When preparing submittals and any required final programming, use a room number schedule generated by the architect and/or the owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, revise the initial submittal, when a schedule is available, to reflect the proper room numbers.

1.4 QUALIFICATIONS

A. Vendor: The vendor must have a minimum of five years' experience in the testing, design and installation of systems equal in size and type required by this project.

1.5 REGULATORY REQUIREMENTS

A. National Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction, and that portion of the NEC which pertains to installation and construction of specified products.

B. FCC Compliance: Comply with U.S. Federal Communication Class B standard for allowable radiation from equipment and wiring.

C. National Fire Protection Association Compliance: Comply with applicable NFPA sections, including, but not limited to 72 and 1221.

D. International Fire Code Compliance: Comply with applicable IFC sections, including, but not limited to 510.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to any testing, a meeting shall be held between the Contractor, Vendor, Owner’s Representative, Fire Department, and Authority Having Jurisdiction to confirm the requirements of the tests. This meeting shall be help early in the construction process to ensure all system tests and installation, should a system be

required, can be accomplished within the timeline of the project, and not delay acquiring the Building Occupancy Permit.

B. Examine areas and conditions under which the site survey is to be performed. Do not proceed with site survey until the building is complete enough to the satisfaction to the testing agency.

3.2 SITE SURVEY AND TEST PROCEDURES

A. Tests must be performed before design.

B. The coverage testing shall be done in accordance with NFPA 72, National Fire Alarm and Signaling Code, NFPA 1221 and as required by the local AHJ. The following shall be considered a minimum:

1. Each floor of the building shall be divided into a grid of at least 20 equal test areas. Additional test areas shall be provided so that no test area exceeds 3,000 square feet.
2. The test shall be conducted using a calibrated portable radio capable of communicating on the same band as is used by the emergency response agency. Coordinate requirements with the fire department and local AHJ.
3. Failure of not more than two (2) nonadjacent test areas shall not result in failure of the test.
4. In the event that three of the test areas fail the test, the floor shall be divided into at least 40 equal test areas, or a maximum of 1,500 square feet. Failure of not more than four (4) non-adjacent test areas shall not result in failure of the test. If the system fails this test the system shall be altered to meet the 95-percent coverage requirement.
5. A test location approximately in the center of each test area shall be selected for the test, with the radio enabled to verify two-way communications to and from the outside of the building through the public agency’s radio communications system. Once the test location has been selected, that location shall represent the entire test area. Failure in the selected test location shall be considered failure of that test area. Additional test locations shall not be permitted.
6. Provide additional tests as required by applicable local codes and standards.

C. All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radio Operator License.

D. All test records must be submitted as early as possible, within two (2) weeks of the tests being performed, to allow the Owner to design and install an amplification system prior to occupancy if necessary.

END OF SECTION 27 51 31

SECTION 27 53 13 – WIRELESS CLOCK SYSTEM

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Furnish and install a complete new wireless clock system.

B. Provide training as listed in part 3.

1.2 SUMMARY

A. This Section addresses the needs and requirements of the wireless clock system. It includes requirements for the wireless clock system components including, but not limited to, the following:

1. Wireless Transceiver.
2. Wireless Repeater.
3. Secondary Analog Clock.
4. Master Clock and Network Synchronization Module.

1.3 SYSTEM DESCRIPTION

A. General: Furnish and install all equipment, accessories, and materials in accordance with these specifications and drawings to provide a complete and operating wireless clock system.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract:

1. Sections:

a. Submit equipment prints, full electronic wiring diagrams and specifications sheets for each item specified herein. Specification sheets shall be submitted on all items.
b. Shop drawings detailing wireless clock.
c. Wiring diagrams, detailing wiring for power, signal, and control.
d. Submit wiring diagrams showing typical connections for all equipment.
e. Submit a certificate of completion of installation and service training.

1.5 QUALITY ASSURANCE

A. All items of equipment 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.

B. 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 three (3) years. The contractor shall utilize a duly authorized distributor of the equipment supplied for this project location with full manufacturer’s warranty privileges.

C. The contractor shall show satisfactory evidence, upon request, that the supplier maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The supplier shall maintain at his facility the necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being supplied.

D. Electrical Component Standard: Provide work complying with applicable requirements of NFPA 70 “National Electrical Code.”

E. Installation and startup of all systems shall be under the direct supervision of a local agency regularly engaged in installation, repair, and maintenance of such systems. The supplier shall be accredited by the proposed equipment manufacturers.

F. The agency providing equipment shall be responsible for providing all specified equipment and mentioned services for all equipment as specified herein. The agency must be a local authorized distributor of all specified equipment for single source of responsibility and shall provide documents proving such. The agency must provide written proof that the agency is adequately staffed with factory-trained technicians for all of the specified equipment. The agency must have established business for and currently be providing all services for the equipment.

G. The contractor shall, at the owner’s request, make available a service contract offering continuing factory authorized service of the system after the initial warranty period.

H. The supplier shall visit the sites and familiarize himself with the existing conditions and field requirements prior to submitting a proposal.

I. The contractor is responsible for all cost associated with proper installation, termination, configuration, programming, impedance and load matching of all system components.

J. The contractor shall provide all necessary masonry, covering, patching, and painting work in order to render any residue of the existing central equipment invisible. All finished surfaces shall be chosen in consultation with the Owner, to assure that the Owner’s aesthetic preferences have been adhered to.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in factory boxes. Store in clean, dry space in original boxes. Protect products from fumes and construction traffic. Handle carefully to avoid damage.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:

1. Sapling, Inc. (Basis of Design).

B. The intent of this specification is to establish a standard of quality, function and features. It is the responsibility of the bidder to ensure that the proposed product meets or exceeds every standard set forth in these specifications.

C. The contractor shall be responsible for providing a complete functional system including all necessary components whether included in this specification or not.

2.2 SYSTEM REQUIREMENTS

A. Wireless clock system with interface capability to GPS, network, internet and existing systems such as: 58-minute, 59-minute, National Time & Rauland sync-wire, once a day reset, 2-wire digital communication and RS485 communication.

2.3 SYSTEM

A. The system can work as a standalone system or in conjunction with an existing wired system and the system shall have interface capability to GPS, network, Internet and existing systems such as: 58-minute, 59-minute, National Time & Rauland sync-wire, once a day reset, 2-wire digital communication and RS485 communication.

B. The system shall be capable of working in 915-928 MHz or 2.4 GHz frequency-hopping technology. The system shall be capable of automatic transmission of data along 51 alternating frequencies that allows for an enhanced signal, even if there is interference in one of the frequencies.

1. System shall be supplied at 900 MHz, unless coordinated otherwise with the owner to match other clocks in the district.

C. Each clock in the system shall be capable of receiving and transmitting the wireless signal which allows it to be used as a repeater while boosting the data stream and sending along the system. With this dual capability there shall be no limit on the number of clocks that can be used in the installation. The clock shall be designed to automatically work together without interference with each other. The system shall be capable of increasing the quality of the signal while increasing the quantity of the clocks.

1. The use of satellite transmitters required to extend the range of the main transmitter shall be acceptable. These satellite transmitters, and all required interface equipment, including, but not limited to, wireless receiver switches, receptacles wired to nearest receptacle circuit with (2) #12 with (1) #12 ground in ¾" conduit, power packs, etc. shall be included with the system, and not be an additional charge to the owner.

D. The analog clocks shall be capable of working in the following manner

1. 110 volts AC; the clock receives and transmits time every one (1) minute.

E. The analog clock shall include automatic digital calibration for time base to minimize deviation from each other.

F. The analog clock shall have a built-in close-loop system that will allow the clock to detect the position of the hands and bring the clock to the right time even if the clock were manually or forcefully altered.

G. The analog clock shall have the capability for diagnostic function that will allow the user to view the quality of the signal, how long since the last time the clock received a signal, as well as functional tests of the electronics and the gears.

H. The system shall operate in a license-free frequency range where no license is required.

2.4 FCC APPROVAL

A. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a commercial installation. This equipment generates uses and can radiate radio frequency

energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

1. Reorient or relocate the receiving antenna.
2. Increase the separation between the equipment and receiver.
3. Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
4. Consult the dealer or an experienced radio/TV technician.

2.5 PRODUCT

A. Transmitter/Transceiver

1. The Master Clock shall be the Sapling SMA 3000 Series. The master clock shall have an LED display, as well as a backlit, two row by twenty-character LCD display. It shall also have a 16-button rubber tactile keypad next to the displays that shall allow a user to program the master clock. The master clock shall have up to ten pre-programmed NTP servers which will be accessible for modification over a network interface. The master clock will be capable of receiving signals from existing master clocks via RS485, 59-minute correction, 58-minute correction, National Time and Rauland transmission protocol, or Dukane transmission protocol. The master clock (when a wireless transmitter is attached) shall be capable of translating a wired synchronization signal into Sapling's wireless signal, and then broadcasting the wireless signal to Sapling SAL(G) and SBL(G) secondary clocks. The master clock shall contain two clock circuits that have the capability to run synchronous wire systems such as 59-minute correction, 58-minute correction, National Time/Rauland or a once-a-day pulse for intercom systems. The master clock shall be capable of interfacing with the SAM Series analog clock via the Converter Box. It shall also be capable of interfacing with the SRM Series analog clock and any of Sapling's 3200 or 3300 series digital clocks via RS485 communication protocol. The master clock shall be powered by 115VAC/60 Hz or 230VAC/50 Hz. The master clock will be capable of acting as a repeater for another master clock. The master clock shall contain the necessary circuitry and programs so that a typical web browser, like Internet Explorer, can access the clock over a local area network. When accessed this way, the clock settings can be modified through a graphic user interface. The interface shall allow the user to program all of the display features for secondary clocks, the IP settings of the master clock, and any system setting that the master clock has.
2. Provide wall mount and install in data closet.
3. Provide with transmitter to be used with wireless clocks.
4. Provide with (S)NTP Server option.
5. Provide with four (4) auxiliary zones.

B. Repeater

1. The repeater shall be a Sapling Wireless Repeater. It shall receive and transmit wireless data using Sapling's proprietary wireless protocol. The repeater shall receive and transmit data on a frequency of either 915-928MHz, or 2.4GHz, depending on the hardware that was ordered. This will allow it to communicate with wireless SAL(G) Analog and SBL(G) Digital clocks operating on the same frequency range using frequency-hopping technology. The repeater shall have a maximum antenna size of seven (7) inches, an RF input sensitivity of –103dbm, a power output of 27 dBm, and shall be FCC approved. The voltage input for the repeater shall be 115V/60Hz or 230V/50Hz.
2. Provide repeaters as necessary to accommodate building. Locate in storage and janitor closets.

C. Analog Clock

1. The secondary clock shall be a Sapling SAL(G) Series wireless clock. It shall be an analog clock with a black hour hand, a black minute hand, and a red second hand. The clock will be capable of receiving and then re-transmitting a signal from any other Sapling device that transmits data using Sapling's wireless protocol. The clock shall use frequency-hopping technology to receive time data on a frequency range of either 915–928 MHz or 2.4GHz, depending on the type of transmitter that was ordered. The clock shall also be able to retransmit time data on the same frequencies: either 915-928MHz or 2.4GHz, depending on the type of transmitter that was ordered. The frequency-hopping technology shall allow the clock to transmit time data without causing interference to other wireless devices that may be transmitting at the same time. The clock shall be designed to be used with the Sapling SMA Series Master Clock (with the transmitter option installed) or the Sapling Repeater. Time data shall be transmitted and received by the clock via Sapling's wireless communication protocol. The clock shall also be designed to receive and retransmit time data to Sapling's SBL(G) Series clocks and other SAL(G) Series clocks. Upon receipt of the wireless signal, the clock will immediately self–correct. The clock's transmitter shall be able to successfully transmit data over a line-of-sight, unobstructed distance of up to 1320 feet (402 meters). The clock shall include an executable method for automatic hand calibration, as well as a diagnostic function that allows the user to view the quality of the signal, the last time the clock received a correction signal, the performance and results of a gearbox test, and a comprehensive analysis of the entire clock movement. These diagnostic functions shall be enabled by pressing a button on the clock movement. The clock shall require fewer than five (5) minutes to perform a correction of the hand positions. The battery-powered model of the clock shall be capable of receiving a signal every two (2) or four (4) hours. The 24V, 115VAC or 230VAC models of the clock shall be capable of receiving a signal every minute. The clock shall have a smooth surface ABS case which can be attached either directly to the wall, or to a standard-sized gang box. The round versions of the case shall be designed such that they will fit within Sapling's wood or aluminum round clock housings. The clock case shall be produced in round cases with diameters of 9, 12, or 16 inches, or square cases with widths of 9 or 12 inches. The dial is to be made of durable polystyrene material. The crystal is to be made of shatterproof, side molded polycarbonate. The clock shall be FCC compliant, in accordance with part 15 Section 15,247.
2. Project shall be supplied with round, 120V black clocks.
    a. Provide 9" dial size in private offices and small conference rooms.
    b. Provide 12" dial size in all other locations.
3. Clocks shall be supplied with mounting brackets to be installed where indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the wireless clock system.

B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Install system in accordance with applicable codes. Install equipment in accordance with manufacturer's written instructions.

B. Wiring Methods:

1. Conceal wiring except in unfinished spaces.
2. All new wiring on this project must be properly rated for the application. All low voltage wiring in ceiling cavity shall be plenum rated, or in conduit.
3. Cable to the new devices at new locations shall be installed in a neat and workmanlike manner, following the standard procedures used in the electrical contracting trade.
4. Exposed wiring will not be permitted under any circumstances on this project.
5. Upon installation completion, a room-by-room test shall be conducted for every device in the system. A technician shall perform the test, and repairs shall be performed as needed at no cost to the Owner to any devices, which do not function correctly, including cable. A written room-by-room report following testing and repairs shall be prepared and submitted to the Engineer.

C. Provide necessary receptacle and connection to 120-volt clocks and repeaters from nearest unswitched receptacle.

3.3 FIELD QUALITY CONTROL

A. Contractor Field Service:

1. Provide services of a service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.

B. Inspection:

1. Make observations to verify that units and controls are properly labeled.

C. Testing:

1. Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at the Contractor's expense. Verify by the system test that the total system meets the specifications and complies with applicable standards.

3.4 TRAINING

A. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. Operators Manuals and Users Guides shall be provided at the time of this training.

B. Schedule training with Owner through the Architect, with at least seven (7) days advance notice.

3.5 CLEANING AND PROTECTION

A. Prior to final acceptance, clean system components and protect from damage and deterioration.

END OF SECTION 27 53 13

SECTION 28 31 00 – INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.1 SYSTEM OVERVIEW

A. Main Office Building: Provide modifications and expansion to the existing system.

B. Reading Crest Ave Facility: Provide a new intrusion detection system meeting the requirements as specified herein and indicated on the drawings. The system shall integrate into the existing IU multi-building system.

C. This Section includes intrusion detection sensors, signal equipment, system controls, alarm displays, and alarm indicating devices.

D. The system shall be interconnected with the districtwide DMP security monitoring system. Coordinate with the Owner's Vendor to ensure integration is complete. Provide any and all necessary programming of the head end and control panel as part of the bid.

1. The Owner Vendor is Yarnell Pye-Barker of Ephrata, PA.

1.2 DEFINITIONS

A. Zone: A space or area for which an intrusion must be detected and uniquely identified, the sensor or group of sensors assigned to perform the detection, and any interface equipment between the sensors and the communication link to central-control unit. May use multiplex cable on this system.

B. LCD: Liquid-crystal display.

C. LED: Light-emitting diode.

D. PIR: Passive infrared.

1.3 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Ensure all programming is provided as required so that all new and existing doors are fully integrated into the existing system, and function as the rest of the IU building in their system.

B. Description: Hard-wired or multiplexed, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

C. Supervision: System components shall be continuously monitored for normal, alarm, supervisory, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.

3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

D. System Control: Master control unit shall directly monitor intrusion detection devices, perimeter detection units when applicable, control units associated with perimeter detection units when applicable, and connecting wiring.

E. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

F. Operator Commands:

1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
5. Protected Zone Test: Initiate operational test of a specific protected zone.
6. System Test: Initiate system-wide operational test.
7. Print reports.

G. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.

H. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

I. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

1.4 SUBMITTALS

A. Product Data: Include components and testing agency listing data.

B. Shop Drawings: Include system wiring diagram. Show connections for all devices, components, and auxiliary equipment. Differentiate between manufacturer-installed and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified.

C. System Operation Description: Include method of operation and supervision of each component and each type of circuit, and sequence of operations for manually and automatically initiated system inputs. Description must cover this specific project; manufacturer's standard descriptions for generic systems are not acceptable.

D. Product Certificates: Signed by manufacturers of components certifying that products furnished comply with requirements.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

F. Record of field tests of system.

G. Maintenance Data: For products and system to include in maintenance manuals specified in Division 1. Include data for each type of product, including all features and operating sequences, both automatic and manual. Include user's software data and recommendations for spare parts and components to be stocked at Project site.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A certified technician accredited by the National Burglar and Fire Alarm Association, and who is an authorized service representative of central-control unit manufacturer.

B. Manufacturer Qualifications: Central-control unit manufacturer or factory-authorized agency maintains a service center capable of providing training, parts, and emergency maintenance and repairs for overall system at Project site with eight hours' maximum response time.

C. Testing Agency Qualifications: Comply with requirements specified in Division 1 Section "Quality Control." A current member firm of the National Burglar and Fire Alarm Association. Experienced in performing tests of intrusion detection systems.

1. Testing Agency's Field Supervisor: Person currently certified as an advanced alarm technician by the National Burglar and Fire Alarm Association.

D. Source Limitations: Obtain system components from central-control unit manufacturer who shall assume responsibility for system components and for their compatibility.

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

F. Comply with NFPA 70.

G. Comply with UL 1023.

1.6 SYSTEM SERVICE CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Ambient Temperature for Indoor Components: 0 to 40 deg C.
2. Relative Humidity for Indoor Components: 5 to 95 percent, noncondensing.

1.7 WARRANTY

A. Warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, signed by manufacturer and Installer agreeing to replace intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.

C. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Digital Monitoring Products, Inc. (DMP).

2.2 EQUIPMENT

A. Protection from Power Line Surges: Use integral surge suppressors listed in UL 1449 and complying with IEEE C62.41, Category B. Include the following features:

1. Suppression Level: 300 V.
2. Maximum Response Time: 5 nanoseconds.
3. Circuit: Multistage, using inductors and silicon-avalanche zener diodes or equivalent.
4. Indicator Lamp: Labeled neon or LED located on control unit and arranged to extinguish on failure of protection.
5. Fuses: Externally accessible.

B. System- and Equipment-Interference Resistance: Not affected by radiated-radio-frequency interference and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHZ and conducted interference signals up to 0.25-V RMS injected into power supply lines at 10 to 10,000 MHZ. Coordinate below with Drawings or detailed device and component Specifications.

2.3 ELECTRICAL POWER

A. Normal System Power Supply: 120 V, 60 Hz, from a local circuit breaker. Provide breaker lock. System control unit supplies power to components.

B. Power Continuity: Batteries in power supplies of control units and individual system components maintain continuous system operation during outages of both normal and backup ac system supply.

1. Batteries: Rechargeable, valve-regulated, recombinant, sealed lead-acid type with nominal 10-year life expectancy. Capacity adequate to operate portion of system served, including audible trouble signal devices for up to four hours and audible and visual alarm devices under alarm conditions for an additional 10 minutes.
2. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Charger recharges fully discharged battery within 24 hours.

C. Annunciation: Central-control unit indicates, as a change in system condition, switching of system or component to backup power.

2.4 DOOR SWITCHES

A. Description: Balanced-magnetic type complying with UL 634, door-mounting magnet part of magnetically operated switch installed on door frame. Bias magnet and sensitive reed switch resists compromise by introducing foreign magnetic fields. **Provide DPDT switches**.

B. Door Switch for Doors (Wood, Hollow Metal and Aluminum) - Flush-Mounted Units: Where not indicated to be furnished and installed by the door hardware installer, provide 1" diameter unobtrusive, flush with surface of door frame and door, wide gap detection.

C. Door Switch for Doors (Wood, Hollow Metal and Aluminum) - Flush-Mounted Units: Furnished and installed by door hardware installer, wired by contractor.

D. Door Switch for Overhead Door: Balanced-magnetic type listed for outdoor locations, with wide gap, door-mounting magnet and floor-mounting switch. Provide with flexible stainless-steel cable.

E. Provide surface type wide-gap at roof hatches.

F. Above all exterior doors, provide compatible microwave request-to-exit sensors. These sensors shall be wired into the system to shunt contacts when exiting the building, allowing the arming of exterior doors with free egress. Programming of the sensors shall be verified with the owner.

1. Where sensors are provided for an access control system in addition to the intrusion detection system, provide additional relays and wiring as required to allow for interaction with both systems.

2.5 INTRUSION DETECTION DEVICES

A. Comply with UL 639.

B. Power Source: Powered from control panel.

C. Detection Indicator: LED in unit housing, latch type where indicated.

D. Sensitivity: Detect presence of an intruder within their zone patterns, but not outside their zone patterns.

E. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to central-control unit.

F. PIR Devices: Detect intrusion by monitoring infrared wavelengths emitted by human body within their protected zone and not to general thermal variations.

1. Wall Mounted Unit - Wide angle mirror: 35' x 45' coverage area.
2. Wall Mounted Unit - Long range curtain mirror: 70' x 10' coverage area.
3. Ceiling-Mounted Unit Spot-Detection Pattern: Full 360-degree 60' diameter coverage area.

G. Acoustical Devices: Detect intrusion by monitoring pattern of a steady-state sonic field produced by an ultrasonic transmitter. Changes in pattern are analyzed and those matching the profile of an intrusion initiate an alarm.

H. Dual-Technology, PIR and Acoustical Devices: Require both methods to result in an alarm signal.

I. Dual-Technology, PIR and Acoustical Devices: Require either or both methods, selectable, to result in an alarm signal. A control in device selects operating mode.

2.6 CONTROL UNITS

A. Comply with UL 1023.

B. Cabinet: Lockable steel enclosure, arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for interconnecting cabinets and field wiring. Identify each enclosure by an

engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch high. Identify individual components and modules within cabinets with permanent labels.

C. Systems: Separate and independent alarm and supervisory systems in control units. Alarm-initiating zone boards consist of plug-in cards. Arrangements requiring removal of field wiring for module replacement are not acceptable.

D. Timing Unit: Solid state, programmable, 365 day. Features include the following:

1. Astronomic Control: For automatic adjustment of light switching at dawn and dusk.
2. Confirmation: Relays, contactors, and other control devices have auxiliary contacts connected to provide confirmation signals to the system of on or off status of the equipment controlled. Software interprets such signals, displays equipment status, and initiates failure signals.
3. Override Capability: Programmed shutdown of lighting and other items can be overridden by using override push buttons or by entering a command over a telephone data link.

E. Control Modules: Types and capacities as required to perform unit functions. Visible and audible signals in central-control unit indicate alarm, supervisory, and trouble conditions for each zone. Each type of audible alarm has a distinct sound.

F. Zones: Quantity of alarm and supervisory zones as indicated with capacity for expanding number of zones by a minimum of 25 percent. System must have a minimum of 2 partitions for separate alarmed areas.

G. Power Supply Circuits: Units provide power for remote power-consuming detection devices. Circuit capacity is adequate for at least a 25 percent increase in load.

H. Indicating Lights: Individual LED devices designate each zone. An LED test switch for each control unit section illuminates all LED devices on that section of the unit. Manual toggle test-switches or push test-buttons do not require a key to operate. Alarm and supervisory signals light a red LED for the associated zone. Trouble signals light an amber LED for the associated zone.

I. Resetting: Controls permit silencing audible signals for individual zones but prevent resetting of alarm, supervisory, or trouble signals while the condition still exists.

J. Alphanumeric Display and System Controls: Arrange for basic interface between human operator at central-control unit and system components, including annunciation and supervision. A display with a minimum of 80 characters displays alarm, supervisory, and component status messages. Arrange keypad to enter and execute control commands.

K. Remote Telephone Access: System shall be completely accessible via IP communications, allowing status check, make changes, arm/disarm system, control up to 32 automatic devices such as heating, lighting, and locks (if programmed to perform these functions).

2.7 SECURE-ACCESS CONTROL STATIONS

A. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

2.8 ALARM DEVICES

A. Exterior Devices: Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at 3 feet (1 m), plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use: two minutes on and five minutes off.

1. Designed for use in industrial areas and in high-noise, severe-weather marine environments.

B. Interior Siren: Speaker with siren driver, rated to produce a minimum sound output of 84 dB at 10 feet (3 m) from master control unit.

2.9 COMMUNICATOR

A. Systems shall utilize same communicator as the fire alarm system, and shall be coordinated with the fire alarm system.

B. Where fire alarm system is not specified, system shall be provided with its own compatible cellular communicator. Coordinate communicator with owner’s monitoring company.

2.10 CONDUCTORS AND CABLES

A. Stranded Copper: Size conductors as recommended by system manufacturer with a plenum rated jacket.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install system according to NFPA 70, applicable codes, and manufacturer's written instructions.

B. Comply with UL 1641.

C. Wiring Method: Install wiring in raceways, except in accessible indoor ceiling spaces and in hollow gypsum board partitions. Use cable in ceilings. Conceal raceways and wiring, except in unfinished spaces.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess. Provide and use lacing bars and distribution spools.

E. Number of Conductors: As recommended by system manufacturer for functions indicated.

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

G. Connections: Comply with torque-tightening values specified in UL 486A.

H. Identify components, conductors, and cables according to Division 26 "Electrical Identification." Color-code conductors, and apply wire and cable marking tape to designate wires and cables so media are identified and in coordination with system wiring diagrams.

3.2 GROUNDING

A. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

3.3 FIELD QUALITY CONTROL

A. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

B. Pretesting: Align and adjust system and perform pretesting of all components, wiring, and functions to verify compliance with specified requirements. Correct deficiencies by replacing malfunctioning or damaged items with new items.

C. Manufacturer's Field Services: Engage a factory-authorized service representative to inspect field-assembled components and perform system pretesting, testing, adjustment, and programming.

1. Operational Tests: Schedule tests after pretesting has been successfully completed. Perform operational system tests to verify compliance with Specifications. Test all modes of system operation and intrusion detection. Methodically test for detection of intrusion and for false alarms in each zone of intrusion detection. Test for false alarms by simulating activities outside indicated detection patterns.
2. Report: Prepare a written report of observations, inspection, and tests.

D. Retesting: Correct deficiencies and retest until total system meets requirements of the Specifications and complies with applicable standards.

E. Schedule testing with at least seven days' advance notice. Notify Architect and Owner.

3.4 ADJUSTING

A. Occupancy Adjustment: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting and reprogramming to suit actual occupied conditions. Provide up to two visits to Project for this purpose without additional cost.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to explain programming and operation of system and to train Owner's maintenance personnel on procedures and schedules for maintaining, programming, operating, adjusting, troubleshooting, and servicing system. Provide a minimum of four (4) hours' training in operation and maintenance.

B. Schedule training with Owner with at least seven days' advance notice.

END OF SECTION 28 31 00

SECTION 28 46 21 - FIRE ALARM AND DETECTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Main Office Building: Provide an upgrade from the existing Siemens MXL system to the current XLS series system. Provide all components, wiring and programming as required to accomplish this upgrade.

B. Reading Crest Ave Facility: Provide a new fire alarm system meeting the requirements as specified herein and indicated on the drawings.

C. The Contractor shall contract with the Owner Current Vendor, Berkshire Systems Group, of Reading, PA, and include all vendor costs in the base bid.

D. It is the intent of these specifications, drawings, schedules and riser diagrams to describe the minimum requirements to furnish and install a completely new fire alarm system. The system shall include the following:

1. Addressable Monitoring and Control.
2. Manual Operator Switches and Annunciation.
3. Manual Stations.
4. Addressable Smoke Detectors with Application Specific Detection.
5. Addressable Duct Smoke Detectors with Application Specific Detection.
6. Addressable Heat Detection.
7. Addressable Continuous Linear Heat-Detector Systems and Air-Sampling Smoke Detector Systems.

    a. For use in elevator pits and shafts.

8. Addressable Monitoring and Control Modes for:

    a. Elevator Recall Control.
    b. Air Handling Unit Control.
    c. Smoke Damper Control.
    d. Kitchen Hood Suppression Monitoring.

        1) Additional relays shall be provided as required to interface with shunt trip devices, gas valve(s), utility distribution system(s), kitchen hood suppression system(s) and other kitchen devices.

    e. Knox Box.
    f. Magnetic Door Holders.

        1) Additional low voltage button, with label, shall be provided at the building administration area to release all mag locks in the building, in the event that there is an emergency.

9. Remote Annunciation and Control.
10. **Firefighter's microphone shall be located near administration area, where directed by the owner in the field. Provide all accessories, wiring, programming, etc. as required.**
11. Remote Network panels.
12. Visual Indicating Appliances.

13. Audible Indicating Appliances. (Speakers)
14. Central Station Reporting of Alarm, Trouble and Supervisory Conditions.
15. Standby Batteries.
16. Record documents in Document Storage Box.
17. Conduit, Wire, Outlet Boxes, Miscellaneous Parts.
18. Other items required for a complete and operational system.

E. The Contractor shall be responsible for submitting all drawings, riser diagrams, calculations etc. to local authority for their approval. All components require U.L. and FM compliance. The Contractor shall be required to provide UL and FM certification documentation to township officials to meet all township requirements before the township will accept the system. The Contractor shall be responsible to review all annunciator, Knox Box and sprinkler gong locations with local officials prior to beginning work. The Contractor shall be responsible for any and all permits required by the township.

F. The Contractor shall verify that all peripheral devices (initiation and annunciation) is compatible with the system. If an alternate manufacturer of peripheral device is required for compatibility with the system, the contractor shall supply the alternate manufacture at no additional cost to the Owner. The alternate manufactured device shall be equivalent in performance and appearance to the specified.

G. Provide interconnections as listed in part 2.

H. Provide training as listed in part 3.

1.2 CODES AND STANDARDS

A. NEC Compliance: Comply with the National Electric Code (NEC), latest version in effect as of the bid due date of this project, as applicable to construction and installation of fire alarm and detection system components and accessories.

B. The Fire Alarm System Supplier shall contract with an independent Electrical Inspection Agency to inspect the fire alarm system installation for compliance with Article 760 of the NEC and other applicable articles of the NEC. The Inspection Agency shall be a different company than the Electrical Inspection Agency used by the Electrical Contractor. An approval certificate from the Electrical Inspection Agency shall be submitted to the Architect and Engineer before final approval of the system is granted.

C. The name of the Electrical Inspection Agency is to be submitted with the shop drawings for approval by the Architect and Engineer of record for this project.

D. NFPA Compliance: Comply with latest edition of NFPA 72 National Fire Alarm Code, as applied to construction and installation of fire alarm and detection system components and accessories. The Contractor shall be responsible to have the Fire Alarm manufacturer review the drawings prior to installation of any device. Any device(s) required to be added or relocated to meet NFPA requirements shall be submitted prior to installation.

E. ADA Compliance: Provide fire alarm system signaling components which meet the Americans with Disabilities Act (ADA) and any subsequent modifications and clarifications to this law.

F. U.L Compliance and Labeling: Provide fire alarm and detection system components which are U.L. listed and labeled for their intended use and service. In addition to the fire alarm equipment listing requirements, if the local municipality requires, the Fire Alarm System Equipment Supplier shall be U.L. listed as an Alarm Service Company for Local, Remote, Auxiliary and Proprietary Protective Signaling Systems. The U.L. Listing Certification number for the Alarm Service Company shall be included in the submittal information.

G. Commonwealth of Pennsylvania: The complete installation shall be installed in a manner to provide a system that meets the requirements of the Pennsylvania Construction Code Act (Title 34) as adopted on April 11, 2003 and the Uniform Construction Code.

H. Local Code Requirements: Comply with the latest codes as adopted by the local code authority having jurisdiction (AHJ) and implemented by its building code services bureau. The Contractor and equipment supplier shall assist the building code services bureau inspectors in the final test of equipment and operation of the system.

I. NICET Certification: The Equipment Supplier shall employ at least one individual full time in the office supporting this project that has attained NICET Level III Certification in Fire Alarm Systems. All submittals and drawings shall be approved, initialed and show the NICET Certification Number of the individual maintaining the certification and taking responsibility for the documentation. As an alternate to the NICET Level III requirement, all submittals, drawings, and testing shall be reviewed, witnessed, and stamped sealed by a Professional Engineer (PE), licensed in the State of Pennsylvania, and the PE shall present a final letter of certification of the system at the completion of the project.

1. While the system has been designed as part of the bidding documents, it is the Vendor's responsibility to review all equipment locations to ensure compliance with the supplied products. The Vendor shall also provide all required battery calculations, wiring requirements, etc. for a complete and functioning code compliant system. Should a deficiency be found during the review process, the Vendor shall submit, in writing, all deficiencies for Engineer review.

1.3 DESCRIPTION OF WORK

A. It is the intent of these Specifications and Drawings to describe the minimum requirements to furnish and install a complete fire alarm system. The system shall be addressable type to include manual stations, automatic detectors, visual indicating appliances, audible indicating appliances, equipment and connections for remote Central Station monitoring, sprinkler flow and tamper switch monitoring, duct detectors, air handling unit control, standby batteries, conduit, wire, outlet boxes, elevator recall, door hold open devices, kitchen hood systems and any other items required to provide a complete and operational system.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A factory authorized installer is to perform the work of this section. The authorized installer shall include a service department and employ factory trained and NICET certified technicians, and shall be located within 100 miles of this project location. The installer shall have a minimum of 5 years' experience installing fire protective signaling systems.

B. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

C. The Manufacturer shall be a nationally recognized company specializing in fire alarm and detection systems.

1.5 SUBMITTALS

A. Submit under provisions of Division 26 "Basic Electrical Requirements."

B. The installing contractor and/or equipment manufacturer shall provide complete and detailed shop drawings and include:

1. Detailed written system description describing system functions and operation. All specification deviations shall be clearly noted and marked.
2. Control panel wiring schematic and interconnections.
3. Complete point to point wiring diagram showing terminal connections to all system devices.
4. Riser wiring diagram and associated zones.
5. Complete floor plan drawings locating all devices associated with the fire alarm system.
6. Factory data sheets on which piece of equipment to be used and so marked as to model, dimensions, size, voltage, and configuration.
7. Complete Bill of Material for reference.
8. Programming matrix defining all input/output functions and zoning.
9. Provide complete battery calculations for both alarm and supervisory mode.
10. Provide audibility calculations shop drawings per IFC 907.

C. The equipment supplier must have a minimum NICET Level 3 Certification, or Submittals and Drawings must be stamped by a Registered Fire Protection Engineer.

D. Submit a copy of NICET Level III Certificate and technician's factory certification cards.

E. All submittal data will be in bound form with contractor's name, supplier's name, project name, and State Fire Alarm License number adequately identified.

F. When preparing submittals and any required final programming, use a room number schedule generated by the architect and/or the owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, revise the initial submittal, when a schedule is available, to reflect the proper room numbers.

1. For existing buildings/spaces undergoing renovations, the vendor shall review the entire fire alarm system, and revise room names and numbers as required to reflect current actual conditions for all devices and zone loops throughout the entire building. Provide all programming as required to accomplish this task.

G. **Project Completion Documentation:**

1. At the completion of the project, the following documentation shall be provided in compliance to Division 26 “Basic Electrical Requirements” and Division 01 sections, as well as included in the Document Storage Box:

a. Complete set of Operation and Maintenance manuals.
b. Program documentation as specified in this section.
c. Complete set of As-Built fire alarm drawings, indicating all device programming and identification, and battery calculations. Drawings must include all newly installed equipment, as well as any exiting equipment scheduled to remain.
d. All other NFPA and UCC required documentation.

1.6 WARRANTY AND MAINTENANCE SERVICE

A. The Contractor shall warrant the fire alarm equipment and wiring to be free from inherent mechanical and electrical defects for a period of two (2) years from the date of the final acceptance of the system of the last phase of the project. The Fire Alarm System equipment shall have a warranty of two (2) years from date of the last phase of the project. Defective equipment shall be replaced at no cost to the Owner during this two-year warranty period.

B. Maintenance Service Contract: Provide warranty maintenance of fire alarm systems and equipment for a period of two (2) years, using factory-authorized service representatives.

C. Basic Services: Systematic, routine maintenance visits on at times scheduled with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.

D. Additional Services: Perform services within the above period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.

E. Testing & Inspections: Perform NFPA 72 and the Pennsylvania Department of Labor & Industry, Uniform Construction Code required testing and inspections during the two (2) year period at no additional cost to the owner.

F. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

1.7 ADDITIONAL DOCUMENTAITON AND PROGRAMMING REQUIREMENTS

A. The vendor shall provide drawings showing all fire alarm devices and their device identification in the software. These drawings must include all devices, whether shown on the project drawings, or not, and shall include any existing devices that are remaining to be reused.

B. At the end of the project, the vendor shall program all device point identification to match existing room numbering at the completion of the project.

1. For existing buildings/spaces undergoing renovations, the vendor shall review the entire fire alarm system, and revise room names and numbers as required to reflect current actual conditions for all devices and zone loops throughout the entire building. Provide all programming as required to accomplish this task.

C. At project completion, all of the above documentation shall be provided as part of the operation and maintenance manuals and as-built documentation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Siemens.

2.2 FIRE ALARM AND DETECTION SYSTEMS

A. General: Provide fire alarm and detection system products of types, sizes and capacities indicated that comply with manufacturer's standard design, materials, and components; construct in accordance with published product information, and as required for complete installation. Provide fire alarm and detection systems for applications indicated, and with the following sequence of operations, components and function features.

B. The system shall be addressable type, to include manual stations, automatic detectors, visual indicating appliances, audible indicating appliances, remote annunciators, equipment and connections for remote monitoring, sprinkler flow switch, sprinkler tamper switch, duct detector, standby batteries, conduit, wire, outlet boxes and any other items required to provide a complete and operational system.

C. Provide fire alarm and detection systems for applications indicated, and with the following sequence of operations, components, and function features.

D. Operation: The system specified is an addressable type system that provides the capability of monitoring individual devices such as smoke detectors, heat detectors, manual pull stations, sprinkler activating devices and other auxiliary functions for alarm and trouble indications. All items monitored for alarm and/or trouble conditions shall be capable of custom programming a minimum of 232 alpha/numeric character identification that is displayed on the control unit. In addition to the text message the user can view a graphic map with an icon indicating the location of the event in the building. Custom programming of automatic operation for individual devices for alarm signaling, fire department reporting, remote annunciation and other auxiliary control functions shall be provided. The system shall have a minimum capacity of 2500 input and 2500 output devices within the Main Processor. If the system needs grow beyond of 2500 points, the system shall be able to be networked to identical panels. In addition, the system shall have the following functions:

1. Initiating Device Calibration Check: It shall be possible to check the calibration at each initiating device at the control unit to verify correct operation.
2. Detector Sensitivity Check/Adjustment: Provide the capability of checking and adjusting individual detectors for alarm condition sensitivity from the control unit. The detector sensitivity monitoring shall meet and be listed by Underwriters' Laboratory for this function.
3. Coded Signaling: Operate audible notification appliance signals on a Coded manor in accordance with the National Standard. The system shall have the ability to code each device with a distinctive code. This code shall be software selectable.
4. Compare Function: Software to allow for a printout of a comparison of the original or previous program and any software modifications that are made to indicate any deficiencies caused by reprogramming. Systems not providing a compare printout function shall require 100% re-testing after every software modification and furnish a print out with each device being re-tested to the institution.
5. Detector Maintenance Monitoring: Provide monitoring of smoke detector chambers for gradual build-up of foreign materials in the sensing chamber. When the control senses a high level of contamination, the control panel shall cause a trouble condition and indicate the specific detector that needs maintenance.
6. Automatic Drift Compensation: All smoke detectors shall be monitored for changes in sensitivity ranges and automatically adjust the detection window, up or down, to compensate for environmental changes or degradation of detector components.
7. Visual Indicating Appliances Control: All visual indicating appliances shall be synchronized throughout the facility.
8. Application Specific Detection: Smoke detectors shall be individually programmed to provide the maximum sensitivity allowed by UL standards to actual fire phenomena and be discriminatory to deceptive phenomena that cause unwanted alarms. The program shall allow for a selection of 11 application specific environments to choose from as listed below. These selections shall be submitted for application to the Engineer before final acceptance of the system. Systems not including this feature shall provide both ionization and photoelectric detection at each location, programmed with algorithms to provide the earliest possible detection and minimize unwanted alarms.

Application Specific	Normal Environment
Office	Reasonably clean, climate-controlled atmosphere

Warehouse	Airborne dust, equipment, fork truck, light-to-medium dock area exhaust fumes
Lobby	Relatively clean area, temperature changes, cellular telephones, cigarette/cigar smoking fumes
Computer Room	Very controlled environment: clean, temperature closely regulated, high-cost clean machinery operating, no smoking, high air velocity
Healthcare	Higher-level; risk, relatively clean, electronic equipment
Dormitory	Airborne dust, temperature changes, living quarters, cooking fumes, smoking
Parking Garage	Airborne dust, car and diesel fumes, temperature swings
Utility Room	Normal to somewhat dirty environment, heat from running equipment
Hostile Environment	Dirty, dusty, humid, operating equipment, RF present, wide temperature swings
Precious Storage	Sensitive materials or equipment storage, clean dust-free environment, earliest warning desired
Duct	Installation in air handling systems

9. Alarm Verification: Provide field programmable alarm verification for all smoke detectors that allows a time delay of up to 50 seconds before a smoke detector signals the alarm. This feature shall not be utilized or required with application specific detectors where no delays of reporting of fire phenomena are necessary and 'deceptive phenomena' is ignored.
10. Detector Maintenance Monitoring: Provide monitoring of smoke detector chambers for gradual build-up of foreign materials in the sensing chamber. When the control senses a high level of contamination, the control panel shall cause a trouble condition and indicate the specific detector that needs maintenance.
11. Automatic Drift Compensation: All smoke detectors shall be monitored for changes in sensitivity ranges and automatically adjust the detection window up or down to compensate for environmental changes or degradation of detector components.
12. Battery Standby: Provide in the control unit cabinet, batteries that will operate all system initiating devices for a minimum of 24 hours during power outage and operate the entire system for a minimum of 2 hours of emergency operation or 15 minutes of evacuation alarm at maximum connected load. The batteries shall be sealed type and automatically recharge after normal power is restored.
13. Device Bypassing: Provide the capability through the control panel keypad to individually disarm an initiating device or output circuit. If an initiating device such as a smoke detector malfunctions, disarming and bypassing the unit shall be possible without affecting other devices within the system. Output control functions such as notification appliance circuits or fun shut down shall be capable of being individually bypassed during tests or abnormal conditions. A trouble condition shall be created when any initiating or output device is disarmed or bypassed.
14. Event History Storage: All events of the system shall be logged in non-volatile history buffer with a minimum capacity of 1000 events. The events may be recalled by category.
15. Walk Test: A walk test feature shall be provided that allows testing individual zones, loops or the entire system in either a silent or audible basis. In either test, programmed functions shall be bypassed.

16. Fully Field Programmable: The complete system operation shall be programmed via a standard laptop computer. The program shall be capable of being stored in the computer hard disk, storage media and printed on standard continuous form paper. The complete program shall be turned over to the Owner upon acceptance of the system. The program shall be in digital format on storage media as well as a printed hard copy.
17. Compare Program: The system program shall allow for a printout of any and only changes that have been made to the program since the last program event or session. This printout shall indicate the time and date of the previous and current program sessions. Once the system is accepted by the authority having jurisdiction (AHJ), a copy of the current program must be signed by the AHJ on the first page and last page of the continuous form printout. Any changes to the program after this time and date, must be submitted for approval by the AHJ in printed form or the entire system must be re-tested and approved at the discretion of the Department of General Services Engineer and the AHJ. With the compare program printout, all the devices and their operation shall be tested in accordance with NFPA 72 which requires an additional 10% of the unchanged portion of the system, up to a total of 50 devices, to be tested. Documentation shall be provided that these tests were made after each programming change or session that is downloaded to the system.

2.3 MATERIALS AND EQUIPMENT

A. Fire Alarm Control Panel:

1. Provide a fire alarm control panel cabinet as shown on the drawings that includes the required power supply, human interface display unit with keyboard, card rack assemblies with spare space capacity to expand the system a minimum of 50%, central processing unit, programmable memory board, addressable input modules, signal circuit modules, auxiliary relay function modules, battery charger, battery shelf, and required sealed batteries. The Contractor shall provide 120V power supply as required.

    a. Provide in a surface mounted enclosure when installed in mechanical or electrical space. When located in a finished location, provide recessed enclosure.

2. All devices must be individually mapped and inputted in the system so that they may be presented with individual identification on the display unit during alarm, trouble and supervisory conditions.
3. The fire alarm control panel shall be microprocessor based using multiple microprocessors throughout the system providing rapid processing of smoke detector and other initiation device information to control system output functions. There shall be a watchdog circuit, which shall verify the system processors and the software program. Problems with either the processors or the system program the panel shall activate a trouble signal, and reset the panel. The system modules shall communicate with an RS 485 network communications protocol. All module wiring shall be to terminal blocks, which will plug into the system card cage. The blocks shall be color coded to prevent accidental crossing of wiring.
4. Provide all required Device Loop Cards, Signal Circuits, Zone Indicating Cards, and other cards as required for a fully functioning system.
5. The system card cage shall provide the mounting of all system cards, field wiring, and panel's inter-card wiring. The terminal strips for the cards shall be color-coded to eliminate the possibility of making the wrong connection. The terminal blocks maybe disconnected and reconnected while the system is powered up without causing any difficulties. All power limited field wiring shall connect to the top of the card cage. All non-power limited internal wiring shall be connected to the bottom of the card cage. The card cage shall hold the systems cards and have capability of connecting multiple card cages to meet system demands.
6. Provide Audio Input Card to allow up to two external audio sources such as Background music or PBX conventional paging or any source such as CD and tape player.
7. Provide Tape Recorder Card as required to allow one analog output (voice/telephone) to be recorded and distributed throughout the building using the fire alarm speakers.

8. The system shall be capable of providing both horns and speakers.
9. When connected with an existing system, provide all required interface cards/modules to communicate with existing devices.

B. Power Supply:

1. The system Power Supply/Charger shall be a 12-amp supply with battery charger. The power supply shall be filtered and regulated. The system power supply shall have 4 relays, 1 for common alarm, one for common trouble and two programmable relays. The power supply shall be rated for 120/240 VAC 50/60 Hz.
2. The battery charger shall be able to charge the system batteries per battery specifications. Battery charging shall be microprocessor controlled and programmed with a special software package to select charging rates and battery sizes.
3. The battery charger shall be able to accept, and be provided with Thermistor for monitoring battery temperature to control charging rate.

C. System Enclosures:

1. Provide the enclosure needed to hold all the cards and modules as specified with at least spare capacity for two cards. The enclosure outer door shall be either black or red. Provide the color as to the local AHJ requirements. The outer doors shall be capable of being a left-hand open or a right-hand open. The inner door shall have a left-hand opening. System enclosure doors shall provide where required ventilation for the modules or cards in the enclosure.
2. Provide system enclosure for all amplifiers. Where required by the manufacturer, provide means for venting heat from the enclosure either by having enclosure sides and top vented or the doors vented.

D. Off-Site Communications:

1. Provide network communications with cellular backup. Coordinate exact requirements with Owner's monitoring agency to ensure complete compatibility. The contractor shall provide all power and interconnecting wiring as required.

    a. Provide remote antenna and plenum rated wiring compatible with the cellular communicator. Install antenna on roof, and route wiring through building.

E. Initiation Devices:

1. All initiation devices shall be insensitive to initiating loop polarity. Specifically, the devices shall be insensitive to plus/minus voltage connections on either Style 4 or Style 6 circuits.
2. Smoke Detectors:

    a. Smoke detectors shall be ceiling mounted digital addressable photoelectric type smoke detectors with integrated heat sensors. The combination detector head and twist lock base shall be U.L. listed compatible with the fire alarm control panel.
    b. The base shall permit direct interchange with the heat detector. The base shall be the appropriate twist lock base.
    c. The smoke detector shall have a flashing status LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady at full brilliance. The detector may be reset by actuating the control panel's reset switch. The sensitivity of the detector shall be capable of being selected and measured by the control panel without the need for external test equipment.
    d. The vandal security-locking feature shall be used in those areas as indicated on the drawing. The locking feature shall be field selectable when required. It shall be possible to perform a sensitivity test of the detector without the need of generating smoke. The test method shall

simulate the effects of products of combustion in the chamber to ensure testing of the detector circuits.

e. Detectors shall have completely closed back to restrict entry of dust and air turbulence and have a 30-mesh insect screen. Electronics of the unit shall be shielded to protect against false alarms from E.M.I. and R.F.I.

3. Heat Detectors:

a. Furnish and install digital addressable heat detectors. The combination heat detector and twist lock base shall be U.L. listed compatible with the fire alarm control panel.
b. The base shall permit direct interchange with the photoelectric smoke detector. The base shall be appropriate twist lock base.
c. The heat detector shall have a flashing status LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady at full brilliance. The detector may be reset by actuating the control panel's reset switch.
d. The vandal security-locking feature shall be used in those areas as indicated on the drawings. Electronics of the unit shall be shielded to protect against false alarms from E.M.I. and R.F.I.

4. Combination Fire and Carbon Monoxide Detectors:

a. Combination fire and carbon monoxide detectors shall be ceiling mounted digital addressable detectors with integrated sensing elements, including smoke, CO, light/flame and heat. The detector head and twist lock base shall be U.L. listed compatible with the fire alarm control panel.
b. The smoke detector shall have a flashing status LED for visual supervision. The detector may be reset by actuating the control panel's reset switch. The sensitivity of the detector shall be capable of being selected and measured by the control panel without the need for external test equipment.
c. The vandal security-locking feature shall be used in those areas as indicated on the drawing. The locking feature shall be field selectable when required. It shall be possible to perform a sensitivity test of the detector without the need of generating smoke. The test method shall simulate the effects of products of combustion in the chamber to ensure testing of the detector circuits.

5. Duct Detectors:

a. Duct Detector shall include an enclosure with a photoelectric smoke head as previously specified and auxiliary output. Duct Detectors shall be provided with remote indicator lights and appropriate sampling tube for duct size.
b. Duct Detectors shall be provided with NEMA 4X enclosure and strip heat as required for exterior applications, powered from the fire alarm system. Provide sufficient power and wire as required to operate detector.
c. Program duct detectors as directed by owner/fire marshal.

6. Manual Pull Stations:

a. Manual Fire Alarm Stations shall be double action type, with a key operated test-reset lock in order that they may be tested, and so designed that after actual emergency operation, they cannot be restored to normal except by use of a key. The reset key shall be so designed that it will reset manual station and open FACP without use of another key. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of fifty feet, front or side. Manual stations shall be constructed with clearly visible operating instructions on the front of the stations in raised letters. Stations shall be suitable for surface mounting on matching back box, or semi-flush mounting on a standard

single-gang box, and shall be installed within the limits defined by the Americans with Disabilities Act (ADA) dependent on manual station accessibility or per local requirements.

b. Manual Fire Alarm Stations shall utilize push in/pull down operation.

c. Housing material shall be metal or LEXAN polycarbonate resin.

7. Addressable Interface Devices:

a. Addressable Interface devices compatible with the system shall be provided to monitor contacts for such items as water-flow, tamper, pressure, and PIV switches, Knox Box, Air Handling Unit Fans that are required by codes to be controlled, Kitchen Hood Suppression System, and Elevator Recall Modes connected to the fire alarm system. These interface devices shall be able to monitor a single or dual contacts. An address will be provided for each contact. Where remote supervised relay is required, the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive.

8. Device Guards:

a. Wire cages, vandal covers and other types of guards shall be provided for devices located in spaces where damage can occur, including, but not limited to gymnasiums, locker areas, weight and aerobic rooms, etc.

F. Notification Appliances:

1. Finishes:

a. All celling devices shall be white with red lettering, unless noted otherwise.

b. All wall mounted devices shall be white with red lettering, unless noted otherwise.

2. The speaker/strobe or speaker appliance as indicated on the drawings shall be a multiple tap speaker having taps for ¼, ½, 1 and 2 watts. The speaker/strobes shall have a synchronized strobe light with multiple candela taps to meet the intended application. The strobe light taps shall be adjustable for 15, 30, 75, and 110 candela. Do not load any circuit beyond 75 % of its capacity.
3. The strobe only appliance as indicated on the drawings shall be a synchronized strobe light with multiple candela taps to meet the intended application. The strobe light taps shall be adjustable for 15, 30, 75, and 110 candela. Do not load any circuit beyond 75 % of its capacity.
4. Where shown on the drawings, provide strobe units in combination with the audible indicating appliances. Strobes shall be supervised and synchronized within each circuit.
5. Wire cages, vandal covers and other types of guards shall be provided for devices located in spaces where damage can occur, including, but not limited to gymnasiums, locker areas, weight and aerobic rooms, etc
6. An alarm extender panel shall be provided where needed. The power supply shall be a minimum of 8 amps. The power supply shall contain four supervised notification circuits strobes and audibles. There shall be a 1 amp filtered auxiliary power limited output.
7. Provide Weatherproof Strobe, Speaker and Speaker/Strobe Units with NEMA 4X enclosures when located exterior of the building and where indicated on the drawings. These units shall have the same feature as speaker/strobe unit mentioned above and shall be weatherproof and rated for outdoor use. Furnish with surface weatherproof backbox.
8. Where notification appliances are indicated, provide manufacturer approved weather proof enclosures, etc.
9. Where devices are indicated to be installed in the ceiling, provide comparable devices designed to be installed in the ceiling.
10. Where devices are indicated to be installed on walls requiring surface installation in lieu of recessed, devices shall be mounted using a manufacturer's prescribed matching enamel outlet box. Finish of box shall match device.

G. Other Conditions:

1. After installation of smoke detectors, in potentially dusty areas, the Contractor shall provide an airtight plastic cover over the units to keep contaminants from entering the unit in all areas, until time of acceptance. It is the responsibility of the Contractor to either clean or replace any devices that have become soiled or contaminated by construction dirt.
2. The fire alarm equipment distributor shall stock the recommended spare parts listed for the UL certification.

H. Knox Box: Provide recessed (surface on existing wall) Knox Box, meeting Authority Having Jurisdiction requirements. Provide connection to fire alarm system.

I. Annunciator: Provide a flush mounted annunciator. Electrical Contractor shall verify exact location of annunciators with local authority having jurisdiction prior to installing. Annunciator shall provide full device information during alarm, trouble and supervisory conditions. Affected device shall be identified with location in the building.

J. Door Holders: Provide 24 VDC magnetic door holders and connect to the fire alarm door control circuit. The door holders shall be wall mounted unless otherwise noted on the drawings. The door holders shall be controlled for fail safe operation and shall not hold open during normal power failure. Provide with finish matching door hardware.

K. Document Storage Box:

1. Description: Enclosure to accommodate standard 8-1/2-by-11-inch manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
2. Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
3. Color: Red powder-coat epoxy finish.
4. Labeling: Permanently screened with 1-inch-high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
5. Security: Locked with 3/4-inch barrel lock. Provide solid 12-inch stainless steel piano hinge.

2.4 INTERCONNECTIONS

A. Connection to the Lighting Control System: Provide auxiliary relay to connect to the Lighting Control System. This relay shall be programmed to indicated to the lighting control system when the building goes into alarm so that all of the connected lights can go to full output. Coordinate the exact requirements with the Lighting Control System manufacturer.

PART 3 - INSTALLATION

3.1 GENERAL

A. Examine areas and conditions under which fire alarm system is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

B. Install system and materials in accordance with manufacturer's instructions and rough-in drawings, and details on the drawings. Install electrical work and use electrical products of these specifications.

C. The Contractor shall install backboxes flush in wall with conduit to above accessible ceilings for fire alarm system. The contractor shall coordinate locations and backbox sizes.

D. This contractor is responsible for furnishing and installing all devices in ceiling tiles, including but not limited to backboxes, and supports.

E. In addition to providing smoke detectors at the locations indicated on the drawings, and within these specifications, smoke detectors shall be provided at all fire alarm control units and transponders, notification appliance circuit power extenders, supervising station transmitting equipment and other NFPA and IFC required areas.

F. Install Document Storage Box near main FACP. Field verify with Owner exact location.

3.2 LABELING

A. All devices shall be labeled with their device point identification, matching the program ID. Provide loop identification for devices without specific point identification.

B. For devices located above the ceiling, provide identification of the device, as well as on the T-bar directly below the device. Identification information shall also be provided on remote indicators installed for duct detectors.

C. Devices requiring power (FACP, remote battery cabinets, etc.) shall be provided with label of circuit feeding device.

3.3 EQUIPMENT INSTALLATION

A. Notification Appliances: Mount semi-flush in recessed backboxes. Where surface mounting is approved, use manufacturer's standard surface backbox with finish matching device (provide red for red devices and white for white devices).

1. The use of pre-punched, or standard galvanized 4” square boxes shall not be acceptable under any circumstances.

B. Manual Pull Stations: Mount semi-flush in recessed back boxes. Where surface mounting is approved, use manufacturers standard surface Red backbox.

1. The use of pre-punched, or standard galvanized 4” square boxes shall not be acceptable under any circumstances.

C. Ceiling Mounted Smoke Detectors: Not less than 4” from a side wall to the near edge. For exposed solid-joist construction, mount detectors on the bottom of joists. On smooth ceilings, install not more than 30 ft. apart in any direction.

D. Notification Appliances: Mount semi-flush in recessed backboxes. Where surface mounting is approved, use manufacturer's standard surface backbox with finish matching device (provide red for red devices and white for white devices).

1. The use of pre-punched, or standard galvanized 4” square boxes shall not be acceptable under any circumstances.

E. Audible Alarm Indicated Devices: Install not less than 6” below the ceiling. Install Speakers on flush mounted back boxes with the device operating mechanism concealed behind a grille. Combine audible and visible alarms at the same location into a single unit.

F. Visible Alarm Indicated Devices: Install at least 6” below the ceiling and at a Maximum height of 96 inches.

G. FACP or Remote Network Panel: Install with tops of cabinets not more than 72” above the finished floor. Verify exact height with local authority having jurisdiction.

H. Annunciator: Install with the top of the panel not more than 72” above the finished floor. Verify exact height with local authority having jurisdiction.

I. Notification Appliances: Mount semi-flush in recessed backboxes. Where surface mounting is approved, use manufacturer's standard surface backbox with finish matching device (provide red for red devices and white for white devices).

J. Remote Battery Panels: Install in mechanical or electrical spaces when available. Janitor closets may be used, if installed high on wall, away from water. Only use storage closets when necessary, and install high and out of the way of Owner storage space.

3.4 WIRING

A. Wiring connections shall be made by the Contractor as shown on drawings furnished by the representative of the equipment manufacturer. Power shall not be applied to the system until the representative of the manufacturer has approved the connections to the control equipment.

B. The system shall be installed in a manner approved by the State Inspections Department and the National Electric Code utilizing approved raceways or approved fire alarm cable.

C. Power for all fire alarm devices, including, but not limited to control panel, remote battery panels, initiation devices and annunciation devices, 120V and less shall be provided. Any power at 120V shall be connected to the nearest available panelboard on a 20A, 1P breaker. Provide a handle locking devices. The breaker or breakers for the fire alarm system shall be clearly marked.

D. All fire alarm cabling shall be plenum rated. Contractor shall install in a code compliant method. Fire alarm cable shall **not** be installed in the cable tray or with data cabling within J-hooks.

E. Fire alarm circuit identification shall meet N.E.C. Article 760.

3.5 FIELD QUALITY CONTROL

A. The manufacturer shall provide local representative to review the system installation with installers to assure proper wiring and installation methods are used. Job visits shall be made by representatives of the equipment manufacturer as necessary through construction.

B. Demonstration of System Operation: After adjustments to the system have been completed, arrange for a demonstration of the system operation for personnel designated by the Owner.

C. Notify in writing through the prime Contractor, the Architect, Consulting Engineer and the Owner of the time and date the demonstration will take place. Provide a technician representing the equipment manufacturer to conduct the system demonstration.

D. Pre-Testing: After installation, align, adjust, and balance the system and perform complete pre-testing. Determine, through pre-testing, the compliance of the system with requirements of drawings and specifications. Correct deficiencies observed in pre-testing. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

E. Report of Pre-Testing: After pre-testing is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of witnesses to preliminary tests.

F. Final Test Notice: Provide a minimum of five (5) days' notice in writing when the system is ready for final acceptance testing.

G. Minimum System Tests: Test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:

1. Verify the absence of unwanted voltages between circuit conductors and ground.
2. Test all conductors for short circuits using an insulation testing device.
3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on record drawing.
4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10% of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequence. Observe indicating lights, displays, signal tones, and Annunciator indications. Observe all voice audio for routing, clarity, quality, freedom from noise and distortion, and proper volume level.
8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.

H. Re-Testing: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets specifications and complies with applicable standards.

I. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log on the satisfactory completion of tests.

J. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

3.6 TRAINING

A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours' training.
2. Schedule training with the Owner at least seven days in advance.

3.7 SEQUENCE OF OPERATIONS

A. In additions to the operations and functions listed, the following shall also occur:

1. Elevator Recall shall be programmed to meet the requirements of the local fire marshal or local authority having jurisdiction.
2. Where duct mounted smoke detectors are indicated specifically for air handling unit control, the associated air handling unit shall be connected to the fire alarm system via interface module. An auxiliary relay base shall not be used, unless noted otherwise.

    a. Upon a duct mounted smoke detector alarm condition, the connection to the mechanical equipment's starter via interface module shall shut down its respective unit. A supervisory signal shall be sent to the fire alarm control panel which in turn will send a signal to the automatic temperature control (ATC) system. The ATC system, depending on its programming, may shut down all or some of the other mechanical equipment in the building.

3. Where smoke detectors are indicated for smoke dampers, individual interface modules shall be wired to each damper, and an additional interface module shall be wired to the ductwork's associated air handler.

    a. Upon activation of a smoke detector associated with a specific damper, or at the unit feeding the ductwork with the damper, the interface module at the air handler starter shall shut down the unit and follow duct mounted smoke detector procedures. In addition, all smoke dampers associated with that particular air handler in addition to transfer ducts shall also close. Notification shall be sent to the fire alarm system and the ATC system.
    b. The smoke dampers will be provided at 24V. Coordinate power connection to smoke dampers with installing contractor, and provide appropriate power to dampers for control meeting all NFPA requirements.

3.8 TOWNSHIP/FIRE MARSHAL DRAWINGS

A. The Contractor shall provide CADD Drawings on 8 ½" x 11" (or as otherwise required by the local Fire Marshall or authority) sheets showing all As-Built device locations with identification numbers attached. These Drawings shall show all devices within the building. These Drawings shall be turned over to the township representative/Fire Marshal for their approval.

END OF SECTION 28 46 21