PROJECT MANUAL

FOR

2019-015 High Fidelity Nursing Simulation Lab

at

Science Building - C Wing

University of Southern Maine, Portland Campus
Portland, MAINE

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Volume 2 of 2

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ISSUED FOR BID DOCUMENTS SPECIFICATIONS

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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. The fire protection system shall be an automatic sprinkler system arranged to properly protect the new spaces and affected areas. Modify the existing sprinkler system as required per NFPA 13 to serve the finished spaces.
   B. This Section includes fire-suppression sprinklers, piping, and equipment.
   C. The Sprinkler Contractor shall place the sprinkler system in service and hand over the sprinkler system to the General Contractor for care and maintenance.
   D. Performance and Design Criteria: Provide products and systems complying with specific performance and design criteria indicated.

1.3 SYSTEM PERFORMANCE REQUIREMENTS
   A. Design sprinklers and obtain approval from authorities having jurisdiction. The design of the automatic sprinkler system shall be complete with all necessary accessories for proper operation.
   B. The system shall be hydraulically calculated in accordance with all provisions of the Contract Documents and any authority having jurisdiction.
   C. Design sprinkler piping according to the following and obtain approval from authorities having jurisdiction:
      1. Include a 5 percent margin of safety for available water flow and pressure.
      2. Include losses through water-service piping, valves, and backflow preventers.
   E. Minimum Density for Automatic-Sprinkler Piping Design shall be in accordance with NFPA 13. Maximum Protection Area per Sprinkler shall be in accordance with NFPA 13.
1.4 GENERAL REQUIREMENTS

A. Components and Installation: Capable of producing piping systems with 175-psig minimum working-pressure rating, unless otherwise indicated.

B. Bundled/Grouped wired in concealed spaces: Non-combustible spaces having 15 or more non-plenum-rated wires grouped together shall be fully sprinklered.

C. Seismic Performance: If required by the authority with jurisdiction, fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13.

D. Contractor shall obtain and pay for required permits.

1.5 SUBMITTALS

A. Shop Drawings: Submit working plans, prepared according to NFPA 13, and hydraulic calculations with cross reference to applicable drawings, water supply data, and equipment schedule with ratings for the system to the Owner’s Representative, Insurance Underwriter, and other authorities having jurisdiction.

B. Product Data: Catalog sheets, specifications, and installation instructions. Indicate UL or FM approval for each product. Include the following additional information:
   1. Pipe and fitting materials and methods of joining for sprinkler piping.
   2. Pipe hangers and supports.
   3. Piping seismic restraints.
   4. Valves, including specialty valves, accessories, and devices.
   5. Mechanical Devices: Complete description of intended use, including normal operating capacities and working pressures.
   6. Enclosures: Dimensions, materials, gages of metals; type of door hinges and locks, and methods of securing the enclosure members to the building construction.

C. Design Data: The portions of the sprinkler system not sized on the Contract Drawings shall be sized in accordance with NFPA requirements for Hydraulically Designed Systems. Submit drawings and hydraulic calculations for approval.

D. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit three copies of a statement, signed and sealed by the responsible sprinkler system design professional. Indicate that products and systems comply with performance and design criteria in the Contract Documents.
   1. Certification: Submit Contractor’s NICET certification and number or PE license number.

E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
F. Maintenance Data: For each type of sprinkler specialty to include in maintenance manuals specified in Division 1.

1.6 QUALITY ASSURANCE

A. Sprinkler Contractor

1. Installer Qualifications: An experienced installer who has designed and installed fire-suppression piping similar to that indicated for this Project and obtained design approval and inspection approval from authorities having jurisdiction.

2. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified sprinkler designer. Base calculations on results of fire hydrant flow test. Sprinkler designer shall be legally qualified and licensed to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of fire-suppression piping that are similar to those indicated for this Project in material, design, and extent.

3. Contractor shall be a licensed fire sprinkler contractor.

B. Manufacturer Qualifications:

1. Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.

2. Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to authorities having jurisdiction.

3. Factory Mutual Engineering Corporation (FM) Approval Guide

C. NFPA Requirements

1. NFPA#1 Fire Prevention Code

2. NFPA #13 “Standard for the Installation of Sprinkler Systems

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Sprinkler Cabinets: Finished, wall-mounting steel cabinet and hinged cover, with space for a minimum of six spare sprinklers plus sprinkler wrench. Include the number of sprinklers required by NFPA 13 and wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.
PART 2 - PRODUCTS

2.1 PIPING

A. Pipe and fittings shall conform to the requirements of NFPA 13. Pipe shall be listed by UL and be FM approved, and installed per its listing and approval.

2.2 Sprinkler piping shall be black steel schedule 40, 2 inch and smaller, and thinwall 2 ½ inch and larger. C factor 120.

A. System piping shall be substantially supported to the building structure. The installation of hangers and supports shall adhere to the requirements set forth in N.F.P.A. 13. Materials used in the installation or construction of hangers and supports shall be listed and approved for such application.

2.3 JOINING MATERIALS

A. Furnish in accordance with NFPA 13.

2.4 SPRINKLERS

A. Fire sprinklers shall be of one manufacturer throughout the building. No mixing of sprinkler brands shall be permitted. Sprinklers shall be of all brass frame construction with a quick response frangible bulb type fusible element.

B. Automatic Sprinklers: With heat-responsive element complying with the following:

1. UL 199, for applications except residential.
2. UL 1767, for early suppression, fast-response applications.

C. Sprinkler Types and Categories: Nominal 1/2-inch orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.

D. Provide quick response sprinklers.

E. Sprinkler Escutcheons: Materials, types, and finishes of sprinklers. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

2.5 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.

B. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

C. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.
2.6 VALVES

A. Valves shall be UL listed and FMG approved

PART 3 - EXECUTION

3.1 PREPARATION

A. The nature of the work requires coordination with other trades. Shop fabrication shall be done at the Contractor’s risk. Relocation of piping and components to avoid obstructions may be necessary. Relocation, if required, shall be done at the Contractor’s expense. The installation shall be performed in a workmanlike manner as determined by the Owner’s Representative and in accordance with the Contract Documents, manufacturer’s printed installation instructions, and submitted and Owner’s Representative reviewed drawings.

B. Existing Sprinkler System Shutdown:
   1. Follow NFPA 13 recommendations.
   2. Before shutting down the sprinkler system to perform the Work, notify the Owner’s Representative in writing, and the local fire department that the system is to be shut down temporarily. Give schedule which states date and time of proposed shut down and the approximate length of time that the system will be out of service. Request instructions for precautions that should be taken during the shut down period.
   3. Do not shut down the system until schedule is approved by the Owner’s Representative.
   4. Return the existing system to pre-shutdown operation immediately after the Work has been completed. Give written notice to the Director’s Representative that the system has been returned to pre-shutdown operation.

3.2 SPRINKLER APPLICATIONS

A. General: Use sprinklers according to the following applications:
   1. Rooms/spaces without Ceilings: Upright sprinklers.
   2. All occupied rooms with Finished Ceilings: Concealed

B. Finishes
   1. Unfinished spaces not exposed to view: rough bronze.
   2. Concealed Sprinklers: White
   3. Provide escutcheons with matching color for finished spaces.

3.3 SYSTEM INSTALLATIONS

A. A sprinkler head wrench of each style and model installed shall be provided to the owner at the completion of the project. A representative sampling of each sprinkler head style and model shall be provided to the owner and housed in a sprinkler head cabinet at or near the sprinkler
riser. The number of sprinkler heads provided to the owner shall be in accordance with NFPA 13.

3.4 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of ceiling tiles. Proposed sprinkler locations are shown on the architectural reflected ceiling plan. Sprinkler shall confirm these locations, provide additional heads and correct the spacing if needed as per NFPA 13.

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

C. Hangers and Supports: Comply with NFPA 13 for hanger materials.

3.5 LABELING AND IDENTIFICATION

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

3.6 FIELD QUALITY CONTROL

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

B. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

C. Verify that specified tests of piping are complete.

D. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

E. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

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

G. Fill wet-pipe sprinkler piping with water.

H. Coordinate with fire alarm tests. Operate as required.

3.7 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers having paint other than factory finish.
3.8 PROTECTION

A. Protect sprinklers from damage until Substantial Completion.

END OF SECTION 211000
SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Section 230500, common work results for plumbing are included in this section.

END OF SECTION 220500
SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

   A. Refer to Section 230529 for hangers and supports for plumbing piping and equipment.

END OF SECTION 220529
SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Section 230553 for identification for plumbing piping and equipment.

END OF SECTION 220553
SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Section 230700 for plumbing insulation.

END OF SECTION 220700
SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   
   B. Related Sections include the following:
      
      1. Division 22 Section “Common Work Results for Plumbing”
      2. Division 22 Section “Hangers and Supports”
      3. Division 22 Section "Plumbing Specialties" for water distribution piping specialties.

1.2 SUMMARY
   
   A. This Section includes tempered water, domestic water, and non-potable water.
   
   B. Drawings show the general layout of piping and accessories but do not show all required fittings and offsets that may be necessary to connect piping to equipment and to coordinate with other trades. Fabricate piping based on field measurements. Provide all necessary fittings and offsets.

1.3 SUBMITTALS
   
   A. Product Data

1.4 QUALITY ASSURANCE
   
   A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
   
   B. Comply with the UPC 2009 edition, subject to the exclusions and amendments set forth by the Maine Plumbers Examining Board.
   
   C. Comply with NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

A. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.
   
   2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

B. Mechanically formed copper or steel tee connections are not acceptable.

C. Viega Pro Press Fittings: 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). The Smart Connect Feature assures leakage of liquids and/or gases from inside the system past the sealing element of an un-pressed 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.

2.2 VALVES

A. Ball Valves

1. Soldered Ends 3” and Smaller: 600# W.O.G. forged brass or cast bronze two piece body, hard chrome plated forged brass ball, true adjustable packing nut ("O"-ring only type stem seal not acceptable), blow-out proof stem: Hammond 8511, Nibco S-585-70, Watts B6001 or FBVS-3C series, Milwaukee BA150, Apollo 70-Series, approved or equal.

2. Comply with MSS SP-110.

B. Refer to Division 22 Section "Plumbing Specialties" for balancing and drain valves.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

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

B. Mechanically formed tee-branch outlets and brazed joints shall not be used.

C. Use the following piping materials for each size range: Hard copper tube, Type L; copper press fittings; or soldered joints.

3.2 VALVE APPLICATIONS

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


2. Drain Duty: Hose-end drain valves.
3.3 VALVE INSTALLATION

A. Install sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment.

B. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops.

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

3.4 PIPING INSTALLATION

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

B. Install aboveground water piping level and plumb.

C. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.

D. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

E. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.5 JOINT CONSTRUCTION

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

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

3.6 HANGER AND SUPPORT INSTALLATION

A. Hanger, support, and anchor devices are specified in Division 22 Section "Hangers and Supports."

3.7 CONNECTIONS

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

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

C. Connect water piping in sizes indicated, but not smaller than sizes of unit connections.

D. Provide shutoff valve and union for each connection.
3.8 FIELD QUALITY CONTROL

A. Follow local code requirements.

B. Inspect water piping as follows:

1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Test water piping as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean interior of water piping system. Remove dirt and debris as work progresses. Clean and disinfect water piping per code requirements or administrative authority requirements. Sample procedure as indicated:

1. Purge new piping and parts of existing water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652.
B. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION 221116
SECTION 221119 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   B. Related Sections include the following: Division 22 Sections.

1.2 SUMMARY
   A. This Section includes plumbing specialties.

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

   1. Domestic Water Piping: 125 psig.

1.4 ACTION SUBMITTALS
   A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections.

1.5 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data

1.6 QUALITY ASSURANCE
   A. Plumbing 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.
   C. Comply with the local building and plumbing codes.
D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

E. Water line components shall be lead-free.


PART 2 - PRODUCTS

2.1 ACCESS PANELS

A. Provide access panels to concealed valves, cleanouts, and components that require service access. All components shall have proper access in accordance with manufactures’ recommendations.

2.2 BALANCING VALVES


1. Balancing valves shall be self-contained and fully automatic without additional piping or control mechanisms.
2. Balancing valves shall regulate the flow of recirculated domestic hot water based on water temperature entering the valve regardless of system operating pressure.
3. When fully closed valve shall bypass a minimum flow to maintain dynamic control of the recirculating loop and provide a means for system sanitizing.
4. Valve shall be factory adjustable from 105°F to 140°F as required by project conditions. Valve shall modulate between open and closed position within a 10°F range.
5. Valve body and all internal components shall be constructed of stainless steel with major components constructed of type 303 stainless steel.
6. Valve shall be rated to 200 PSIG maximum working pressure. Valve shall be rated to 300°F maximum working temperature.
7. Valves shall be standard tapered female pipe thread, NPT.
8. Valve shall be ANSI/AWWA C800 compliant and shall be NSF-61 certified with zero lead content for use in all domestic water systems.
9. Thermal actuator shall be spring operated and self-cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits. Thermal actuator shall be rated for a minimum of 200,000 cycles.

B. Provide the following with the balancing valves either built-in or in the pipeline:

1. Upstream: shutoff valve and strainer.
2. Downstream: shutoff valve and threaded temperature port with threaded plug.
2.3 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:
   2. Pressure Rating: 400-psig minimum CWP.
   4. Body: Copper alloy.
   5. Ball: Chrome-plated brass.
   8. Inlet: match piping.

2.4 CLEANOUTS

A. Manufacturers
   1. Zurn
   3. Josam Co.
   6. Mifab
   7. Wade

B. Provide per plumbing code.

C. Cleanouts shall be easily accessible and shall be gastight and watertight. Provide a minimum clearance of 24 inches for the rodding. Size of cleanout shall be same as pipe size through 4". Pipes 4" and larger shall have 4” cleanouts.

D. Basis of Design ZN1400-NH-5BZ1
   1. Compliance: ANSI/ASME A112.36.2M.
   2. Load Rating: Up to 2,000 pounds or as scheduled
   3. Body: Dura Coated cast iron, with gas and water tight non-corroding ABS tapered plug and standard or EZ1 top assembly.
   4. When a waterproof membrane is used in the floor system, provide clamping collars on the cleanouts.
   5. In carpeted areas, provide carpet cleanout markers.
   6. Round, square, or recessed for tile tops as required
   7. Provide vandal secured top when scheduled

E. Cleanouts shall consist of "Y" fittings and (1/8 inch) bends with brass or bronze screw plugs.

F. Provide cleanouts at or near the base of the vertical stacks with the cleanout plug located approximately 24 inches above the floor. If there are no fixtures installed on the lowest floor,
the cleanout shall be installed at the base of the stack. Cleanout shall consist of sanitary tees. Extend the cleanouts to the wall access cover; Zurn 1400 Series.

G. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Cleanouts:

1. Provide cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated: Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated. Locate at each change in direction of piping greater than 45 degrees. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping. Locate at base of each vertical soil and waste stack.
2. Provide cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
3. Provide cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
4. Provide flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

C. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated. Fasten recessed-type plumbing specialties to reinforcement built into walls. Provide wood-blocking reinforcement for wall mounting and recessed-type plumbing specialties.

D. Provide individual shutoff valve in each water supply to plumbing specialties. Provide shutoff valves in accessible locations.

E. Provide air vents at piping high points. Include ball valve in inlet.

F. Provide 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.

G. DHW Recirculation Balancing Valves:

1. Provide DHW recirculation balancing valves in each domestic hot water return piping branch beyond last hot water device in that branch.
2. Provide suitable line size isolation valves, unions, and strainer.
3. Provide suitable access panel as required in non-accessible ceilings and walls.
3.2 CONNECTIONS

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

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

C. Connect plumbing specialties to piping specified in other Division 22 Sections.

D. Connect plumbing specialties and devices that require power according to Electrical Specification Sections.

3.3 FIELD QUALITY CONTROL

A. Test plumbing specialties according to authorities having jurisdiction and the device's reference standard.

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

C. Prepare test and inspection reports.

END OF SECTION 221119
SECTION 221316 - PLUMBING SANITARY AND STORM 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.

B. Related Sections include the following:
   1. Division 22 Section "Common Work Results for Plumbing"
   2. Division 22 Section "Plumbing Specialties" for soil, waste, and vent piping systems specialties.

1.2 SUMMARY

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

B. Drawings show the general layout of piping and accessories but do not show all required fittings and offsets that may be necessary to connect piping to equipment and to coordinate with other trades. Fabricate piping based on field measurements. Provide all necessary fittings and offsets.

C. General layout shown, provide piping to fixtures as required by the Maine Plumbing Code. A licensed master plumber shall perform or supervise the work and provide layouts, piping, and fittings as required by code.

1.3 PERFORMANCE REQUIREMENTS

A. Comply with the utility requirements for the connection of to the municipal utility services. Obtain and pay for all necessary permits from the applicable municipal department. Obtain authority to connect to their existing mains.

B. Provide components and installation capable of producing piping systems with working-pressure ratings per local plumbing code.

1.4 SUBMITTALS

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

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

B. Comply with local building and plumbing codes.

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 CAST-IRON SOIL PIPING

A. Hubless

1. 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.

2. Hubless couplings shall conform to CISPI Standard 310 for standard couplings or ASTM C-1540 for heavy duty couplings where indicated. Gaskets shall conform to ASTM C-564. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer’s recommendations and local code requirements. Couplings shall be installed in accordance with the manufacturer’s band tightening sequence and torque. Tighten bands with a properly calibrated torque limiting device.

B. Hub and Spigot Cast Iron Soil Pipe and Fittings:

1. 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. Pipe and fittings to be Service (SV) Extra Heavy (XH)

2. Joints can be made using a compression gasket manufactured from a neoprene elastomer meeting the requirements of ASTM C-564 or lead and oakum. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer’s recommendations and local code requirements. The system shall be hydrostatically tested after installation to 10 ft. of head (4.3 psi maximum).
2.3 PVC DRAINAGE PIPING

A. Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D-1784 and conform with National Sanitation Foundation (NSF) standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM D-1785 and ASTM D-2665. Fittings shall conform to ASTM D-2665.

B. All pipe and fittings to be produced by a single manufacturer and to be installed in accordance with manufacturer’s recommendations and local code requirements. Solvent cements shall conform to ASTM D-2564, primer shall conform to ASTM F-656. The system to be manufactured by Charlotte Pipe and Foundry Co. or approved equal; and shall be intended for non-pressure drainage applications where the temperature will not exceed 140°F.

2.4 JOINING MATERIALS

A. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.

B. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

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

B. Soil, Waste, and Vent Piping: Cast iron or Schedule 40 PVC DWV

3.2 PIPING INSTALLATION

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

B. Provide firestopping as per Section 230500 “Common Work Results for HVAC”.

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. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.
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. 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 drainage and vent piping at the minimum slopes as required by the local plumbing code.

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

3.3 JOINT CONSTRUCTION

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


3.4 HANGER AND SUPPORT INSTALLATION

A. Hanger, support, and anchor devices are specified in Division 22 Section "Hangers and Supports."

3.5 CONNECTIONS

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

B. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to fixtures and equipment as shown on the plans.

D. Connect drainage piping in sizes indicated, but not smaller than required by plumbing code or equipment manufacturer’s recommendations.

3.6 FIELD QUALITY CONTROL

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

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

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

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

C. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

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

3.7 CLEANING

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

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

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

END OF SECTION 221316
SECTION 221513 – SIMULATED MEDICAL GAS & VACUUM PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes piping and related specialties for simulation lab piping. The piping system will NOT be NFPA-99 compliant.
      1. “Medical Oxygen” – simulated, connected to the existing building laboratory compressed air piping.
      2. “Medical Vacuum” – simulated, connected to the existing building laboratory vacuum piping.

1.3 ACTION SUBMITTALS
   A. Product Data: For the following:
      1. Pipes, fittings, and valves.

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

1.5 QUALITY ASSURANCE
   A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping".

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS
   A. Copper Tube: ASTM B88, Type K or L seamless, drawn-temper, water tube.
      1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
      2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
3. Copper Unions: ASME B16.22 or MSS SP-123.
4. Viega Press-Type Fittings: Wrought-copper fitting with EPDM O-ring seal in each end.

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

2.2 JOINING MATERIALS

A. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

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

1. PVC Piping: ASTM D2564. Include primer complying with ASTM F656.

2.3 VALVES & SPECIALTIES

A. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Allied Healthcare Products Inc.; Chemetron Division.
   b. Amico Corporation.
   c. BeaconMedaes.
   d. Conbraco Industries, Inc.
   e. NIBCO INC.
   f. Ohio Medical Corporation.
   g. Tri-Tech Medical Inc.

3. Description: Three-piece body, brass or bronze.
4. Pressure Rating: 300 psig minimum.
5. Ball: Full-port, chrome-plated brass.
6. Seats: PTFE or TFE.
8. Stem: Blowout proof with PTFE or TFE seal.

B. Line Pressure Regulators: Amico, or equal, relieving type pressure regulator, adjusting knob, rated for 200-psig minimum inlet pressure. Provide built-in pressure gauge.

1. Simulated medical O2: Set at 50 psig.
2. Simulated medical vacuum: Set at 15” Hg.
2.4 GAS-SERVICE CONNECTIONS

A. General Requirements for Gas-Service & Vacuum Connections:
   1. Suitable for specific gas pressure and suction service listed.
   2. Include roughing-in assemblies, finishing assemblies, and cover plates.
   3. Recessed-type units made for concealed piping unless otherwise indicated.

B. Roughing-in Assembly:
   1. Steel outlet box for recessed mounting and concealed piping.
   2. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
   3. Double seals that will prevent gas leakage.
   4. ASTM B819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

C. Finishing Assembly:
   1. Brass housing with primary check valve.
   2. Double seals that will prevent gas leakage.
   3. Cover plate with gas-service label.

D. Provide with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

E. Coordinate connection type with Owner.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION, GENERAL

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

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

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

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
E. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

F. Install piping to permit valve servicing.

G. Install piping free of sags and bends.

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

3.2 JOINT CONSTRUCTION

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

B. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Join according to ASTM B828 or CDA's "Copper Tube Handbook."

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

3.3 HANGER AND SUPPORT INSTALLATION

A. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable clevis hangers.

B. Support horizontal piping within 12 inches of each fitting and coupling.

C. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/2: 72 inches with 3/8-inch rod.
   2. NPS 3/4: 84 inches with 3/8-inch rod.

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

3.4 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

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

END OF SECTION 221513
SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:

1. Section 115300 “Laboratory Equipment”
2. Section 123200 “Wood Casework”
3. Section 123600 “Countertops”
4. Division 22 Section "Common Work Results for Plumbing"
5. Section 221116 - Domestic Water Piping: Material and installation of piping systems, valves, and piping specialties.
6. Division 22 Section "Plumbing Specialties" for backflow preventers and specialty fixtures not in this Section.

1.2 SUMMARY

A. Plumbing Fixtures

1.3 SUBMITTALS

A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer. 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. Comply with the UPC 2009 edition, subject to the exclusions and amendments set forth by the Maine Plumbers Examining Board.


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

1.5 COORDINATION

A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

PART 2 - PRODUCTS

2.1 GENERAL

A. Common Plumbing Fixture Requirements

1. Provide combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
2. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings.

2.2 PLUMBING FIXTURES

A. Sink Manufacturers:

1. Elkay Manufacturing Co.
2. Just Manufacturing Co.
3. Moen
4. Kindred
5. Advance Tabco
6. Aero

B. Faucet Manufacturers

1. Moen
2. Symmons
3. Delta Commercial
4. Chicago
5. Zurn
6. T & S Brass and Bronze Works
7. American Standard

C. Sinks – Common Requirements:

1. Standard: ASME A112.19.2/CSA B45.1; ADA.
2. Faucet-Hole Punching: Match faucet, coordinate hole-locations.
3. Risers: Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft. Shall be lead-free, loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with wheel handles, two 12" flexible chrome-plated lavatory risers complete with two forged brass with set screw flanges; connections: 1/2" sweat x 3/8" OD.

4. Waste Fittings: Standard: ASME A112.18.2

5. P-trap: heavy cast brass adjustable body, with slip nut, with cleanout, box flange and seamless tubular wall bend.

6. Provide grid drains or basket type, shall be 304SS.

7. Provide ADA trim kits for exposed piping.

D. Faucets - Common Requirements:

1. Comply with ASME A112.18.1M, NSF372-2011, ADA; UL 1951

2. Body Material: Commercial, solid cast brass.

3. Lead Free: Faucet contains ≤ 0.25% total lead content by weighted average

E. P-1 Sim Room Hand Washing Sink:

1. Basis of Design: Elkay model LK20-5184, Rear Left Drain Placement

2. Bowl: 18 Gauge Type 304 SS; Undermount.

3. Dimensions: 16.5" W x 20.5" L x 5.375" D (ADA depth).

4. Faucet: American Standard Monterrey 6405.170 Top mounted faucet with 5" Gooseneck Swivel Spout. Vandal-resistant metal wrist blade handles with red/blue indexes. 1.0 gpm laminar flow outlet

5. Waste: Provide perfect grid drain model LKPDVR18B.

6. Provide all hardware required for installation.

F. P-2 Storage Room Sink:

1. Basis of Design: Elkay budget series sink model B1C24X24X.

2. Bowl: 18 Gauge Type 300 SS; Single compartment, no drainboard. 1.5" diameter rolled edge.

3. Overall Dimensions: 12"D x 27"L x 27.5"W

4. Inside Dimensions: 24"L x 24"W

5. Backsplash: 9” high.

6. Body: 18 Gauge Type 300 SS welded construction.

7. Legs: H-Frame stainless steel legs with stainless steel flange feet.
8. Faucet: T & S Brass model B-2414 wall mount faucet with 8” swing nozzle. Polished chrome plated brass body. Quarter-turn compression cartridges w/ spring checks. Adjustable centers. 4” metal wrist blade handles with red/blue indexes. 1.5 gpm vandal resistant aerator flow outlet
9. Waste: 3.5” drain with stainless steel basket strainer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

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

3.2 FIXTURE INSTALLATION - GENERAL

A. Assemble and support fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

C. 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.

D. Install traps on fixture outlets as required.
3.3 CONNECTIONS

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

B. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

C. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

3.4 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

A. Operate and adjust fixtures. Replace damaged and malfunctioning fixtures.

B. Adjust water pressure to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

END OF SECTION 224000
SECTION 226700 - PROCESSED WATER SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

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 PP reverse-osmosis-water piping: Miscellaneous relocations of existing.

1.3 ACTION SUBMITTALS

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

1.4 QUALITY ASSURANCE


PART 2 - PRODUCTS

2.1 PLASTIC PIPE AND FITTINGS


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

   a. George Fischer LLC.
   b. IPEX Inc.
   c. NIBCO INC.
   d. Orion Fittings; a division of Watts Water Technologies Inc.

2.2 POLYPROPYLENE (PP-H) PIPE AND FITTINGS

A. Polypropylene Pipe shall be manufactured from a Group 1, Class 2 Beta Polypropylene Homopolymer material manufactured to SDR 11 dimensions with a pressure rating of 150 psi when measured at 68°F (20°C). Pipe internal surface finish shall be Ra ≤ 39.4μin. Pipe shall be manufactured in sizes from \( \frac{1}{2}'' \) through 16''.
B. Polypropylene Fittings shall be manufactured from a Group I, Class 2 Beta Polypropylene Homopolymer material manufactured to SDR 11 dimensions with a pressure rating of 150 psi when measured at 63°F (20°C). Fittings shall be available in sizes from ½” up to 16”. Fittings shall be manufactured and cataloged for either IR®/Butt Fusion or socket fusion joining methods.

C. All components of the pipe and fitting system shall conform to the following applicable ASTM Standards, D4101, D 638, D2837, D2122, and shall conform to FDA CFR 21 177.1520, USP 25 Class VI and ASME-BPE. All pipe shall be marked with manufacturers name, pipe size, wall thickness, type, quality control mark and pressure rating information.

D. Piping shall be PROGEF® Standard PP Piping System as manufactured by GF Piping Systems.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

B. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure ratings unless otherwise indicated.

C. Install piping free of sags and bends.

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

3.2 JOINT CONSTRUCTION

A. System components shall be installed using the Socket, IR® (Infrared) Butt Fusion or Standard Butt Fusion joining method according to current installation instructions as delivered in print or documented online at www.gfpiping.com.

B. Only the following GF Piping Systems fusion units may be used to install the PROGEF® Standard piping system:

1. For Socket Fusion Installation – SG 110 Socket Fusion Machine or MSE hand tool
3. For IR Fusion Installation – IR63 Plus, IR225 Plus, IR-315 Plus, Infrared Butt Fusion Machines

C. Installer shall ensure that all pipe and fittings used for Pure Water Piping are components of the same system. No mixing of various manufacturers’ pipe and/or fittings shall be allowed.
3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment." Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable clevis hangers; provide padding.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Rod diameter may be reduced one size for double-rod hangers, to minimum 3/8 inch.

D. Install padded hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters: 32 inches with 3/8-inch rod.

3.4 FIELD QUALITY CONTROL

A. The system shall be tested in accordance with the manufacturers’ recommendations.

B. Piping systems shall be pressure tested prior to being placed into operational service.

C. Pressure tests shall be conducted in accordance with the appropriate building, plumbing, mechanical and safety codes for the area where the piping is being installed.

D. Tests shall be conducted hydrostatically and should not exceed the pressure rating of the lowest rated component in the piping system (often a valve). Test the system at 150% of the designed operational pressure, i.e.: If the system is designed to operate at 80PSI, then the test will be conducted at 120PSI.

E. When hydrostatic pressure is introduced to the system, it should be done gradually through a low point in the piping system with care taken to eliminate any entrapped air by bleeding at high points within the system. This should be done in four stages, waiting ten minutes at each stage (adding ¼ the total desired pressure at each stage).

F. Allow one hour for system to stabilize after reaching desired pressure. After the hour, in case of pressure drop, increase pressure back to desired amount and hold for 30 minutes. If pressure drops by more than 6%, check system for leaks.

G. Confirm flow through the lab using the existing flow meter.

3.5 CLEANING

A. Before using, purge new piping and parts of existing piping that have been altered, extended, or repaired.

B. Clean piping by flushing with reverse-osmosis water.

END OF SECTION 226700
SECTION 230500 - COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This section applies to all other mechanical and plumbing sections.

1.2 GENERAL

A. This Section includes mechanical items common to all of this division specification sections.

B. Provide services, skilled and common labor, and all apparatus and materials required for the complete installation as shown and within the intent of the contract documents, field conditions, and code requirements.

C. The intention of these Contract Documents is to call for finished work, fully tested and ready for operation. Any components or labor not mentioned in the Contract Documents but required for functioning systems shall be provided. Should there appear to be any discrepancies or questions of intent, the Contractor shall refer the matter to the Architect/Engineer for decision before start of any related work.

D. Consistency and Completeness:

1. The contract documents are intended to include all components; however, the contract documents may not be perfect. Repetitive, common components (such as volume dampers, thermostats, condensate drains, trap primers, vent pipes, valves, etc.) are shown throughout. If a common component is missing in from the drawings, provide as similar per other areas. There will be no change orders for missing such components, the contractor shall provide consistent, complete, functioning systems. For example, thermostats are shown in rooms. If a thermostat was inadvertently not shown, the contractor shall provide to be consistent with the other room. Another example, if a plumbing fixture is shown with missing waste piping, provide per code and per other similar fixtures.

2. The contract documents indicate required valves, fittings, and accessories. If additional materials are required by code or manufacturer’s instructions, they shall be provided at no cost to the owner.

E. This contractor will be responsible to carry out the commissioning requirements specified. Refer to Division 1 for additional requirements.
1.3 DEFINITIONS

A. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

B. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations. Installation shall be complete and tested ready for intended use, in accordance with code and manufacturers recommendations.

C. "Provide": Furnish and install.

D. "Shall": The word shall is used to indicate mandatory requirements strictly to be followed in order to conform to the standard and procedures and from which no deviation is permitted.

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

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

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

H. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

1.4 SUBMITTALS

A. Provide in accordance with Division 1 of the specifications.

1.5 SUBSTITUTIONS

A. Provide in accordance with Division 1 of the specifications.

1.6 QUALITY ASSURANCE

A. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications.

B. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
D. Electrical Characteristics for 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.

E. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.

F. Plumbing work shall be performed by, or under, the direct supervision of a licensed master plumber.

G. Electrical work shall be performed by, or under, the direct supervision of a licensed electrician.

1.7 DELIVERY, STORAGE, AND HANDLING OF PIPING

A. Pipe and tube required by the applicable standard to be cleaned and capped shall be delivered to the job site with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipe and tube from moisture and dirt. Elevate above grade. When stored inside, do not exceed the structural capacity of the floor.

C. Protect fittings, flanges, and piping specialties from moisture and dirt.

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

1.8 COORDINATION

A. Coordinate use of project space and sequence of installation of mechanical and electrical work, which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts, and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

B. Coordinate use of project space and sequence of installation of work.

C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Access panels shall be provided for concealed valves and controls, or any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced.

E. Coordinate requirements for access panels and doors for items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8.
PART 2 - PRODUCT

2.1 PRODUCT CRITERIA

A. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. See other specification sections for any exceptions.

B. Equipment Service: Products shall be supported by a service organization that maintains a complete inventory of repair parts and is located reasonably close to the site.

C. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

D. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.

E. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.

2.2 PIPE JOINING MATERIALS

A. Refer to individual Division 22 and 23 piping Sections for pipe, tube, and fitting materials and joining methods. Refer to individual piping Sections for special joining materials not listed below.

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

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

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

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


2.3 TRANSITION FITTINGS

A. Aboveground Pressure Piping: Pipe fitting.

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

A. Provide where copper tubing and ferrous metal pipe are joined.


C. Dielectric Nipples: Electroplated steel or ductile-iron nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig maximum working pressure at 230 deg F. Victaulic Style 47.

2.5 ESCUTCHEONS

A. Escutcheons shall be manufactured from nonferrous metals and shall be chrome-plated. Metals and finish shall conform to ASME A112.19.2. Escutcheons shall be one-piece type where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. ID shall closely fit around pipe, tube, and insulation of insulated piping and an OD that completely cover the opening.

B. All escutcheons shall have setscrews for maintaining a fixed position against a surface.

PART 3 - EXECUTION

3.1 DEMOLITION AND REMOvals

A. Refer to Division 1 for general demolition requirements and procedures.

3.2 COMMON REQUIREMENTS

A. Install piping, ductwork, and equipment to allow maximum possible headroom unless specific mounting heights are 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 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.

C. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

D. Any structural member weakened or impaired by cutting, notching, or otherwise shall be reinforced, repaired, or replaced so as to be left in safe structural condition in accordance with the local building code requirements.
E. Install piping and ductwork in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

F. 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.

G. Install systems above accessible ceilings to allow sufficient space for ceiling panel removal.

H. Install piping to permit valve servicing.

I. Install equipment and other components to allow right of way for piping installed at required slope.

J. Install free of sags and bends.

K. Provide unions or flanges at connections to equipment.

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

M. Make allowances for application of insulation.

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

O. Verify final equipment locations for roughing-in.

P. Protection and Cleaning: Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items shall be replaced. Protect all finished parts of equipment. Close duct and pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water, chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

### 3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and the relevant specification section specifying piping systems.

B. Installer Qualifications

1. Pipe fitters shall be qualified to the procedure used to perform the pipe joining.
2. The contractor is responsible for documenting all qualification and training records of each pipe fitter. Pipe fitters shall have current, formal training on the pipe jointing method.
3. Contractor must submit documentation that lists personnel assigned to this project prior to beginning construction who have successfully completed formal training conducted by an authorized manufacturer's representative. The Contractor Training documentation shall be specific to the manufacturer of the pipe and fittings.
4. Personnel’s training documentation must be current and have been updated within the past two (2) years. Training received more than two years prior to operation with no evidence of activity within the past 6 months shall not be considered current.

5. Piping Warranty: Contractor shall provide and document required training and required by the piping system manufacturer in order to maintain the piping manufacturer’s warranty.

C. Ream ends of pipes and tubes and remove burrs. Bevel or groove plain ends of steel pipe.

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

E. 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.

F. 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. Only brazing alloys having a liquid temperature above 1000°F shall be used.

G. Fusion Joints: The employer of the fusion machine operator is responsible for the fusion joint quality of the fusion weld made by that individual. Fusion equipment operators shall be qualified to the procedure used to perform pipe joining. Fusion equipment operators shall have current, formal training on all fusion equipment employed on the project. Training received more than two years prior to operation with no evidence of activity within the past 6 months shall not be considered current.

H. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Non-pressure Piping: Join according to ASTM D 2855.

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

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

K. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer’s installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tools approved by the manufacturer.
3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

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

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

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

3.5 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor materials and equipment. Field Welding: Comply with AWS D1.1.

3.6 PIPE PENETRATIONS

A. Provide sealants for all pipe penetrations. All pipe penetrations shall be sealed.

B. Refer to Section 230700 “Mechanical Insulation”.

C. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation.

D. Escutcheons: Provide for penetrations in finished spaces where pipes are exposed.

E. Plastic and copper piping penetrating framing members, and within one-inch of the framing, shall be protected with 10-gauge steel nailing plates. The steel plate shall extend along the framing member a minimum of 1.5” beyond the OD of the pipe or tubing.

3.7 FIRESTOPPING

A. Provide through-penetration firestop systems to comply with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated. Provide in accordance Division 7.

END OF SECTION 230500
SECTION 230529 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:
   1. Division 23 Section "Common Work Results for Mechanical"
   2. Division 23 Section “Mechanical Insulation”
   3. Division 23 Section “Ductwork”

1.2 SUMMARY

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

1.3 SUBMITTALS

A. Submit product data on all hanger and support devices, including shields and attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

1.4 QUALITY ASSURANCE

A. Install in accordance with MSS SP69 - Manufacturers Standardization Society: Pipe Hangers and Supports- Selection and Application

B. Steel pipe hangers and supports shall have the manufacturer’s name, part number, and applicable size stamped in the part itself for identification.

C. Pipe Hangers, Supports, and Components: The materials of all pipe hanging and supporting elements shall be in accordance with MSS SP-58.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Pipe Hangers and Supports:
   a. B-Line Systems, Inc.
   b. Carpenter & Patterson, Inc.
   c. Grinnell Corp.
   d. Hubbard Enterprises/Holdrite®
   e. National Pipe Hanger Corp.
   f. Piping Technology & Products, Inc.
   g. Unistrut
   h. Anvil International, Inc.
   i. Empire

2.2 HANGERS

A. Hanger “Types” listed below are from Table 1 of MSS SP-69.

B. The material in contact with the pipe shall be compatible with the piping material so that neither will have a deteriorating action on the other. Provide means of preventing dissimilar metal contact such as plastic coated hangers, copper colored epoxy paint, or non-adhesive isolation tape- B-Line Iso-pipe. Galvanized felt isolators sized for copper tubing may also be used, B-Line B3195CT.

C. Uninsulated pipes 2 inch and smaller:
   1. Type 10: Adjustable steel swivel ring (band type) hanger, B-Line B3170.
   2. Type 10, copper tubing; Adjustable steel swivel ring (band type) hanger, B-Line B3170CT.
   3. Type 12: Malleable iron ring hanger, B-Line B3198R or hinged ring hanger, B3198H.
   4. Type 1: Adjustable steel clevis hanger, B-Line B3100.
   5. Type 1: Adjustable steel clevis hanger, copper piping, B-Line B3104CT.

D. Uninsulated pipes 2-1/2 inch and larger: Type 1: Adjustable steel clevis hanger, B-Line B3100.

E. Insulated pipe- carrying fluid temperature of 60°F or warmer: Use adjustable steel clevis with galvanized sheet metal shield. Type 1 with Type 40 (B-Line B3151) series insulation protection shield. Anvil International Figure 260 insulation saddle system may be utilized (200°F maximum temperature).

F. Insulated pipe- Coldwater piping: Use adjustable steel clevis with galvanized sheet metal shield. Type 1 with Type 40 (B-Line B3151 series) insulation protection shield. Anvil International Figure 260 insulation saddle system may be utilized (200°F maximum temperature).

G. Shields shall be 180° degree galvanized sheet metal, 18 gauge minimum thickness, designed to match outside diameter of the insulated pipe, B-Line B3151. Refer to Section 230700 “Mechanical Insulation” for shield and insert lengths.
H. Pipe Clamps

1. Type 4: When flexibility in the hanger assembly is required due to horizontal movement, use pipe clamps with weld-less eye nuts, B-Line B3140.
2. Type 3: For insulated lines use double bolted pipe clamps, B-Line B3144.
3. For copper piping, Type 12: Malleable iron ring hanger, B-Line B3198RCT or hinged ring hanger B3198HCT.

I. Vertical Supports

1. Type 8: Steel riser clamp sized to fit outside diameter of pipe, B-Line B3373.
2. Type 8: For supporting vertical runs of copper tubing, use epoxy painted or plastic coated riser clamps, B-Line B3373CT or B3373CTC.

2.3 UPPER ATTACHMENTS

A. Beam Clamps

1. Beam clamps shall be used where piping is to be suspended from building steel. Clamp type shall be selected on the basis of load to be supported, and load configuration.
2. Type 23 C-Clamps shall have locknuts and cup point set screws, B-Line B351L, or B3036L.
3. Type 19 Top flange c-clamps shall be used when attaching a hanger rod to the top flange of structural shapes, B-Line B3034 or B3033.
4. Refer to manufacturer’s recommendation for setscrew torque.
5. Retaining straps shall be used to maintain the clamps position on the beam where required.

2.4 ACCESSORIES

A. Hanger Rods shall be threaded both-ends, or continuous threaded rods of circular cross section. Use adjusting locknuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.

B. Pipe protection saddles shall be formed from carbon steel, 1/8 inch minimum thickness, sized for insulation thickness. Saddles for pipe sizes greater than 12 inch shall have a center support rib.

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

D. Design and fabricate supports using structural quality steel bolted framing materials as manufactured by Cooper B-Line. Channels shall be roll formed, 12 gauge ASTM A1011 SS Grade 33 steel, 1-5/8 inch by 1-5/8 inch or greater as required by loading conditions. Submit designs for pipe tunnels, pipe galleries, etc., to engineer for approval. Use clamps and fittings designed for use with the strut system.
PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger requirements are specified in Sections specifying equipment and systems. Hangers shall be as recommended by manufacturer of piping.

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

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

D. Support of pipe, tubing and equipment shall be accomplished by means of engineered products, specific to each application. Makeshift, field devised methods shall not be allowed.

3.2 HANGER SPACING

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

B. Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:

1. NPS ¾ and smaller: Maximum span, 5 feet; minimum rod size, 3/8 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.

C. Piping Hangers for Plastic Piping:

1. Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
2. In systems where large fluctuations in temperature occur, allowances must be made for expansion and contraction of the piping system. Since changes in direction in the system are usually sufficient to allow for expansion and contraction, hangers must be placed so as not to restrict this movement.
3. Hangers shall not compress, distort, cut or abrade the piping. All piping shall be supported at intervals sufficiently close to maintain correct pipe alignment and to prevent sagging or grade reversal. Pipe should also be supported at all branch ends and at all changes of direction.
4. Install hangers for piping with the following maximum horizontal spacing and minimum rod diameters (pipe temperature 100°F or lower).
   a. NPS 1 and smaller: 4 feet with 3/8-inch rod.
   b. NPS 1-1/4 and 1-1/2 and NPS 2: 5 feet with 3/8-inch rod.
5. Install supports for vertical piping every 10 feet.
6. Refer to Section 226600 for chemical waste support spacing.
7. Refer to Section 226700 for RO water support spacing.
D. Support vertical piping independently of connected horizontal piping. Support vertical pipes at base and at every floor. Wherever possible, locate riser clamps directly below pipe couplings or shear lugs.

E. Place a hanger within 12 inches of each horizontal elbow.

3.3 HANGER AND SUPPORT INSTALLATION

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

B. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.

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

D. 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.

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

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

G. Install hangers to provide a minimum of 1/2-inch space between finished covering and adjacent work.

H. Do not support piping from other pipes, ductwork or other equipment that is not building structure.

3.4 ADJUSTING

A. Adjust hangers and supports to distribute loads equally on attachments and to achieve indicated slope of pipe. Ensure that rods are vertical under operating conditions. Equalize loads. Tighten all nuts and screws after adjustment.

B. Follow manufacturer’s recommended written instructions and torque values when tightening C-clamps to flange of beam.

END OF SECTION 230529
SECTION 230553  IDENTIFICATION FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 1 Specification Sections, apply to this Section.
   B. Division 23 Section “Common Work Results for Mechanical”

1.2 SUMMARY
   A. This Section includes the following mechanical identification materials and their installation.

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

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

1.5 COORDINATION
   A. Coordinate installation of identifying devices with completion of covering and painting of
      surfaces where devices are to be applied.
   B. Coordinate installation of identifying devices with location of access panels and doors.
   C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 PIPING IDENTIFICATION DEVICES
   A. Manufactured Pipe Markers, General: Seton, Brady, or approved equal; preprinted, color-
      coded, with lettering indicating service, and showing direction of flow.
      1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length. Size of letters and length of color field per ASME A13.1.
3. Pipes with OD, Including Insulation; Full-band snap-around pipe markers extending 360 degrees around pipe at each location.
4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
5. Minimum length of color field and size of letters shall be in accordance with Uniform Plumbing Code requirements.

B. Types:
   2. Snap-around type: Seton Setmark.
   3. Wrap-around type: Seton Ultra-mark; PVF over-laminated polyester construction seals in and protects graphics; suitable for outdoor or harsh environments.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL
A. Products specified are for applications referenced in other Division 22 or 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 PIPING IDENTIFICATION
A. Piping Identification Types: Snap-around marker or self-adhesive marker.
B. Install manufactured pipe markers indicating service on each piping system.
   1. Install pipe markers to manufacturer's instructions.
   2. Identify piping, concealed or exposed. Include service and flow direction.
   3. Install in clear view and align with axis of piping.
   4. Locate identification at maximum 20 feet centers on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
   5. At access doors and similar access points that permit view of concealed piping.
   6. At least one per room.
C. Equipment located above the ceiling that requires servicing shall be labeled on the ceiling using a labeling machine.
   1. Ceilings 10 feet and lower: Letters shall be ¼” high, black.
   2. Ceilings higher than 10 feet: Letters shall be 3/8” high, black.
   3. Label all equipment above ceiling that requires servicing or access.
   4. Locate labels on the ceiling grid, adjacent to the ceiling tile that provides the best access to the valve or item that requires servicing.
3.3 ADJUSTING

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

3.4 CLEANING

A. Clean faces of mechanical identification devices.

END OF SECTION 230553
SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems
2. Testing, Adjusting, and Balancing Equipment
3. Control system verification.

B. Equipment Requiring Testing, Adjusting, and Balancing:

1. Air Terminal Units
2. Air Inlets and Outlets
3. Terminal Transfer Units (radiant panel)
4. HW duct coils

1.3 QUALITY ASSURANCE

A. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4: "Instrumentation."

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.4 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, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

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

E. Examine equipment performance data.
   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.

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 HVAC 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 terminal units and verify that they are accessible and their controls are connected and functioning.

J. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine operating safety interlocks and controls on HVAC 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.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

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

1. Airside:
   a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
   b. Duct systems are complete with terminals installed.
   c. Volume dampers are open and functional.
   d. Automatic temperature-control systems are operational.
   e. Ceilings are installed.
   f. Windows and doors are installed.
   g. 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 according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

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

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish.

C. Mark equipment and balancing devices, including damper-control positions, 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 BALANCING AIR SYSTEMS

A. Obtain manufacturer's outlet factors and recommended testing procedures.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check dampers for proper position to achieve desired airflow path.

F. Check for airflow blockages.

3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. After fume hoods have been calibrated and balanced, test and adjust system for total airflow.
2. Verify final system conditions as follows:
   a. Re-measure and confirm that outdoor airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Mark final settings.

3.6 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Adjust flow-measuring devices installed in mains and branches to design water flows.
   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.

2. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Perform temperature tests after flows have been balanced.

3. Mark final settings and verify that all memory stops have been set.
3.7 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of valve and damper actuators.
6. Verify that controlled devices are properly installed and connected to correct controller.
7. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
8. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.8 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Air Outlets and Inlets: Plus or minus 10 percent.
2. Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.9 FINAL TEST & BALANCE REPORT

A. The report shall be a complete record of the HVAC system performance, including conditions of operation, items outstanding, and any deviations found during the T&B process. The final report also provides a reference of actual operating conditions for the owner and/or operations personnel. All measurements and test results that appear in the reports must be made on site and dated by the AABC technicians or test and balance engineers.

B. The report must be organized by systems and shall include the following information as a minimum:

1. Title Page:
   a. Company address
   b. Company telephone number
   c. Project identification number
   d. Location
   e. Project Architect
   f. Project Engineer
   g. Project Contractor
   h. Project number
   i. Date of report
2. Table of Contents.
3. AABC National Performance Guaranty.
4. Report Summary:
   a. The summary shall include a list of items that do not meet design tolerances, with information that may be considered in resolving deficiencies.
5. Instrument List:
   a. Type.
   b. Manufacturer.
   c. Model.
   d. Serial Number.
   e. Calibration Date.
6. T&B Data: Provide test data for specific systems and equipment as required by the most recent edition of the "AABC National Standards."

END OF SECTION 230593
SECTION 230700 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:
   1. Division 23 Section "Common Work Results for Mechanical"
   2. Division 23 Section "Hangers and Supports for Piping and Equipment" for pipe insulation shields and protection saddles.

1.2 SUMMARY

A. This Section includes insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

1.3 SUBMITTALS

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

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

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

B. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
C. Store tapes, adhesives, mastics, cements, and insulation materials in ambient conditions in accordance with the recommendations of the manufacturer.

D. Follow manufacturer’s recommended handling practices.

E. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.

F. Fiber Glass and Mold: Contractor shall take precaution to protect insulation. Any fiber glass insulation that becomes wet or torn should be replaced at no additional cost. Air handling insulation used in the air stream must be discarded if exposed to water.

1.6 COORDINATION

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

B. Schedule insulation application after testing systems. Insulation application may begin on segments of systems that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Certainteed
2. Knauf
3. Owens-Corning
4. John Mansville
5. Armstrong
6. Aeroflex USA
7. Nomaco K-Flex
8. Pabco

2.2 PIPING INSULATION MATERIALS

A. General

1. Supply fiber glass products that have achieved GREENGUARD Children & Schools Certification.
2. Surface Burning Characteristics: Insulation and related materials shall have surface burning characteristics determined by test performed on identical products per ASTM E
84 mounted and installed as per ASTM E 2231. All testing shall be performed by a
testing and inspecting agency acceptable to authorities having jurisdiction. Insulation,
jacket materials, adhesives, mastics, tapes and cement material containers shall be labeled
with appropriate markings of applicable testing and inspecting agency. Flame-spread
index of 25 or less, and smoke-developed index of 50 or less.

3. Supply fiber glass products that are manufactured using a minimum of 40% “post-
consumer” recycled material.

B. Glass Fiber:

1. Knauf 1000° Pipe Insulation with ECOSE Technology meeting ASTM C547 Type IV
   Grade A, ASTM C585, and ASTM C795; rigid, molded, noncombustible per ASTM
   E136; k value: ASTM C335, 0.23 at 75°F mean temperature. Maximum Service
   Temperature: 1000°F. Vapor Retarder Jacket: ASJ/SSL conforming to ASTM C1136
   Type I, secured with self-sealing longitudinal laps and butt strips.

2. PVC Fitting Covers: The Proto Fitting Cover System shall consist of one piece and two
   piece pre-molded high impact UV-resistant PVC fitting covers with fiberglass inserts and
   accessories, which include elbows, tee/valves, end caps, mechanical line couplings, and
   specialty fittings. Fittings shall be made of LoSMOKE® grade PVC, 25/50 rated per
   ASTM E-84. Thermal Value of fiberglass insert: K value of .26 at 75°F; resistance to
   fungi and bacteria. (ASTM G 21, ASTM G 22): does not promote growth of fungi or
   bacteria.

2.3 DUCTWORK INSULATION MATERIALS

A. Flexible Fiber Glass Blanket: Knauf Friendly Feel® Duct Wrap with ECOSE Technology
   meeting ASTM C553 Types I, II and III, and ASTM C1290; GREENGUARD certified;
   flexible, limited combustible; k value: ASTM C177, 0.29 at 75°F mean temperature. Maximum
   Service Temperature: faced: 250°F; unfaced: 350°F. Vapor Retarder Jacket: FSK conforming to
   ASTM C1136 Type II. Installation: Maximum allowable compression is 25%. Securement:
   Secured in place using outward cinching staples in combination with appropriate pressure-
sensitive aluminum foil or PSK tape, or in combination with glass fabric and vapor retarder
   mastic. Density: concealed areas: Minimum 0.75 PCF; exposed areas: Minimum 1.0 PCF.

2.4 ACCESSORY MATERIALS

A. Accessory materials installed as part of insulation work under his section shall include (but not
   be limited to):

1. Closure Materials - Butt strips, bands, wires, staples, mastics, adhesives; pressure-
sensitive tapes.

2. Adhesive: As recommended by insulation material manufacturer. Materials shall be
   compatible with insulation materials, jackets, and substrates and for bonding insulation to
   itself and to surfaces to be insulated

3. Support Materials - Hanger straps, hanger rods, saddles, support rings

B. All accessory materials shall be installed in accordance with manufacturer's instructions.
PART 3 - EXECUTION

3.1 EXAMINATION

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

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

C. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.

3.2 PREPARATION

A. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

3.3 GENERAL APPLICATION REQUIREMENTS

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

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

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

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

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

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

G. Keep insulation materials dry during application and finishing.
H. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer. Apply insulation with the least number of joints practical.

I. 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.

J. 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.

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

L. Maintain manufacturer's recommended temperatures and conditions for tapes, adhesives, mastics and cements.

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

N. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions. Firestopping and fire-resistive joint sealers are specified in Section 230500.

3.4 GLASS FIBER PIPING INSULATION

A. Locate all seams in the least visible location.

B. Insulation installed on piping operating below ambient temperatures must have a continuous vapor retarder. All joints, seams and fittings must be sealed. On systems operating above ambient, the butt joints should not be sealed.

C. Metal shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed as required between the pipe and the insulation shields. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required.

3.5 FLEXIBLE FIBER GLASS BLANKET

A. Install Duct Wrap using manufacturer’s stretch-out tables to obtain specified R-value using a maximum compression of 25%.

B. Firmly butt all joints.

C. The longitudinal seam of the vapor retarder must be overlapped a minimum of 2 inches. A 2-inch tab is provided on Knauf Friendly Feel® Duct Wrap for the circumferential seam.

D. Where vapor retarder performance is required, all penetrations and damage to the facing shall be repaired using pressure-sensitive tape matching the facing, or mastic prior to system startup.
Pressure-sensitive tapes shall be a minimum 3 inches wide and shall be applied with moving pressure using a squeegee or other appropriate sealing tool. Closure shall have a 25/50 Flame Spread/Smoke Developed Rating per UL 723.

E. Duct Wrap shall be additionally secured to the bottom of rectangular ductwork over 24 inches wide using mechanical fasteners on 18-inch centers. Care should be exercised to avoid over-compression of the insulation during installation. Unfaced Duct Wrap shall be overlapped a minimum of 2 inches and fastened using 4-inch to 6-inch nails or skewers spaced 4 inches apart, or secured with a wire/banding system. Care should be exercised to avoid damage to the Duct Wrap.

3.6 GENERAL PIPE INSULATION INSTALLATION

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

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

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

3.7 PIPING INSULATION APPLICATION SCHEDULE

A. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements. For piping systems not indicated, insulate to with a similar thickness and type as those specified.

B. All cold surfaces that may “sweat” must be insulated. Vapor barrier must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.

C. If piping type is omitted from list below, provide insulation as per similar duty.

D. Domestic hot water:
   1. Runouts and non-recirculated portions: Glass Fiber 1/2” thickness.
   2. Recirculating piping including the supply and return: Glass Fiber, 1” thickness.

E. Domestic cold water: Glass Fiber, ½” thickness.

F. Heating supply and return:
   1. Pipe size 1-1/4” and less: Glass Fiber; 1-1/2” thickness.
   2. Pipe size 1-1/2” and larger: Glass Fiber; 2” thickness.
   3. Insulation is not required strainers, control valves, unions, and balancing valves associated with piping 1” or less diameter. Insulate piping to within approximately 1-inch of un-insulated items.

3.8 DUCT SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section. For duct systems not indicated, insulate to with a similar thickness and type as those specified.

B. Insulation thicknesses and installations shall meet or exceed the requirements of ASHRAE Standard 90.1-2007, or thicknesses indicated, whichever is of superior insulating performance.

C. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
   1. Metal ducts with duct liner.
   2. Factory-insulated flexible ducts.
   3. Factory-insulated plenums, casings, and access doors.
   4. Flexible connectors.
3.9 DUCT AND PLENUM APPLICATION SCHEDULE

A. Supply Ducts: Flexible Fiber Glass Blanket: 1.5” thickness.

B. Return/exhaust ducts: None required.

END OF SECTION 230700
SECTION 230900 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment, and service necessary for an extension of the existing/addition to the existing building automation system.

B. The Controls Contractor’s work shall consist of the provision of all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, project-specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, warranty, specified services and items required by the Contract that are required for the functional turn-key operation of the complete and fully functional Controls Systems. Documents are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner.

C. Related Sections include the following:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
2. Division 1 Section “Testing, Adjusting, and Balancing”
3. Division 23 Section “Common Work Results for Mechanical”
4. Division 26

1.2 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing valves and control devices.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of valves including flow characteristics.
7. DDC System Hardware:
   a. Wiring diagrams for control units with termination numbers.
   b. Schematic diagrams and floor plans for field sensors and control hardware.
   c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
9. Controlled Systems:
   a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
   b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
   c. Written description of sequence of operation including schematic diagram.
   d. List of I/O Points (Point Schedule): provide for each input and output point physically connected to a digital controller: point name, point description, point type (Analog Output (AO), Analog Input (AI), Binary Output (BO), Binary Input (BI)), point sensor range, point actuator range, point address, BACnet object, associated BIBBS (where applicable), point connection terminal number. Typical schedules for multiple identical equipment are allowed unless otherwise requested in design or contract criteria.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.
B. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.4 QUALITY ASSURANCE

A. All products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved by the owner’s representative in writing. Spare parts shall be available for at least five years after completion of this contract.

B. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer. Use only employees who are qualified, skilled, experienced, manufacturer trained and familiar with the specific equipment, software and configurations to be provided for this Project.

C. Provide a complete, neat and workmanlike installation.

D. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications.

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, and marked for intended use.

F. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

G. The contractor shall protect all work and material from damage by his/her work or employees. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

1.5 CONTRACTOR QUALIFICATIONS

A. System shall be as manufactured, installed and serviced by:

1. IB Controls - Delta
1.6 COORDINATION

A. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition.

B. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

C. Coordinate location of thermostats and other exposed control sensors with existing conditions.

D. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the controls system specified in this section. These controls shall be integrated into the system and coordinated by the contractor.

E. 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 unit manufacturer.

F. HVAC Contractor: Installation of automatic control valves.

G. Electrical Subcontractor: Power wiring

H. Complying with the principle of "unit responsibility" all electrical work for automatic controls, except as otherwise specified, or shown on the electrical drawings shall be included in Division 23. Electrical work shall, in general, comply with the following, unless otherwise directed by Division 26:

1. All electrical work shall comply with the N.E.C. and local electrical codes.
2. Electrical work may include both line voltage and low voltage wiring, as required.

I. Coordinate with controls specified in other sections of divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:

1. All communication media and equipment shall be provided as specified hereinafter.
2. Each supplier of a control product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
3. The contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
4. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.
1.7 WARRANTY

A. Refer to Division 1 Requirements.

B. At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the engineer, the engineer shall sign certificates certifying that the control system’s operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty. All work shall have a single warranty date, even when the owner has received beneficial use due to an early system start-up.

C. All components, system software, and parts supplied by the BMS contractor shall be guaranteed against defects in materials and workmanship for one year from acceptance date. The BMS contractor at no charge shall furnish Labor to repair, reprogram, or replace components during the warranty period. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner’s request for warranty service within 24 hours during normal business hours.

D. Provide remote service diagnostic monitoring from the nearest service location. At the request of the owner, a service diagnostic call will be made to troubleshoot and resolve (if possible) any reported system complaints. The owner will provide a dedicated telephone line for connection to the system.

E. Operator workstation software, project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies as identified by the contractor shall be provided at no charge during the warranty period. Any upgrades or functional enhancements associated with the above-mentioned items also can be provided during the warranty period for an additional charge to the owner by purchasing an in-warranty service agreement from the contractor. Written authorization by the owner must, however, be granted prior to the installation of any of the above-mentioned items.

PART 2 - PRODUCTS

2.1 DELTA SYSTEM

A. Direct digital controllers shall be UL 916 rated. All controls shall be DDC.

B. Control system provided for this project shall consist of a peer-to-peer networked, stand-alone, distributed system.

C. Provide internal clocks for all BACnet Building Controllers (B-BC) and BACnet Advanced Application Controllers (B-AAC) using BACnet time synchronization services. Automatically synchronize system clocks daily from an operator-designated controller. The system shall automatically adjust for daylight saving time.

D. Provide sufficient memory for each controller to support the required control, communication, trends, alarms, and messages. Protect programs residing in memory with EEPROM, flash memory, or by an uninterruptible power source (battery or uninterruptible power supply). The backup power source shall have capacity to maintain the memory during a 72-hour continuous
power outage. Rechargeable power sources shall be constantly charged while the controller is operating under normal line power. Batteries shall be replaceable without soldering. Trend and alarm history collected during normal operation shall not be lost during power outages less than 72 hours long.

E. Immunity to Power Fluctuations: Controllers shall operate at 90% to 110% nominal voltage rating.

F. Transformer: The controller power supply shall be fused or current limiting and rated at 125% power consumption.

G. Wiring Terminations: Use screw terminal wiring terminations for all field-installed controllers. Provide field-removable modular terminal strip or a termination card connected by a ribbon cable for all controllers other than terminal units.

H. Input and Output Interface: Provide hard-wired input and output interface for all controllers as follows:

1. Protection: Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with sources up to 24 volts AC or DC for any duration shall cause no controller damage.
2. Binary Inputs: Binary inputs shall have a toggle switch and monitor on and off contacts from a "dry" remote device without external power, and external 5-24 VDC voltage inputs.
3. Pulse Accumulation Inputs: Pulse accumulation inputs shall conform to binary input requirements and accumulate pulses at a resolution suitable to the application.
4. Analog Inputs: Analog inputs shall monitor low-voltage (0-10 VDC), current (4-20 mA), or resistance (thermistor or RTD) signals.
5. Binary Outputs: Binary outputs shall have a toggle switch and send a pulsed 24 VDC low-voltage signal for modulation control, or provide a maintained open-closed position for on-off control. For HVAC equipment and plant controllers, provide for manual overrides, either with three-position (on-off-auto) override switches and status lights, or with an adjacent operator display and interface. Where appropriate, provide a method to select normally open or normally closed operation.
6. Analog Outputs: Analog outputs shall send modulating 0-10 VDC or 4-20 mA signals to control output devices.

I. Provide a BACnet inter-network with control products, communication media, connectors, repeaters, hubs, and routers. Controller and operator interface communication shall conform to ASHRAE 135, BACnet. If a controller becomes non-responsive, the remaining controllers shall continue operating and not be affected by the failed controller.

2.2 PROGRAMMING

A. Provide programming to execute the sequence of operation indicated. Provide all programming and tools to configure and program all controllers. Provide programming routines in simple, easy-to-follow logic with detailed text comments describing what the logic does and how it corresponds to the project's written sequence of operation.
B. Parameter Modification: All writeable object properties, and all other programming parameters needed to comply with the project specification shall be adjustable for devices at any network level, including those accessible with web-browser communication, and regardless of programming methods used to create the applications.

C. Time Synchronization: Provide time synchronization, including adjustments for leap years, daylight saving time, and operator time adjustments.

D. Scheduling: Provide operating schedules as indicated, with equipment assigned to groups. Changing the schedule of a group shall change the operating schedule of all equipment in the group. Groups shall be capable of operator creation, modification, and deletion. Provide capability to view and modify schedules in a seven-day week format. Provide capability to enter holiday and override schedules one full year at a time.

E. Object Property Override: Allow writeable object property values to accept overrides to any valid value. Where specified or required for the sequence of control, the Out-Of-Service property of Objects shall be modifiable. When documented, exceptions to these requirement are allowed for life, machine, and process safeties.

F. Alarms and Events: Alarms and events shall be capable of having programmed time delays and high-low limits. When a computer workstation or web server is connected to the inter-network, alarms/events shall report to the computer, printer, alphanumeric pager, email, or cell phone, as defined by USM’s maintenance personnel. Otherwise alarms/events shall be stored within a device on the network until connected to a user interface device and retrieved. Provide alarms/events in agreement with the point schedule, sequence of operation, and USM. At a minimum, provide programming to initiate alarms/events any time a piece of equipment fails to operate, a control point is outside normal range or condition shown on schedules, communication to a device is lost, a device has failed, or a controller has lost its memory.

G. Trending: Provide trend services capable of trending all object present values set points, and other parameters indicated for trending on project schedules. Trends may be associated into groups, and a trend report may be set up for each group. Trends are stored within a device on the network, with operator selectable trend intervals from 10 seconds up to 60 minutes. The minimum number of consecutive trend values stored at one time shall be 100 per variable. When trend memory is full, the most recent data shall overwrite the oldest data. The operator workstation shall upload trends automatically upon reaching 3/4 of the device buffer limit (via Notification-Threshold property), by operator request, or by time schedule for archiving. Archived and real-time trend data shall be available for viewing numerically and graphically for at the workstation and connected notebook computers.

H. Device Diagnostics: Each controller shall have diagnostic LEDs for power, communication, and device fault condition. The DDC system shall recognize and report a non-responsive controller.

I. Power Loss: Upon restoration of power, the DDC system shall perform an orderly restart and restoration of control.
2.3 BACNET OPERATOR WORKSTATION

A. Existing Delta Controls workstation.

B. Graphics Software: Update for new systems, consistent with USM standards.

2.4 SENSING DEVICES

A. Wall temperature sensors: Delta BACstat

2.5 OUTPUT HARDWARE

A. Electronic valve actuation shall be provided.

1. Manufactured, brand labeled or distributed by BELIMO, or approved equal.
2. Size for torque required for damper seal at load conditions.
3. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
4. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
5. Overload protected electronically throughout rotation.
6. Fail-Safe Operation: Mechanical, spring-return mechanism.
7. Proportional Actuators shall be fully programmable through an EEPROM without the use of actuator mounted switches.
8. Proportional actuators shall have an external, built-in switch to allow the reversing of direction of rotation.
9. Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10 VDC position feedback signal.
10. Temperature Rating: -22 to +122°F
11. Housing: Minimum requirement NEMA type 2 mounted in any orientation.
12. Agency Listings: ISO 9001, cULus, CE or CSA
13. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.

B. Control Valves: Control valves shall be two-way two-position or modulating service as shown.

1. Steam pressure is maintained at 3 to 5 psig.
2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide a minimum close-off pressure rating of 20 psi.
3. Body and trim materials shall be in accordance with manufacturer’s recommendations for design conditions and service with linear ports for modulating service. Sizing Criteria, modulating service: pressure drop 80% of inlet of psig.

C. Output Switches: Control Relays; Field installed and DDC panel relays shall be double pole, double throw, UL864 listed, with contacts rated for the intended application, indicator light, and dust proof enclosure. The indicator light shall be lit when the coil is energized and off when coil is not energized. Relays shall be the socket type, plug into a fixed base, and replaceable without
tools or removing wiring. Encapsulated "PAM" type relays may be used for terminal control applications.

2.6 ELECTRICAL POWER AND DISTRIBUTION

A. Transformers: Transformers shall conform to UL 506. For control power other than terminal level equipment, provide a fuse or circuit breaker on the secondary side of each transformer.

B. Surge and Transient Protection: Provide each digital controller with surge and transient power protection.

C. Wiring: Provide complete electrical wiring for the DDC System, coordinate line of demarcation with Division 26.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.

B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started. Verify that pipe and equipment-mounted devices and wiring are installed before proceeding with installation.

C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor’s work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor’s work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and the expense of—this contractor.

3.2 GENERAL WORKMANSHIP AND FIELD QUALITY CONTROL

A. Install all components in accordance with the manufacturer’s recommendations.

B. Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.

C. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

D. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

F. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

G. Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.

H. Patch holes and finish to match existing walls.

3.3 BACNET

A. Minimum BACnet Object Requirements: consistent with USM standards.

B. Minimum BACnet Service Requirements: consistent with USM standards.

1. Alarming
   a. Alarm Priorities - Coordinate alarm and event notification with USM.
   b. Notification Class - Enable writeable Priority, Ack required, and Recipient List properties of Notification Class objects.
   c. Event Notification Message Texts - Use condition specific narrative text and numerical references for alarm and event notification.

2. Updating Displayed Property Values: Allow workstations to display property values at discrete polled intervals, or based on receipt of confirmed and unconfirmed Change of Value notifications. The COV increment shall be adjustable by an operator using BACnet services, and polled intervals shall be adjustable at the operator workstation.

C. BACnet Routers, Bridges, and Switches: Provide the quantity of BACnet routers, bridges, and switches necessary for communications shown on the BACnet Communication Architecture schematic. Provide BACnet routers with BACnet Broadcast Message Device (BBMD) capability on each BACnet inter-network communicating across an IP network. Configure each BACnet device and bridge, router, or switch to communicate on its network segment.

3.4 WIRING CRITERIA

1. Run circuits operating at more than 100 volts in rigid or flexible conduit, metallic tubing, covered metal raceways, or armored cable.

2. Do not run binary control circuit wiring in the same conduit as power wiring over 100 volts. Where analog signal wiring requires conduit, do not run in the same conduit with AC power circuits or control circuits operating at more than 100 volts.

3. Provide circuit and wiring protection required by NFPA 70.

4. Run all wiring located inside mechanical rooms in conduit.

5. Do not bury aluminum-sheathed cable or aluminum conduit in concrete.
6. Input/output identification: Permanently label each field-installed wire at each end with descriptive text using a commercial wire marking system that fully encircles the wire, cable, or tube. Locate the markers within 2 inches of each termination. Match the names and I/O number to the project's point list. Similarly label all power wiring serving control devices, including the word "power" in the label. Label all terminal blocks with alpha/numeric labels. All wiring and the wiring methods shall be in accordance with UL 508A.

7. For controller power, provide new 120 VAC circuits, with ground.

8. Provide each circuit with a dedicated breaker, and run wiring in its own conduit, separate from any control wiring. Connect the controller's ground wire to the electrical panel ground; conduit grounds are not acceptable.

9. Surge Protection: Install surge protection according to manufacturer's instructions. Multiple controllers fed from a common power supply may be protected by a common surge protector, properly sized for the total connected devices.

10. Grounding: Ground controllers and cabinets to a good earth ground as specified in Division 26.

11. Conduit grounding is not acceptable; all grounding shall have a direct path to the building earth ground. Ground sensor drain wire shields at the controller end.

12. The Contractor shall be responsible for correcting all associated ground loop problems.

13. Run wiring in panel enclosures in covered wire track.

B. Accessibility: Install all equipment so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install digital controllers, data ports, and concealed actuators, valves, dampers, and like equipment in locations freely accessible through access doors.

C. Digital Controllers: Install as stand alone control devices. Locate control cabinets at the locations shown on the drawings. If not shown on the drawings, install in the most accessible space, close to the controlled equipment.

3.5 INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer’s recommendations.

B. Temperature Sensors: Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate sensors according to manufacturer's instructions. Do not use sensors designed for one application in a different application.

C. Room Temperature Sensors: Verify location of thermostats and other exposed control sensors with plans and room details before installation. Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts.

3.6 ACTUATORS

A. Electronic valve actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer’s recommendations.
3.7 TEST AND BALANCE SUPPORT

A. The controls contractor shall coordinate with and provide on-site support to the test and balance (TAB) personnel. This support shall include:

1. On-site operation and manipulation of control systems during the testing and balancing.
2. Control setpoint adjustments for balancing all relevant mechanical systems.
3. Tuning control loops with setpoints and adjustments determined by TAB personnel.

3.8 CONTROLS SYSTEM OPERATORS MANUALS

A. Provide three electronic and printed copies of a Controls System Operators Manual. The manual shall be specific to the project, written to actual project conditions, and provide a complete and concise depiction of the installed work. Provide information in detail to clearly explain all operation requirements for the control system.

B. Provide with each manual: CDs of the project's control system drawings, control programs, data bases, graphics, and all items listed below. Include gateway back-up data and configuration tools where applicable. Provide CDs in jewel case with printed and dated project-specific labels on both the CD and the case. For text and drawings, use Adobe Acrobat or MS Office file types. When approved by the Owner, AutoCAD and Visio files are allowed. Give files descriptive English names and organize in folders.

C. Provide printed manuals in sturdy 3-ring binders with a title sheet on the outside of each binder indicating the project title, project location, contract number, and the controls contractor name, address, and telephone number. Each binder shall include a table of contents and tabbed dividers, with all material neatly organized. Manuals shall include the following:

1. A copy of the as-built control system (shop) drawings set, with all items specified under the paragraph "Submittals." Indicate all field changes and modifications.
2. A copy of the project's mechanical design drawings, including any official modifications and revisions.
3. A copy of the project's approved Product Data submittals provided under the paragraph "Submittals."
5. A copy of the project's approved final TAB Report.
6. Printouts of all control system programs, including controller setup pages if used. Include plain-English narratives of application programs, flowcharts, and source code.
7. Printouts of all physical input and output object properties, including tuning values, alarm limits, calibration factors, and set points.
8. A table entitled "AC Power Table" listing the electrical power source for each controller. Include the building electrical panel number, panel location, and circuit breaker number.
9. The DDC manufacturer's hardware and software manuals in both print and CD format with printed project-specific labels. Include installation and technical manuals for all controller hardware, operator manuals for all controllers, programming manuals for all controllers, operator manuals for all workstation software, installation and technical manuals for the workstation and notebook, and programming manuals for the workstation and notebook software.
10. A list of qualified control system service organizations for the work provided under this contract. Include their addresses and telephone numbers.
11. A written statement entitled "Software Upgrades" stating software and firmware patches and updates will be provided upon request at no additional cost to the Owner for a minimum of two years from contract acceptance. Include a table of all DDC system software and firmware provided under this contract, listing the original release dates, version numbers, part numbers, and serial numbers.

3.9 PERFORMANCE VERIFICATION TESTING (PVT)

A. General: The PVT shall demonstrate compliance of the control system work with the contract requirements. The PVT shall be performed by the Contractor and witnessed and approved by the commissioning agent if applicable. If the project is phased, provide separate testing for each phase.

B. Performance Verification Testing Plan

1. Develop the PVT Plan specifically for the control system in this contract. The PVT Plan shall be a clear list of test items arranged in a logical sequence. Include the intended test procedure, the expected response, and the pass/fail criteria for every component tested. The plan shall clearly describe how each item is tested, indicate where assisting personnel are required (like the mechanical contractor), and include what procedures are used to simulate conditions. Include a separate column for each checked item and extra space for comments. Where sequences of operations are checked, insert each corresponding routine from the project's sequence of operation. For each test area, include signature and date lines sign-off.

2. PVT Sample Size: Test all central plant equipment and primary air handling unit controllers unless otherwise directed. Test all terminal units. The Engineer, Owner, or Commissioning Agent may witness all testing, or random samples (at their discretion) of PVT items.

C. Pre-Performance Verification Testing Checklist: Submit the following as a list with items checked off once verified. Provide a detailed explanation for any items that are not completed or verified.

1. Verify all required mechanical installation work is successfully completed, and all HVAC equipment is working correctly (or will be by the time the PVT is conducted).
2. Verify all required control system components, wiring, and accessories are installed.
3. Verify the installed control system architecture matches approved drawings.
4. Verify all control circuits operate at the proper voltage and are free from grounds or faults.
5. Verify all required surge protection is installed.
6. Verify all DDC network communications function properly, including uploading and downloading programming changes.
7. Verify each digital controller's programming is backed up.
8. Verify all wiring, components, and panels are properly labeled.
9. Verify all required points are programmed into devices.
10. Verify all TAB work affecting controls is complete.
11. Verify all valve and actuator zero and span adjustments are set properly.
12. Verify all sensor readings are accurate and calibrated.
13. Verify each control valve and actuator goes to normal position upon loss of power.
14. Verify all control loops are tuned for smooth and stable operation. View trend data where applicable.
15. Verify each controller works properly in stand-alone mode.
16. Verify all safety controls and devices function properly, including freeze protection and interfaces with building fire alarm systems.
17. Verify all electrical interlocks work properly.
18. Verify all system and database software is installed, and graphic pages are created for each workstation and notebook.
19. Verify the as-built (shop) control drawings are completed.

D. Conducting Performance Verification Testing

1. Conduct witnessed PVT after approval of the completed Pre-PVT Checklist. Notify the Owner of the planned PVT at least 15 days prior to testing. Provide an estimated time table required to perform the testing. Furnish personnel, equipment, instrumentation, and supplies necessary to perform all aspects of the PVT. Ensure that testing personnel are regularly employed in the testing and calibration of DDC systems.
2. During testing, identify any items that do not meet the contract requirements and if time permits, conduct immediate repairs and re-test. Otherwise, deficiencies shall be investigated, corrected, and re-tested later. Document each deficiency and corrective action taken.
3. If re-testing is required, follow the procedures for the initial PVT. The Owner may require re-testing of any control system components affected by the original failed test.

E. Controller Capability and Labeling; Test the following for each controller:

1. Memory: Demonstrate that programmed data, parameters, and trend/alarm history collected during normal operation is not lost during power failure.
2. Direct Connect Interface: Demonstrate the ability to connect directly to each type of digital controller with a portable electronic device like a notebook computer or PDA. Show that maintenance personnel interface tools perform as specified in the manufacturer's technical literature.
3. Stand Alone Ability: Demonstrate controllers provide stable and reliable stand-alone operation using default values or other method for values normally read over the network.
4. Wiring and AC Power: Demonstrate the ability to disconnect any controller safely from its power source using the AC Power Table.
5. Demonstrate the ability to match wiring labels easily with the control drawings. Demonstrate the ability to locate a controller's location using the BACnet Communication Architecture Schematic and floor plans.
6. Nameplates and Tags: Show the nameplates and tags are accurate and permanently attached to control panel doors, devices, sensors, and actuators.

F. BACnet Communications and Interoperability Areas; Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. If available or required in this specification, use a BACnet protocol analyzer to assist with identifying devices, viewing network traffic, and verifying interoperability. These requirements must be met even if there is only one manufacturer of equipment installed. Testing includes the following:

1. Data Presentation: On each BACnet Operator Workstation, demonstrate graphic display capabilities.
2. Reading of Any Property: Demonstrate the ability to read and display any used readable object property of any device on the network.

3. Setpoint and Parameter Modifications: Show the ability to modify all setpoints and tuning parameters in the sequence of control or listed on project schedules. Modifications are made with BACnet messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.

4. Peer-to-Peer Data Exchange: Show all BACnet devices are installed and configured to perform BACnet read/write services directly (without the need for operator or workstation intervention), to implement the project sequence of operation, and to share global data.

5. Alarm and Event Management: Show that alarms/events are installed and prioritized according to the BMS Owner. Demonstrate time delays and other logic is set up to avoid nuisance tripping, e.g., no status alarms during unoccupied times or high supply air during cold morning start-up. Show that operators with sufficient privilege can read and write alarm/event parameters for all standard BACnet event types. Show that operators with sufficient privilege can change routing (BACnet notification classes) for each alarm/event including the destination, priority, day of week, time of day, and the type of transition involved (TO-OFF NORMAL, TO-NORMAL, etc.).

6. Schedule Lists: Show that schedules are configured for start/stop, mode change, occupant overrides, and night setback as defined in the sequence of operations.

7. Schedule Display and Modification: Show the ability to display any schedule with start and stop times for the calendar year.

8. Show that all calendar entries and schedules are modifiable from any connected workstation by an operator with sufficient privilege.

9. Archival Storage of Data: Show that data archiving is handled by the operator workstation/server, and local trend archiving and display is accomplished with BACnet Trend Log objects.

10. Modification of Trend Log Object Parameters: Show that an operator with sufficient privilege can change the logged data points, sampling rate, and trend duration.

G. Device and Network Management: Show the following capabilities -

1. Display of Device Status Information
2. Display of BACnet Object Information
3. Silencing Devices that are Transmitting Erroneous Data
4. Time Synchronization
5. Remote Device Re-initialization
6. Backup and Restore Device Programming and Master Database(s)
7. Configuration Management of Half-Routers, Routers and BBMDs

H. Execution of Sequence of Operation: Demonstrate that the HVAC system operates properly through the complete sequence of operation. Use read/write property services to globally read and modify parameters over the inter-network.
1. Control Loop Stability and Accuracy: For all control loops tested, provide trend graphs of the control variable over time, demonstrating that the control loop responds to a 20% sudden change of the control variable set point without excessive overshoot and undershoot. If the process does not allow a 20% set point change, use the largest change possible. Show that once the new set point is reached, it is stable and maintained. Control loop trend data shall be in real-time with the time between data points 30 seconds or less.

END OF SECTION 230900
SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:
   1. Division 01 Section “Allowances”
   2. Division 23 Section “Common Work Results for Mechanical”
   3. Section 230900 – Instrumentation and Control for HVAC for control equipment and devices and submittal requirements.
   4. Division 26

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment. Provide control devices, control software and control wiring as required for automatic operation of each sequence specified.

B. The system is BAS controlled using electric actuation. Provide proportional-integral-derivative (PID) algorithms for all control programs.

C. Functions called for in sequence of operations are minimum requirements and not to limit additional BAS system capabilities. Determine, through operation of the system, proportional bands, interval time, integral periods, adjustment rates, and any other input information required to provide stable operation of the control programs.

D. For each item of equipment, provide following functions which are not specifically mentioned in each Sequence of Operation:
   1. Start-Stop, manual, and scheduled
   2. On-Off status of each piece of equipment
   3. Run-time
   4. Alarm

E. All setpoints shall be monitored and adjustable. Setpoints listed herein are approximate. It is the responsibility of the BAS contractor to calibrate the system and all setpoints to actual working conditions once the system is on line.
PART 2 - SEQUENCES

2.1 AIR TERMINAL UNITS

A. Each pressure-independent VAV box shall include have a discharge air sensor to monitor DA temperature.

B. Unoccupied Mode

1. When the central air handling unit is off, the BAS shall command the VAV supply air damper closed.
2. When the central air handling unit is off, the BAS shall command the hot water valve closed.
3. If the room temperature falls below 60°F (adjustable), the BAS shall generate an alarm.

C. Occupied Mode

1. The BAS shall schedule the VAV to occupied mode. The central air handling unit must be running before the VAV will operate in the occupied mode.
2. Provide “dual maximum” control for maximum efficiency. In addition to a minimum airflow setpoint and a cooling maximum airflow setpoint, there is also a heating maximum airflow setpoint; hence the name "dual maximum".
   a. When the zone is in the cooling mode, the cooling loop output is mapped to the airflow setpoint from the cooling maximum to the minimum airflow setpoints. The hot water valve is closed.
   b. When the zone is in the deadband mode, the airflow setpoint shall be the minimum airflow setpoint. The hot water valve is closed.
   c. When the zone is in the heating mode, the heating loop shall maintain space temperature at the heating setpoint as follows:
      1) From 0%-50% loop signal, the heating loop output shall reset the discharge temperature from supply air temperature setpoint (e.g., 55°F) to 90°F. Note the upper temperature is limited to prevent stratification during heating.
      2) From 50%-100% loop signal, the heating loop output shall reset the zone airflow setpoint from the minimum airflow setpoint to the maximum heating airflow setpoint. The supply air discharge temperature remains at 90°F.
      3) The hot water valve shall be modulated using a PI control loop to maintain the discharge temperature at setpoint. Note that directly controlling the hot
The water valve from the zone temperature PI loop is not acceptable since it will not allow supply air temperature to be under control and limited in temperature to prevent stratification.

4) The VAV damper shall be modulated to maintain the measured airflow at setpoint.

3. CO2 Demand Control Ventilation:
   a. When the zone CO2 sensor is below 900 ppm (adj.), the system will have the terminal damper at minimum position and modulate the damper based on its PID temperature control algorithm to maintain desired zone temperature set-points.
   b. If the CO2 level at the zone exceeds its set point the system will begin to modulate the damper using a PID control loop. When the CO2 level set point is reached the box will stop modulation and begin back toward minimum position.
   c. If while modulating-open the damper, the space temperature limit is reached the system will engage reheat, modulating the 2-way control valve to maintain setpoint.
   d. If the maximum damper position is reached and the CO2 set point is still not satisfied the associated AHU will modulate its OA damper using a PID loop to bring the zone CO2 level below set point.

4. The BAS shall limit the maximum cooling setpoint to 78°F (adj.) and the minimum cooling setpoint to 74°F (adj.).
5. The BAS shall limit the maximum heating setpoint to 72°F (adj.) and the minimum heating setpoint to 65°F (adj.).
6. Operator Workstation: Display the following data:
   a. Room/area served.
   b. Room temperature, alarm high and low (2°F out of range)
   c. Room temperature set point, occupied.
   d. Room temperature set point, unoccupied.
   e. VAV supply box CFM
   f. VAV box damper % open
   g. VAV box supply temperature (units with reheat coils)
   h. Heating coil control-valve position as percent open.
   i. CO2 Setpoint
   j. CO2 ppm

D. Heating staging:
   1. Reheat coil modulate HW valve as required to maintain space setpoint.
   2. Fintube or HW Radiant panels, as a second heating stage, 2-position valve shall operate as required to maintain space setpoint. Panels shall be disabled and remain closed at OA temperatures above 40F.

END OF SECTION 230993
SECTION 233113 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

  B. Related Sections include the following:

    1. Division 23 Section "Common Work Results for Mechanical"
    2. Division 23 Section "Mechanical Insulation"
    3. Division 23 Section "Air Terminals"
    4. Division 23 Section "Diffusers, Registers, and Grilles."
    5. Division 23 Control Section
    6. Division 23 Section "Testing, Adjusting, and Balancing".

1.2 SUMMARY

  A. This Section includes metal ducts and accessories for heating, ventilating, and air-conditioning systems.

1.3 SYSTEM DESCRIPTION

  A. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions, which maybe altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.

  B. The contractor must comply with the enclosed specification in its entirety. If on inspections, the engineer finds changes have been made without prior written approval, the contractor will make the applicable changes to comply with this specification, at the contractor’s expense.

  C. At the discretion of the engineer, sheet metal gauges, and reinforcing may be randomly checked to verify all duct construction is in compliance.
1.4 SUBMITTALS

A. Ductwork:

1. Material, gage, type of joints, sealing materials, and reinforcing for each duct size range, including sketches or SMACNA plate numbers for joints, method of fabrication and reinforcing.
2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Duct layout indicating pressure classifications and sizes on plans.
4. Fittings.
5. Reinforcement and spacing.
6. Seam and joint construction.
7. Penetrations through fire-rated and other partitions.
8. Hangers and supports, including methods for building attachment

B. Ductwork Specialties Product Data; provide for the following:

1. Sealant
2. Duct-mounted access doors and panels.
3. Flexible ducts.

C. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.


1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver sealant and fire stopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Deliver, store and handle materials according to manufacturer's written recommendations.

C. All ductwork, equipment, and fittings delivered and stored on the job site must be capped to prevent the entry of moisture, construction dust or other debris.
PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. SMACNA: Gages of materials, fabrication, reinforcement, sealing requirements, installation, and method of supporting ductwork shall be in accordance with the following SMACNA manuals. Conform to the applicable requirements of NFPA 90A, 91, 96, and 101.

B. Galvanized, Sheet Steel, normal service: Lock-forming quality; ASTM A653, G60.

C. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 RECTANGULAR DUCT FABRICATION

A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with sheet steel, according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

2. Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

3. Maximum allowable deflection for transverse joints and intermediate reinforcements will not exceed 0.250 inch.

4. Longitudinal Seams: Pittsburgh lock shall be used on all longitudinal seams. Snap-lock seams are not acceptable.

5. If SMACNA seal class A or B is specified, the longitudinal seam shall be sealed from the inside.

B. Slide-on Transverse Joint Connectors: Prefabricated slide-on transverse duct connectors and components will be accepted. Duct constructed using prefabricated systems will refer to the manufacturer guidelines for sheet gauge, intermediate reinforcement size and spacing, and proper joint reinforcement(s). Approved connection systems: Ductmate Industries: or W.D.C.I.

C. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of un-braced panel area, unless ducts are lined. All large ducts must be braced as required to prevent drumming.

D. Fittings per SMACNA acceptable, specific fittings requirements below:

1. Fig. 2-3 Rectangular Elbows: Type RE2 square throat with vanes, Type RE1 radius, or Type RE5 dual radius.

2. Vane support in elbows: Fig 2-4. Turning vanes shall be Harper double wall turning vanes fabricated from the same material as the duct. Mounting rails shall have friction
3. Insert tabs that align the vanes automatically. Tab spacing shall be as specified in Figure 2-3 of the 1995 SMACNA Manual, “HVAC Duct Construction Standards, Metal & Flexible” Second Edition standard. Rail systems with non-standard tab spacing shall not be accepted. Due to tensile loading, vanes shall be capable of supporting 250 pounds when secured according to the manufacturer’s instructions.

4. Fig. 2-5 Rectangular Divided Flow Branches: Type 1, Type 2, Type 4A, or 4B.

5. Fig. 2-6 Branch Connections: 45-degree entry, 45-degree lead-in, bell-mouth or spin-in (single diffuser supply only).

6. Fig. 2-7 Offsets and Transitions. Use gradual offsets as shown, 90-degree offsets shall be avoided.

2.3 ROUND DUCT FABRICATION

A. Fabricate supply ducts of galvanized steel according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" latest edition.

B. Round ducts shall be longitudinal Grooved Seam Flat lock (RL-5 seam) at 2-inch wg construction. Snap lock seams shall not be used for this project.

C. Round Joints: Interior slip coupling beaded at center and fastened to duct with screws shall be used to join ducts. Seal joint with an approved sealing compound, continuously applied around joint prior to assembling and after fastening, making certain that majority of sealant resides on interior of the joint.

2.4 SEALANT MATERIALS

A. Joint Sealant/Mastic: Shall be flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall prevent the entry of water, air and moisture into the duct system. Sealer shall be UL 723 and UL 181 listed and meet NFPA 90A requirements.

1. Maximum 5 flame spread and 0 smoke-developed (ASTM E-84 Tunnel Test).
2. Generally provide liquid sealant for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger.
3. Resistance to mold, mildew and water: Excellent
4. Color: Gray
5. Duct sealant/mastic shall meet requirement for “LEED IEQ Credit 4.1: Low Emitting Materials: Adhesive and Sealant”. ITW TACC Miracle Kingco water-based sealants, or approved equal.

B. Flange Gasket: A butyl rubber gasket which complies with UL Standard 181 and 723 testing and meets Mil-C 18969B and TTS-S-001657. This material, in addition to the above, shall not contain vegetable oils, fish oils, or any other type vehicle that will support fungal and/or bacterial growth. Approved: Ductmate 440 Butyl gasket tape.
2.5 HANGERS AND SUPPORTS

A. Building Attachments: Fasteners appropriate for building materials. Provide per SMACNA Fig’s. 4-1, 4-2, and 4-3.

1. Sheet Metal Screws, Machine Bolts and Nuts: Same material as duct, unless otherwise specified.
2. C Clamps: Fee & Mason Co.’s 255L with locking nut, and 255S with retaining strap.
3. Metal Deck Ceiling Bolts: B-Line Systems, Inc.’s Fig. B3019.
5. Structural (carbon) Steel Shapes and Steel Plates: ASTM A36, shop primed.
7. Machine Bolt Expansion Anchors: Non-caulking single unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 1; Non-caulking double unit type: FS FF-S-325, Group II, Type 2, Class 2, Style 2; Self-drilling type: FS FF-S-325, Group III, Types 1 and 2.

B. Hanger Materials: Sheet steel or round, threaded steel rod. Straps and Rod Sizes: Comply with SMACNA for sheet steel width and thickness and for steel rod diameters.

1. Duct Attachments: Strap hangers, angles, trapezes, and rods per SMACNA Fig. 4-4. Wire supports are not permitted.
2. Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
3. Trapeze and Riser Supports: Steel shapes complying with ASTM A36/A36M.

C. Dissimilar Metals: Separate dissimilar metals used for ductwork with 12 oz vinyl coated woven fiberglass duct connector fabric, such as Duro Dyne's Glasseal. No separation is required between screws or rivets and the materials in which they are inserted.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

2.6 FITTINGS

A. Tees, Laterals, and Conical Tees: Use 45 degree; fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal seam straight duct.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.

C. Elbows: Diameters 3 through 8 inches shall be two-section die stamped; all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
2.7 MANUAL-VOLUME DAMPERS

A. Manual balancing dampers meeting the following specifications shall be furnished and installed on all branch ducts and where shown on plans. Testing and ratings to be in accordance with AMCA Standard 500-D.

B. Single-Blade Rectangular Dampers shall consist of: an 18 ga. galvanized steel frame with 3-1/2 in. depth; blades fabricated from 20 ga. galvanized steel; integral 1/2 in. dia. axles. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD-10.

C. Multi-Blade Rectangular Dampers shall consist of: a 16 ga. galvanized steel hat channel frame with 5 in. depth; triple V type blades fabricated from 16 ga. galvanized steel; ½ in. dia. plated steel axles; external (out of the airstream) blade-to-blade linkage. Damper suitable for pressures to 4.0 in. w.g. (996 Pa), velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD15.

D. Round dampers shall consist of: a 20 ga. galvanized steel frame with 6 in. depth; blades fabricated from 20 ga. galvanized steel; 3/8 in. square plated steel axles turning in acetal bearings. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBDR50.

2.8 DUCT-MOUNTED ACCESS DOORS

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

1. Ductmate Industries, Inc.
2. Greenheck Fan Corporation.
3. McGill Air Flow LLC.
4. Nailor Industries Inc.
5. Cesco
6. Buckley


2.9 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 0 or 1. Flame Spread: Less than 25; Smoke Developed: Less than 50.

B. All products shall be certified by Greenguard Environmental Institute; independent testing of products for emissions of respirable particles and Volatile Organic Compounds (VOC’s), including formaldehyde and other specific product-related pollutants. Greenguard provides independent, third-party certification of IAQ performance. Certification is based upon criteria used by EPA, OSHA and WHO.
C. Rated Positive Pressure: 10\" w.g. per UL-181. Maximum negative pressure: \(\frac{3}{4}\"\).

D. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch-thick (R = 6.0), glass-fiber insulation around a continuous inner liner.
   1. Reinforcement: Steel-wire helix encapsulated in inner liner.
   3. Inner Liner: Polyethylene film.

E. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size. Hangers shall be band type, 1" wide minimum.

PART 3 - EXECUTION

3.1 MATERIALS
   A. Hangers, accessories, and dampers shall be same material as parent duct.
   B. All ducts shall be G60 galvanized steel.

3.2 DUCT CLASSIFICATIONS AND SEALING
   A. Static-Pressure Classifications: Unless otherwise indicated, construct ducts to the following:
      1. Supply Ducts: 2-inch wg.
      2. Return Ducts: 2-inch wg, negative pressure.
      3. General Exhaust Ducts: 2-inch wg, negative pressure.

   B. Seam And Joint Sealing
      1. General: Seal duct seams and joints according to the duct pressure class indicated and as described in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
      2. Seal to SMACNA Class A; all joints, longitudinal and transverse seams, and connections in ductwork shall be securely fastened and sealed with welds, gaskets, or duct sealant.

   C. Seal externally insulated ducts before insulation installation.

3.3 DUCT INSTALLATION, GENERAL
   A. Construct and install each duct system for the specific duct pressure classification indicated.
   B. Properly seam, brace, stiffen, support and render ducts mechanically airtight. Adjust ducts to suit job conditions. Dimensions may be changed as approved, if cross sectional area is maintained.
   C. Install ducts in lengths not less than 12 feet, unless interrupted by fittings. Install ducts with fewest possible joints.
D. Install fabricated fittings for changes in directions, changes in size and shape, and connections.

E. Install couplings tight to duct wall surface with a minimum of projections into duct.

F. Install ductwork to allow maximum headroom. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.

I. Coordinate layout with suspended ceiling, lighting layouts, and similar finished work.

3.4 DUCT PENETRATIONS

A. Where ducts pass through walls or partitions, the opening in the construction around the duct shall be as follows:
   1. Not exceeding a 1” average clearance on all sides.
   2.Filled solid with firestoppping material as specified in Section 230500.

B. Flexible air ducts or connectors shall not pass through any wall, floor, or ceiling.

3.5 HANGING AND SUPPORTING

A. Install duct with support systems indicated in SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible."
   1. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.
   2. Support horizontal ducts at a maximum interval of 10 feet.
   3. Support vertical ducts at a maximum interval of 16 feet and at each floor.
   4. Secure upper hanger attachments to structural steel or steel bar joists wherever possible.
   5. Do not use drive-on beam clamps, flat bars or bent rods, as upper hanger attachments.
   6. Do not attach hangers to pre-cast concrete planks less than 2-3/4 inches thick.
   7. Avoid damage to reinforcing members in concrete construction.
   8. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

3.6 FLEXIBLE DUCT

A. Provide in accordance with manufacturer’s and Air Diffusion Council recommendations.

B. Flexible ducts shall be supported at manufacturer’s recommended intervals, but at no greater distance than 5 feet. Maximum permissible sag is ½” per foot of spacing between supports.
C. Install duct fully extended; do not install in the compressed state or use excess lengths.

D. Avoid bending ducts across sharp corners or incidental contact with metal fixtures, pipes, conduits, or hot equipment. Radius at centerline shall not be less than one duct diameter.

E. Hanger or saddle material in contact with the duct shall be at least 1-1/2” wide.

F. Provide at least 2 duct diameters of straight duct at the entrance to register, grilles, and diffusers.

3.7 DUCT ACCESSORIES INSTALLATION

A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

B. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards

C. Each register, grille, or diffuser shall have a means of air flow adjustment. Provide volume damper in branch duct if not furnished with the RGD.

D. Adjust operable devices for proper action.

E. Install duct access panels for access components that require servicing.

1. Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining per equipment manufacturers’ requirements.
2. Install access panels on side of duct where adequate clearance is available.
3. Locate panel upstream and/or downstream as recommended by manufacturer.

3.8 FIELD QUALITY CONTROL

A. HVAC systems shall not be operated during construction.

B. Upon completion of installation duct systems and before HVAC system start-up, visually inspect the ductwork proper installation

C. All ductwork shall be provided with temporary enclosures to keep the HVAC system free of dust and construction debris. Confirm that the duct system is free from construction debris. Check all registers, grilles, and diffusers to ensure that they are clean and free from construction debris. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean; however, the Owner reserves the right to further verify system cleanliness through Surface Comparison Testing or the NADCA vacuum test specified in the NADCA standards. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be cleaned and subjected to re-inspection for
cleanliness. If cleaning is required, the procedures of the National Air Duct Cleaners Association (NADCA) General Specifications for the Cleaning of Commercial HVAC Systems (free download) shall be followed. Costs of this work shall be borne by Division 23.

END OF SECTION 233113
SECTION 233600 - 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 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for HVAC"
2. Division 23 Controls Section for control devices installed on air terminals.

1.2 SUMMARY

A. This Section includes single-duct air terminals.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings and schedules indicate requirements of air terminals and are based on specific systems indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

B. Listing and Labeling: Provide electrically operated air terminals specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
C. Testing Requirements: Test and rate air terminals according to ARI 880, "Industry Standard for Air Terminals."

D. Identification: Label each air terminal with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

E. NFPA Compliance: Install air terminals according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

F. Comply with NFPA 70 for electrical components and installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Trane
2. Titus
4. Price
5. Metal Aire
6. Krueger

B. All terminal units shall be ARI 880 - 98 certified and UL Listed.

2.2 SINGLE-DUCT AIR TERMINALS

A. The unit casing shall be comprised of 22 gauge galvanized steel. Outlet connection shall be slip and drive. Basis of Design: Trane VariTrane Single-Duct VCCF – Cooling Only or Trane VCWF – With Hot Water Coil

B. Casings: 22 gauge galvanized steel. Maximum casing leakage: 7 cfm at 1-inch wg inlet static pressure.

C. 3/8" Closed-cell Insulation—Interior surface of the unit casing is acoustically and thermally lined with 3/8-inch, 4.4 lb/ft³ closed-cell insulation. Insulation is UL listed and meets NFPA-90A and UL 181 standards. Insulation has an R-Value of 1.4. There are no exposed edges of insulation (complete metal encapsulation).

D. The air inlet connection shall be an 18 gauge galvanized steel cylinder sized to fit standard round duct. A multiple point, averaging flow sensing ring shall be provided with balancing taps for measuring within +/- 5% of unit cataloged airflow. Airflow versus pressure differential calibration chart shall be provided. The damper blade shall be constructed of a closed cell foam seal mechanically locked between two 22 gauge galvanized steel disks. The damper blade assembly shall be connected to a cast zinc shaft supported by self lubricating bearings. The shaft shall be cast with a damper position indicator. The valve assembly shall include a
mechanical stop to prevent over stroking. At 4.0" wg air valve leakage does not exceed 1% of cataloged airflow.

E. Hot Water Coil: Factory mounted on outlet. Provide full fin collars provided for accurate fin spacing and maximum fin-tube contact. The seamless copper tubes shall be mechanically expanded into the fin collars. Coils shall be proof tested at 450-psi and leak tested at 300-psi air pressure under water. Coil connections shall be sweat with left hand or right hand coil connections as per field constraints. Coils shall be provided with an access for cleaning.

F. Controls

1. The terminals will have pressure independent direct digital controls supplied and mounted by the control contractor.
2. Terminals shall be furnished with a pneumatic inlet velocity sensor. The sensor shall be multi-point center averaging type, with a minimum of four measuring ports parallel to the take-off point from the sensor. Sensors with measuring ports in series are not acceptable. The sensor must provide a minimum differential pressure signal of 0.03" wg. at an inlet velocity of 500 fpm.
3. Flow measuring taps and flow curves shall be supplied with each terminal for field balancing airflow.
4. All pneumatic tubing shall be UL listed fire retardant (FR) type.
5. Each terminal shall be equipped with labeling showing unit location, size, and scheduled cfm.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminals level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards.

B. Support in accordance with SMACNA and manufacturer recommendations.

C. Connect ductwork to air terminals according to Division 23 ductwork Sections. Slip each inlet duct over the inlet collar of the terminal. Fasten and seal the connection airtight. The diameter of the inlet duct must be equal to the listed size of the terminal; e.g. a duct that actually measures 8 inches must be fitted to a size 8 terminal.

D. Inlet and outlet duct must be installed in accordance with SMACNA guidelines. Provide a minimum of 2.5 equivalent duct diameters of straight duct at the inlet.

3.2 CONNECTIONS

A. Install piping adjacent to air terminals to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, and union; and to return with control valve, balancing valve and union.
3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Air terminal unit will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.5 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION  233600
SECTION 233713 - 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 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for HVAC"
2. Division 23 Section "Ductwork"
3. Division 23 Section "Testing, Adjusting, and Balancing" for balancing diffusers, registers, and grilles.

1.2 SUMMARY

A. This Section includes diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Each manufacturer shall check noise level ratings for registers and diffusers to insure that the sizes selected will not produce noise to exceed 30 db, "A" scale, measured at occupant level; notify Owner’s representative of problems prior to shop drawing submittal.

B. Pressure drop, airflow and noise criteria selection is based on design equipment. Manufacturers not submitting design makes must provide written certification in front of submittal that equipment submitted has been checked against and performs equal to the design make.

C. Product Data: 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. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.

D. Coordinate locations with reflected ceiling plans and wall elevations as applicable.

E. Coordinate mounting frame with associated mounting surface.
1.4 QUALITY ASSURANCE

A. Product Options: Drawings and schedules indicate specific requirements of diffusers, registers, and grilles and are based on the specific requirements of the systems indicated. Other manufacturers' products with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."


C. Sound pressure levels shall be determined by using AHRI Standard 885-2008 “Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Outlets”.

PART 2 - PRODUCTS

2.1 GENERAL

A. Diffusers, registers, and grilles are scheduled on Drawings.

B. Mounting type shall match the mounting surface. Coordinate with mounting conditions.

C. Material shall match the specified ductwork. Coordinate with Section 233113 "Ductwork".

D. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

E. Grilles shall be finished in White Powder Coat, unless noted otherwise.

F. Manufacturers

1. Price
2. Titus
3. Metal-Aire
4. Anemostat
5. Nailor

2.2 RETURN OR EXHAUST

A. Return/Exhaust Grille, 45-degree deflection

1. Material: Steel (Price 530 Series)
2. Provide damper as scheduled.
3. Grilles of the sizes indicated on the plans. Grilles shall be 45 degree deflection fixed louver type with blades spaced 3/4" on center. The blades shall run parallel to the long dimension of the grille.

B. Linear Slot Ceiling Return: Price SDR, similar to SDS specification below.
2.3 SUPPLY

A. High-induction Ceiling Diffusers
   1. Material: steel (Price Model SMX)
   2. Air pattern shall be 1-way, 2-way, 3-way, or 4-way as scheduled.
   3. Rapid mixing diffusers shall consist of an outer frame assembly which facilitates mounting. A collar that allows connection to the square (or rectangular) duct size indicated shall be an integral part of the frame assembly. This collar shall fit inside the duct.
   4. Internally mounted discharge vanes shall be engineered to create a high rate of induction that will rapidly mix warm room air with the conditioned supply air. This rapid mixing (induction) shall quickly equalize the temperature differential between the two air masses, thus minimizing the chances of uncomfortable drafts.
   5. Provide a square to round adaptor, adaptor shall be coated steel construction.

B. Linear Slot Ceiling Diffusers
   1. Material: steel (Price Model SDS with SDA Plenum)
   2. Diffusers shall have discharge slots (quantity and widths as scheduled) with extruded aluminum aerodynamically curved “ice-tong” shaped pattern controllers for 180-degree air pattern control and airflow-dampering if required.
   3. The diffuser border shall be heavy extruded aluminum construction with extruded aluminum spacers and end caps.
   4. Diffuser shall be provided with insulated plenums. Plenums shall be constructed of zinc coated steel and have 1/4" internal insulation. Plenum assembly shall have sloped shoulders for enhanced spread characteristics. Plenum assemblies shall be of a side inlet configuration. Provide adaptors as required for connecting ductwork to plenum.
   5. Paint Specification: Provide in a color as selected by the Architect.
   6. End Conditions, Fastening, & Border Style: The diffuser shall be suitable for surface mounting in the ceiling as shown on the architectural plans.

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. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
B. 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 the 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 connection to ducts.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

B. Adjustable outlet diffuser: adjust pattern for draft-free air distribution.

C. Adjust diffusers to direct airflow away from fume hoods.

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 233713
SECTION 238213  RADIANT HOT WATER CEILING HEATING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary
      Conditions and Division 1 Specification Sections, apply to this Section.
   B. Division 23 Section "Common Work Results for HVAC"

1.2 SUMMARY
   A. This Section includes hydronic heating panels.

1.3 SUBMITTALS
   A. Product Data: Include rated capacities, specialties, and accessories for each product indicated.

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

1.5 COORDINATION
   A. Coordinate layout and installation of radiant heaters and panels and suspension system
      components with other construction that penetrates ceilings or is supported by them.

PART 2 - PRODUCTS

2.1 HYDRONIC HEATING PANELS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the
      following:
      1. Sterling Mg. (basis of design)
      2. Rosemex Products.
      4. Aerotech
      5. Price Industries
RADIANT HOT WATER CEILING HEATING UNITS

B. Description: Modular panels shall be a system of standard sized radiant panels which can be integrated into a suspended ceiling to provide overhead radiant heating. The system shall be designed to used with hot water at various temperatures; insulation blankets with a heat reflecting foil backing shall be utilized to maintain heating efficiency.

C. The panels shall be fabricated from an aluminum sheet to which a heating pipe coil shall be mechanically fastened.

1. Pipe coil: Each panel has its own serpentine pipe coil of 5/8" O.D. tubing.
2. Panels: 0.040" aluminum or 0.027" steel sheet with standard square edges or tegular edge detail.
3. Paint finish: white.
4. Thermal contact strips: Aluminum heat saddle bolted to the back of the panel using steel or aluminum studs which are welded to the panel.
5. Insulation: Provide a minimum of 1" thick foil back fiberglass batt insulation.

D. Modular panels shall be provided to match the ceiling grid. The working weight for the aluminum panels is approximately 1.5 lb/ft²

E. Provide trim panels for trimming end of panels to match room dimensions.

F. Provide factory inter-connectors between adjacent series panels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive radiant heating and cooling units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for hydronic piping connections to verify actual locations before radiant heating and cooling unit installation.

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

3.2 INSTALLATION

A. Install radiant heating units level and plumb.

B. Suspend radiant heaters from structure.

C. Use ceiling grid as a support element.

1. Install a minimum of four ceiling support system rods or wires for each panel. Locate not more than 6 inches from panel corners.
2. Support Clips: Fasten to panel and to ceiling grid members at or near each panel corner with clips designed for the application.
3. Panels of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support panels independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on panel. Wire or rod shall have breaking strength of the weight of panel at a safety factor of 3.

3.3 CONNECTIONS

A. Heating mains shall be flushed prior to connection to the radiant panels. After connection, the hydronic system shall be flushed again and then dry pressure tested to isolate any leaks. Any remaining air shall be vented from the system and boiler temperature shall be brought up gradually.

B. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Unless otherwise indicated, install shutoff valve and union or flange at each connection.

D. Install piping adjacent to unit to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. After installing panels, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

END OF SECTION 238213
SECTION 238233 - CONVECTION HEATING UNITS

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.

B. Related Sections include the following: Division 23 Section "Common Work Results for Mechanical"

1.2 SUMMARY

A. This Section includes convection heating units.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated. Enclosure joints, corner pieces, access doors, and other accessories.

1.4 QUALITY ASSURANCE

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

B. Factory test and rate finned-tube radiators according to Hydronic Institute's "Testing and Rating Standard for Finned-Tube (Commercial) Radiation."

PART 2 - PRODUCTS

2.1 HYDRONIC FINNED-TUBE RADIATORS

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

1. Sterling (Basis of Design)
2. Trane
3. Rittling
4. Slant/Fin.
5. Trane.
6. Vulcan

B. Furnish and install where shown on plans, Sterling LB2 Finned Tube Radiation as described in the following specification or approved quality and capacity equal.

C. Enclosure shall be one piece manufactured of 18-gauge CRS steel with pencil proof louvered discharge grille.

D. Enclosures shall be joined by means of slip joint. Full back panel (20 gauge) shall be die formed for rigidity and will have pre-punched slots for rod hangers. It shall be off-the-wall type allowing for removal of enclosure without damage to finished wall. Backplate shall incorporate fixed and/or adjustable element rod hangers.

E. All accessories shall be anchor type providing additional support of enclosures.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive convection heating units for compliance with requirements for installation tolerances and other conditions affecting performance. Examine roughing-in for hydronic-piping connections to verify actual locations before convection heating unit installation.

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

3.2 GENERAL

A. Provide units level and plumb.

B. Provide piping adjacent to units to allow service and maintenance.

3.3 INSTALLATION

A. Provide enclosure continuously around corners, using outside and inside corner fittings.

B. Join sections with splice plates and filler pieces to provide continuous enclosure.

C. Terminate enclosures with manufacturer's end caps.

3.4 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Provide piping adjacent to convection heating units to allow service and maintenance.
3.5 FIELD QUALITY CONTROL

A. Perform a leak test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

B. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

END OF SECTION 238233
SECTION 261000 - BASIC ELECTRICAL REQUIREMENTS

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. Alternates: Refer to Division 01 to determine extent of, if any, work of this section that will be affected by any alternates if accepted.

B. Furnish all materials, equipment, labor, and supplies and perform all operations necessary to complete the electrical work in accordance with the intent of the drawings and these specifications.

C. All work shall be per currently adopted edition of the NEC and NFPA 99 including any local or state amendments.

D. Temporary Power and Lighting:

   1. Power Distribution: Provide weatherproof, grounded circuits with ground-fault interruption features, with proper power characteristics and either permanently wired or plug-in connections as appropriate for intended use. Provide overload-protected disconnect switch for each circuit at distribution panel. Space 4-gang convenience outlets (20 amp circuit) so that every portion of work can be reached with 100' extension cord.

   2. Temporary Lighting: Provide lighting of intensity and quality sufficient for proper and safe performance of the work and for access thereto and security thereof. (Consult OSHA requirements.)

E. Selective Demolition

   1. The work of Division 26 shall include removal and disposal of existing wiring, conduit, boxes, devices, etc., within existing walls and ceilings to be removed. Refer to Architectural drawings for locations of walls to be removed. Existing branch circuit wiring shall be permitted to be re-used where it complies with current code and this specification.

   2. Where electrical items to be removed feed through to other items intended to remain, provide wiring, connections, junction boxes, etc. as required to re-feed the existing items to remain.

   3. No unused wiring shall be abandoned in place. Where electrical items are removed, remove wiring back to source connection at wiring or equipment intended to remain.
4. Where existing ceilings to be removed, all existing fire alarm smoke detectors, speakers, and other devices shall be removed.

1.3 QUALITY ASSURANCE

A. All wiring shall be in accordance with the currently adopted edition of the National Electrical Code.

B. The Contractor shall show evidence, upon request, of having successfully completed at least five similar projects. Installation of each system shall be under the supervision of a factory-authorized organization.

C. The Contractor shall show evidence, upon request, that he maintains a fully equipped service organization capable of furnishing adequate inspection and service to the system. The Contractor must have a service contract program for the maintenance of the system after the guarantee period.

D. All electrical equipment shall be listed by Underwriters Laboratories, Inc. Each system shall be products of a single manufacturer of established reputation and experience. The Contractor shall have supplied similar apparatus to comparable installations rendering satisfactory service for at least three years.

E. For each system, the manufacturer shall furnish "gratis" to the Owner a one-year contract effective from the date of installation for maintenance and inspection services of the manufacturer's equipment with a minimum of two inspections during the contract year.

F. Telecommunications System Performance: The cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to the test procedures of this standard.

G. Telecommunications Installation shall be under the direct supervision of a BICSI Registered Technician or Level 2 Installer, who shall present at all times when work of this section is performed at project site.

1.4 EFFICIENCY MAINE

A. This project intends to pursue Efficient Maine prescriptive and/or custom incentives. The contractor shall be an Efficiency Maine Qualified Partner and shall participate in the activities associated with Efficiency Maine incentive pre-approval and approval process including but not limited to; preparation and submission of required incentive application(s) and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.

B. The contractor shall also:

1. Become familiar with the Efficiency Maine Business Program including available incentives and the application and review process.
2. Review plans and specifications for compliance with Efficiency Maine standards for applicable systems and technologies.
3. Review plans and specifications for any and all incentive opportunities, prescriptive and custom.

C. The project schedule shall reflect and accommodate the time required to achieve application preapproval from EM. No equipment shall be purchased until preapproval is received from EM.

D. All invoices shall be forwarded to EM within 60 days of the completion of work. This deliverable shall be shown on the project schedule as a milestone date and coordinated with all contractors to assure compliance with this requirement.

E. Efficiency Maine is available to assist in the application process and can be reached at 866-376-2463.

1.5 FIRE ALARM SYSTEM

A. Modify and add to the existing fire alarm system to provide a complete and code compliant system including but not limited to: new smoke detectors, heat detectors and notification appliances in all areas required. Fire alarm systems shall generally comply with requirements of NFPA 72 for local building systems except as modified and supplemented by this specification. All units of equipment shall be listed by Underwriters Laboratories and shall consist of a battery-backed fire alarm control station, with audio/visual and visual alarm indicating devices, heat detectors, smoke detectors, and pull stations. All equipment shall be located as shown on the plans and wired in accordance with the manufacturer's instructions to form a complete and workable emergency evacuation life safety system as hereinafter described.

1.6 TELECOMMUNICATIONS

A. Telecommunications work shall be in accordance with Building Industry Consulting Service International (BICSI) standards. Installation shall be under the direct supervision of a BICSI Registered Technician, who shall be present at all times when Work of this Section is performed at Project site. Testing Supervisor shall be currently certified by BICSI as a Registered Communications Distribution Designer (RCDD).

1.7 NURSE CALL SYSTEM

A. Provide new, local reporting only, instructional visual/voice nurse call system and components (patient station, corridor lights and lab control room) in locations indicated on the drawings and as required for a complete and operable system. All new components shall be as recommended by the system manufacturer. Provide power/control wiring and terminations as required for new devices. Coordinate with system technician from manufacturer to program devices at nurse call annunciation station serving the two patient/lab rooms.
1.8 SUBMITTALS

A. In accordance with Division 01, furnish the following:

1. Manufacturer's descriptive literature: For each type of product indicated.
2. Submit shop drawings which include engineering drawings of the system with specification sheets covering all component parts of the system and interconnection diagrams.
3. Submit fire alarm battery calculations.
4. Certification:
   a. Prior to final inspection, deliver to the Owner's Representative certification that the material is in accordance with the drawings and specifications and has been properly installed.
   b. Submit certification of system operating test.
5. Manuals: Submit copies of complete set of operating instructions including circuit diagrams and other information of system components.

1.9 PROJECT CONDITIONS

A. Regulatory Requirements:

1. Conform to the requirements of all laws and regulations applicable to the work.
2. Cooperate with all authorities having jurisdiction.
3. Compliance with laws and regulations governing the work on this project does not relieve the Contractor from compliance with more restrictive requirements contained in these specifications.
4. If the Contract Documents are found to be at variance with any law or regulation, the Contractor shall notify the Architect/Engineer promptly in writing. The Contractor shall assume full responsibility for any work contrary to law or regulation, and shall bear all costs for the corrections thereof.
5. Minimum Requirements: The National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL), the National Fire Codes, and National Fire Protection Association (NFPA) are a minimum requirement for work under this section. Design drawings and other specification sections shall govern in those instances where requirements are greater than those required by code.

B. Permits, Fees, and Inspections:

1. Secure and pay for all permits, fees, licenses, inspections, etc., required for the work under Division 26.
2. Schedule and pay for all legally required inspections and cooperate with inspecting officers.
3. Provide Certificates of Inspection and Approval from all regulatory authorities having jurisdiction over the work in Division 26.
C. Drawings:
   1. Do not scale the drawings. The general location of the apparatus and the details of the work are shown on the drawings, which form a part of this specification. Exact locations are to be determined at the building as the work progresses and shall be subject to the Architect/Engineer's approval. Actual field conditions shall govern all dimensions.
   2. Anything shown on the drawings and not mentioned in the specifications or vice versa shall be provided as if it were both shown and specified.
   3. It is not intended that the drawings shall show every wire, device, fitting, conduit or appliance, but it shall be a requirement to furnish without additional expense, all material and labor necessary to complete the systems in accordance with applicable codes and the best practice of the trade.

1.10 WARRANTY
   A. The Contractor shall guarantee all equipment and wiring free from inherent mechanical or electrical defects for one year from date of acceptance.

1.11 RELATED WORK
   A. Division 23 - Mechanical

PART 2 - PRODUCTS

2.1 MATERIALS
   A. Switches
      1. Toggle Switches: 20A, 277V, 1-pole, white specification grade, mount 4'-0" above finished floor at door entrance.
   B. Switchbox type occupancy sensors: Adaptive-technology type, 120/277 V, adjustable time delay up to 20 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. Configure for manual-on/automatic-off operation.
      C. Indoor Occupancy Sensors
         1. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
            a. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
            b. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
c. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.

d. Mounting:

1) Sensor: Suitable for mounting in any position on a standard outlet box.
2) Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

e. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

f. Bypass Switch: Override the on function in case of sensor failure.

g. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

2. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

a. Sensitivity Adjustment: Separate for each sensing technology.

b. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

c. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

D. Receptacles shall be 20-amp Hospital grade, tamper-proof, mounted 18" above finished floor unless otherwise noted. Red color for emergency power and Ivory color for normal power.

E. Duplex Receptacles with Ground-Fault Interrupter shall be an integral unit suitable for mounting in a standard outlet box.

1. Ground-Fault Interrupter shall consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. It shall be rated for operation on a 60 Hz, 120-volt, 20-ampere branch circuit. Device shall have nominal sensitivity to ground leakage current of five milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes on the load side of the device. Device shall have a minimum nominal tripping time of 1/30th of a second.

2. Receptacle shall be rated 20 amperes, 125 volts for indoor use and shall be the standard duplex, three-wire, grounding type.

F. Device plates shall be commercial grade Ivory thermoplastic.

G. Boxes shall be steel minimum 2-1/2" deep.

H. Light Fixtures: The light fixtures shall be as described on the drawings or approved equal.
I. Disconnect Switches shall be heavy-duty type, horsepower rated.

J. Motor Starters:

1. Manual motor starters shall be toggle-switch type with melting alloy thermal overload relay. Thermal units shall be one-piece construction and interchangeable. Starter shall be inoperative with thermal unit removed. Contacts shall be double break, silver alloy. Starters in finished areas shall be flush mounted over the light switch at 60" above finished floor. Starters shall be mounted behind stainless steel device plate and shall have adjacent pilot lights. Square D Class 2510 Type FS-1P-FL1 or approved equal. Starters in unfinished areas shall be surface mounted 60" above finished floor. Square D Class 2510 Type FG-5P or approved equal.

2. Magnetic motor starters shall be combination circuit breaker or fused disconnect switch type, mounted in a common enclosure. Starters shall be three-pole with three melting alloy overload relays. Overload heaters shall be coordinated with Division 23. Thermal units shall be of one-piece construction and interchangeable. Starter shall be inoperative with any thermal unit removed. The disconnect operating handle shall be position indicating.

   a. Provide a control device and pilot light on the cover of each combination starter. Control devices for motors with remote manual or automatic control shall be "hand-off-auto" switches. Control devices for locally controlled motors shall be "start-stop" pushbuttons.

   b. 120-volt magnetic motor starters may consist of a circuit breaker or fused disconnect switch and a magnetic starter in separate enclosures mounted next to each other.

   c. Control circuits shall operate at a maximum of 120 volts. Provide control transformers as required.

3. Starters shall be mounted within NEMA-1 enclosures unless specified otherwise.

4. All starters shall be lockable in the "off" position.

5. Overload heaters shall be sized for the motor nameplate full-load amperes per the manufacturer's recommendations.

K. Wiring Materials:

1. Wiring shall be enclosed in electrical rigid galvanized steel, intermediate metal conduit, or electrical metallic tubing sized in accordance with code requirements for the conductors. Metal non-flexible conduit shall be used for feeders and emergency system circuits. Hospital grade Types MC or AC cable shall be permitted for normal power circuits where concealed in walls or ceilings and allowed by code.

   a. Conduit fittings shall be steel compression type.

   b. Terminations for all conduit shall have insulated bushings or insulated throat connectors in accordance with code requirements.

   c. All conduits shall be substantially supported with approved clips or hangers spaced not to exceed ten feet on center. Minimum conduit size shall be 3/4".
2. Surface Metal Raceway: UL 5 listed.
   a. Boxes and fittings for surface metal raceways shall be as recommended by the manufacturer.
   b. Support clips for surface metal raceways shall be the concealed type, with attachment screws concealed behind the raceway.

3. Flexible Metal Conduit shall be used for all connections to motors and vibrating equipment and shall comply with Fed. Spec. WW-C-566.

4. Liquid-Tight Flexible Metal Conduit shall consist of flexible steel conduit with a liquid-tight PVC jacket over the conduit.
   a. Fittings shall incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening.
   b. Liquid-tight flexible metal conduit shall be used in damp or wet locations when flexible metal conduit would otherwise be used.
   c. Liquid-tight flexible metal conduit shall not penetrate the roof or exterior walls, and shall not be installed in lengths exceeding 72” except where necessary for flexibility.

5. All Wiring shall be type THW, XHHW, or THWN, UL labeled, copper conductors with 600-volt insulation, except as otherwise noted. Minimum size wire shall be No. 12 AWG.

6. Types MC and AC Cable shall have minimum No. 12 AWG type THWN or XHHW insulated copper conductors with an internal bare or insulated copper ground wire. Comply with NEMA WC 70 for armored cable, Hospital-Grade Type AC.

7. Fire Alarm Wiring: Wiring shall be in accordance with NEC Article 760, as shown on the drawings, and as recommended by the manufacturer of the fire alarm system. All wires shall be color-coded and installed in metal conduit. Conduit fill shall not exceed 40 percent of interior cross-sectional area. Number and size of conductors shall be as recommended by the fire alarm system manufacturer. Conduit shall be 1/2” minimum.

L. Fire-Stop Material:

1. Fire-stopping material shall maintain its dimension and integrity while preventing the passage of flame, smoke, and gases under conditions of installation and use when exposed to the ASTM E 119 time-temperature curve for a time period equivalent to the rating of the assembly penetrated. Cotton waste shall not ignite when placed in contact with the non-fire side during the test. Fire-stopping material shall be noncombustible as defined by ASTM E 136; and in addition for insulation materials, melt point shall be a minimum of 1700°F for one-hour protection and 1850°F for two-hour protection.

2. Seals for floor, exterior wall, and roof shall also be watertight.

M. Circuit Breakers: Circuit breakers to be added to existing panelboards shall match existing circuit breakers.
N. Grounding Conductors:
   1. Grounding conductors shall be soft-drawn bare copper.
   2. Insulated grounding wires shall be UL and NEC approved types, copper, with THWN or XHHW insulation color identified green, except where otherwise shown on the drawings or specified.
   3. Wire shall not be less than shown on the drawings and not less than required by the NEC.

O. Ground Clamps:
   1. Ground clamps shall be cast bronze or cast copper and shall be UL listed for grounding connections.
   2. Ground clamps shall be sized for the specific conductor and electrode to be clamped.

P. Equipment Grounding Connections: Connections shall be of the compression type solderless connectors.

Q. Fire Alarm System Components:
   1. The existing fire alarm system serving the building shall remain. Provide power supply, batteries, programming, common components, amplifiers, etc. as required for a fully functioning, code-compliant system expanded to serve the project area.
   2. Additional Fire alarm devices shall match with the existing system and generally comply with requirements of NFPA 72 except as modified and supplemented by this specification. All equipment shall be wired in accordance with the manufacturer’s instructions.
   3. Voice/Tone Speakers:
      a. UL 1480 listed.
      b. High-Range Units: Rated 2 to 15 W.
      c. Low-Range Units: Rated 1 to 2 W.
      d. Mounting: Flush, semi-recessed, or surface mounted; bidirectional as indicated.
      e. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.
   4. Strobe lights shall meet the requirements of the ADA, UL Standard 1971 and shall meet the following criteria:
      a. Strobes shall be multi-candela rated and intensity shall be field selectable.
      b. The maximum pulse duration shall be 2/10 of one second. Clear Lexan lens in housing.
      c. Strobe intensity shall meet the requirements of UL 1971.
      d. The flash rate shall meet the requirements of UL 1971.
      e. Strobes in the same area shall be synchronized.
   5. Audible/Visual Combination Devices:
      a. Shall meet the audibility requirements specified herein for horns.
      b. Shall meet the visibility requirements specified for strobes.
6. Addressable Devices - General:

   a. Addressable devices shall provide an address-setting means using rotary decimal switches.

   b. Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches. Devices which use a binary address or special tools for setting the device address, such as a dip switch are not an allowable substitute.

   c. Detectors shall be analog and addressable, and shall be capable of sensitivity adjustment through field programming of the system and automatically adjusted by the panel on a time-of-day basis.

   d. Addressable smoke and thermal detectors shall provide dual (2) status LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected.

   e. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

   f. The detectors shall be ceiling-mount and shall include a separate twist-lock base which includes a tamper proof feature.

   g. The following auxiliary functions shall be provided where indicated on the drawings, and where required by code:

      1) Form-C Relay base rated 30VDC, 2.0A
      2) Auxiliary relay for HVAC shutdown.

   h. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

   i. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).

7. Addressable Pull Box (manual station):

   a. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key. Units shall be supplied with plastic tamper covers that produce an audible alarm when lifted.

   b. All operated stations shall have a positive, visual indication of operation.

   c. Manual stations shall be constructed of metal with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters.
8. Intelligent Photoelectric Smoke Detector:
   a. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

9. Intelligent Thermal Detectors:
   a. Thermal detectors shall be intelligent addressable devices rated at 190 degrees Fahrenheit (except as otherwise indicated) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

10. Intelligent Duct Smoke Detector:
   a. The duct smoke detector housing shall accommodate an intelligent ionization detector that provides continuous analog monitoring and alarm verification from the panel.
   b. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
   c. Provide sampling tubes as required by the ductwork.
   d. Provide remote test/indicator stations where indicated. Provide engraved nameplate with HVAC unit designation for each station.
   e. The detector shall use the photoelectric principal to sense products-of-combustion and report the measured level of such products to the control panel.

11. Provide addressable modules as required to monitor and control non-addressable devices such as solenoid valves, water flow switches, etc. indicated on the drawings and where required to provide a complete and operational system in accordance with the intent of the drawings and specifications. All shall be monitored separately.

12. Sprinkler and Standpipe Valve Supervisory Switches:
   a. Valve supervisory switches shall be furnished and installed under Div. 21 and wired and connected under this section.

13. Conduit and Wire:
   a. Wiring shall be in accordance with NEC Article 760, as shown on the drawings, and as recommended by the manufacturer of the fire alarm system. All wires shall be color-coded. Exposed wiring in unfinished areas shall be installed in metal conduit. Conduit fill shall not exceed 40 percent of interior cross-sectional area. Number and size of conductors shall be as recommended by the fire alarm system manufacturer. Conduit shall be 1/2" minimum.
   b. Wires in junction boxes and cabinets shall be permanently tagged and identified with tags.
14. Terminal Boxes, Junction Boxes and Cabinets:
   a. Shall be galvanized steel in accordance with UL.
   b. Paint red and identify with white markings as "Fire".

15. Junction boxes shall have a volume 40 percent greater than required by the NEC. Minimum sized wire shall be considered as 14 AWG for calculation purposes.

R. Telecommunications

1. Performance Requirements
   a. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
   b. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      1) Flame-Spread Index: 25 or less.
      2) Smoke-Developed Index: 50 or less.

2. UTP Cable: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
   a. Comply with ICEA S-90-661 for mechanical properties.
   b. Comply with TIA/EIA-568-B.1 for performance specifications.
   d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      1) Communications, Plenum Rated: Type CMP, complying with NFPA 262.

3. UTP Cable Hardware:
   a. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
   b. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
      1) Number of Jacks per Field: One for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.
   c. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
2.2 NURSE CALL SYSTEM COMPONENTS

A. Annunciation/Master Station (control room) shall be capable of selectively communicating with other stations or groups of stations on its system by touch screen, mouse click, or manual switch; and capable of programming up to 6 stations. At the master station, a programmable tone announces an incoming call; an annunciator light or digital display identifies the calling station and indicates the priority of the call.

B. Staff/Duty Stations (patient/lab rooms): A minimum of two call lamps, one for routine calls and one for emergency calls; and an audible tone signal device. Operation shall be identified to patient station except the message staff shall display on all devices when the staff call button is activated.

C. Patient Stations (patient/lab beds) shall be capable of hands-free and two-way conversation. Pressing "talk/listen" key shall cause the annunciation tone to cease. Pressing "cancel" key terminates normal calls and conversations.

D. Corridor wall lights (above patient/lab door frame) shall be compatible with new local training system.

E. System Reset: Operating reset button at the originating station cancels signals associated with the call. Illuminates a green digital display on the patient station and log presence on the master station.

F. System Reset at Master Station: A normal, incoming call can be canceled, associated lights and audible tones extinguished, and the system reset when the station switch is returned to the normal position.

G. Patient Station Call: Lights a steady call-placed lamp on the station, steady lamps in the zone light and corridor dome light associated with the patient's room, and steady lamps at the central annunciator and other system display devices and displays message on master and staff/duty stations. At the same time, it sounds a programmed tone at intervals, at the respective annunciator and master and staff/duty stations. Legends at the central annunciator and master station identify the calling station.

H. System shall be provided by Rauland-Borg Responder Series 5 or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. All work shall be in accordance with the National Electrical Code's requirements as amended to date, with the local electric utility company's rules, the Fire Underwriter's requirements, and all local, state and federal laws and regulations.

2. In general, all wiring in finished areas shall be concealed in walls or above ceilings. Where wiring cannot be concealed due to existing construction, exposed wiring shall be installed in conduit or surface metal raceway as indicated on the drawings. Exposed
wiring shall not be installed in finished areas without prior written authorization from the Engineer.

3. Conduits shall be of sizes required by the National Electrical Code. Exposed conduits shall be installed with runs parallel or perpendicular to walls and ceiling, with right-angle turns consisting of bends, fittings, or outlet boxes. No wire shall be installed until work that might cause damage to wires or conduits has been completed. Conduits shall be thoroughly cleaned of water or other foreign matter before wire is installed.

4. Where conduits, wireways and other electrical raceways pass through fire partitions, fire walls, or floor, install a fire-stop that provides an effective barrier against the spread of fire, smoke and gases. Fire-stop material shall be packed tight and completely fill clearances between raceways and openings. Floor, exterior wall, and roof seals shall also be made watertight.

5. Where raceways puncture roof, coordinate with Division 07.

6. Surface metal raceways shall be sized as required by the National Electrical code and as recommended by the manufacturer. Surface metal raceways shall be installed with runs parallel or perpendicular to walls and ceiling. Changes in direction shall only be made at device box locations or with fittings designed for the particular application. Installation shall be as visually unobtrusive as possible:

a. Surface metal raceways shall be painted to match wall finishes.

7. All splices shall be mechanically and electrically perfect, using crimp type wire connectors.

8. Provide all disconnect switches required by the N.E.C.

9. Locate motor starters as shown on drawings.

10. Mount disconnect switches and starters at a height of 60" above finished floor unless otherwise noted.

11. Provide all necessary hardware for mounting motor starters.

12. Revise existing panelboard directories. Furnish new cards as needed. Directories shall be typewritten or printed using a computer.

13. Circuit numbers indicated on the drawings are the actual numbers assigned to the circuit in the panelboard and shall not be varied without the consent of the Architect/Engineer.

14. Feeder circuit wiring shall be in conduit or EMT.

15. All wiring in outside walls shall be in conduit or EMT.

16. All wiring in masonry walls shall be in conduit or EMT.

17. In general, conductors shall be the same size from the last protective device to the load and shall have an ampacity the same as or greater than the ampacity of the protective device where the wire size is not shown on the drawings. Use the 60°C ampacity rating for wire sizes No. 12 through No. 1. For 120V circuits, home runs longer than 100 feet shall be minimum No. 10 AWG, longer than 200 feet shall be minimum No. 8 AWG.

B. Grounding:

1. The entire electrical system shall be permanently and effectively grounded in accordance with Code requirements.

2. Connections to junction boxes, equipment frames, etc., shall be bolted.
3. Conduit Systems:
   a. Ground all metallic conduit systems.
   b. Conduit systems shall contain a grounding conductor sized per NEC Table 250-122 or as shown on the drawings. Increase conduit size where necessary to accommodate the grounding conductor.

4. Feeders and Branch Circuits: Install green grounding conductors with all feeders and branch circuits.
5. Lighting Fixtures: Conduits shall not be used for grounding fixtures. Green equipment grounding conductor must be bonded to all fixtures.

C. Alterations:
1. The Contractor shall study all drawings and specifications, visit the site, and acquaint himself with the existing conditions and the requirements of the plans and specifications. No claim will be recognized for extra compensation due to the failure of the Contractor to familiarize himself with the conditions and extent of the proposed work.
2. The Contractor shall execute all alterations, additions, removals, relocations or new work, etc., as indicated or required to provide a complete installation in accordance with the intent of the drawing and specifications.
3. Reconnect existing circuits to remain. Remove existing equipment to be discontinued.
4. Any existing work disturbed or damaged by the alterations or new work shall be repaired or replaced to the Engineer's satisfaction.
5. Equipment relocated or removed and reinstalled shall be cleaned and repaired to a first-class condition before reinstallation.

D. Fire Alarm System Installation:
1. Installation shall be in accordance with the NEC Article 760, and the Americans with Disabilities Act and as shown on the drawings.
2. Installation shall be as shown on the drawings and on the manufacturer's wiring diagrams and shall be performed under the supervision of a factory-trained representative.
3. All wiring shall be one wire per terminal to insure supervision. Crimp-on connectors shall not be used.
4. All wiring shall be color-coded and tagged and shall be checked for continuity, short circuiting, and resistance to ground.
5. All fire alarm wiring shall be installed in raceways.
6. A factory-trained technician shall be present during testing and final inspection and shall instruct the Owner in system operation.
7. Splices and taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
8. Mounting Heights:
   a. Manual Stations: 48" AFF
   b. Visual Units: 80" above the highest floor level within the space or 6 in (152 mm) below the ceiling, whichever is lower.
9. Tests:

a. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Make all adjustments and tests in the presence of the Owner's Representative.

b. When the systems have been completed and prior to the final inspection, furnish testing equipment and perform the following tests in the presence of the Owner's Representative.

1) Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
2) Test the insulation on all installed cable and wiring by standard methods as recommended by the equipment manufacturer.
3) Open fire alarm detector circuits to see if trouble signal actuates.
4) Check installation, supervision, operation and sensitivity of smoke detectors as recommended by the manufacturer to ascertain that they will avoid false alarm signals and will function as specified.
5) Perform any other tests recommended by the equipment manufacturer.

10. Final Inspection: At the final inspection a factory-trained representative of the manufacturer of the existing equipment shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of the Architect/Engineer.

E. Continuity of Services: Arrange to execute work at such times and in such locations to provide uninterrupted service to the building or any of its sections. If necessary, temporary power shall be installed to provide for this condition. Authorization for interrupting service shall be obtained in writing from the Owner. Any interruption of normal supply shall be performed during an overtime period to be scheduled with the Owner. Cost for overtime work shall be included in the bid.

F. Identification: Provide a machine-printed label on the faceplate of each receptacle indicated source panel and branch circuit. Provide tags on each end of all pulled wires giving location of other end. Provide phenolic nameplates for all panelboards, motor starters, disconnect switches (except switches located at motors), and duct smoke detector remote test/alarm-indicating stations.

G. Record Drawings: The Contractor shall keep on the job a set of prints showing any changes to the installation. These shall be given to the Engineer at the completion of the work.

H. Testing and Adjusting:

1. The entire installation shall be free from short-circuits and improper grounds. Tests shall be made in the presence of the Engineer or his representatives.
2. Each individual lighting circuit shall be tested at the panel; and in testing for insulation resistance to ground, the lighting equipment shall be connected for proper operation. In no case shall the insulation resistance be less than that required by the National Electrical Code. Failures shall be corrected in a manner satisfactory to the Architect/Engineer.
3. Each system shall be completely tested and shall be adjusted for proper operation as required by the Engineer.
I. Instruction: Furnish the services of a competent instructor for not less than four hours on site for instructing personnel in the operation and maintenance of the fire alarm system.

END OF SECTION 261000