Allied Engineering

Structural Mechanical Electrical Commissioning

66 Industrial Drive / Phase 2

State WIN # 020118.20

66 Industrial Drive, Augusta, Maine

Maine Department of Transportation

Issued for Bid

Volume 3 of 4

Divisions 20 through 23

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VOLUME 1 OF 4 (MaineDOT Front End THROUGH 6)

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SECTION 21 10 00 - FIRE-SUPPRESSION SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.2 SUMMARY

A. The fire protection system shall be an automatic sprinkler system arranged to properly protect the entire building. The sprinkler service shall extend from the existing 8” service at the project site and shall replace the system currently in place within the current building shell in its entirety, for complete coverage of the new and renovated areas of the facility in accordance with NFPA 13 requirements.

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. The contract documents do not include a fire pump. Provide over-sized piping as required to meet required system hydraulics. Contractor shall review the civil plans, the existing site and existing fire flow data. If the contractor or authority with jurisdiction determines that a fire pump is required, immediately notify the owner/architect for resolution.

D. In the event it is determined that a pump be necessary, installation shall be in accordance with NFPA 20, "Stationary Pumps for Fire Protection," for fire pumps, drivers, controllers, accessories, and their installation.

E. 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.

F. Sprinkler Occupancy Hazard Classifications:

1. Light Hazard:

   a. Office and Public Areas

2. Ordinary Hazard, Group 1:

   a. General Storage Areas
   b. Mechanical Equipment Rooms
   c. Building Service Areas.
   d. Electrical Equipment Rooms
   e. Sign Shop

3. Ordinary Hazard, Group 2
   a. Heavy and Light Service Areas
   b. Fabrication Shop
   c. Machine Shop

G. 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. Protect all systems from freezing. Provide freeze protection for sprinklers in unheated areas with glycol or dry pipe system.

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

D. 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.

E. Coordinate Fire Department Connection type and location with local fire department.

F. The sprinkler contract starts inside the sprinkler valve room with a connection to the 8-inch entry. Two ¾ inch threaded anchor rods shall be provided by the sprinkler contractor to anchor the incoming water entry.

G. 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. Alarm devices. Include electrical data.
6. Electrical Devices: Complete description of intended use, wiring diagrams, data plate information and, in the case of switching devices, whether normally on or normally off. Include motor test data.
7. Mechanical Devices: Complete description of intended use, including normal operating capacities and working pressures.
8. Enclosures: Dimensions, materials, gages of metals; type of door hinges and locks, and methods of securing the enclosure members to the building construction.
9. Hose Threads: Verify that hose threads on fire department connections match threads on equipment used by the local or servicing fire department.

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. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
4. Factory Mutual Engineering Corporation (FM) Approval Guide

C. NFPA Requirements

1. NFPA#1 Fire Prevention Code, 2007 edition.
2. NFPA #13 “Standard for the Installation of Sprinkler Systems” 2007 edition.
3. If a fire pump is required: Comply with NFPA 20, "Stationary Pumps for Fire Protection," for fire pumps, drivers, controllers, accessories, and their installation.
4. NFPA #24 Standard for the Installation of Private Fire Service Mains and Their Appurtenances, 2007 edition
5. NFPA 291: Recommend Practice for Flow Testing and Marking of Hydrants
6. NFPA #14 Standard for the Installation of Standpipe, Private Hydrants and Hose Systems, 2007 edition

1.7 COORDINATION

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

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

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

1.8 EXTRA MATERIALS

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

B. Coordinate the installation of sprinkler piping with all other trades, to avoid conflict with mechanical, electrical, structural, and conveying systems throughout.

2.3 JOINING MATERIALS

A. Furnish in accordance with NFPA 13.

B. Transition Couplings: AWWA C219, sleeve type, or other manufactured fitting the same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

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. Institutional Semi-Recessed or "Vandal-Resistant" sprinkler heads as required by application.

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

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

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 Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

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

D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

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

2.6 VALVES

A. Valves shall be UL listed and FMG approved

B. System Control Valve: The wet system control valve shall be a listed indicating type valve. Control valve shall be UL Listed and Factory Mutual Approved for fire protection installations. System control valve shall be rated for normal system pressure but in no case less than 175 PSI.

2.7 WATERFLOW ALARMS

A. Flow of water equal to or greater than that from a single automatic sprinkler (smallest orifice in system) shall result in an audible alarm on the premises within 5 minutes after such flow begins and until such flow stops.

B. The alarm apparatus shall consist of a listed alarm check valve or other listed waterflow-indicating device with the necessary attachments to give an alarm.

C. The apparatus for a dry pipe system shall consist of alarm attachments to the dry pipe valve.

2.8 FIRE DEPARTMENT CONNECTION

A. A system fire department connection shall be provided on the system riser in accordance with N.F.P.A. 13, Standard for Installation of Sprinkler Systems. Fire department connection shall be constructed of a brass body with an integral clapper assembly to separate flow between inlets. Fire department connection shall be installed in an area accessible for the first response unit. Fire department connection shall be UL Listed and Factory Mutual Approved for fire protection use. Configuration and style for the fire department connection shall be coordinated strictly with the authority having jurisdiction.

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

2.9 BACKFLOW PREVENTION

A. Provide in accordance with manufacturers recommendations.

B. Provide in accordance with NFPA 13. Provide a permanent means of testing the backflow preventer in accordance with NFPA 13 requirements.

C. Backflow preventer types; provide as required by the local water district.

1. Double check: Watts Series 709DCDA or 774DCDA detector check fire service applications; or approved equal.

2. RPZ: Watts Series 909RPDA or 994RPDA, detector check fire service applications; or approved equal. Provide proper drainage.

2.10 MECHANICAL SLEEVE SEALS

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

1. Manufacturers:

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

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

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 32 for excavating, trenching, and backfilling.

3.2 FIRE-SUPPRESSION DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.3 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 32 Section "Water Distribution" for exterior piping.

B. Install shutoff valve, pressure gage, drain, and other NFPA-required accessories at connection to water-service piping.

C. Provide backflow prevention as required by the local water district.

3.4 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. The existing system is currently de-commissioned.

3.5 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: Recessed Pendent.
3. Provide sprinkler guards for heads throughout the service, fabrication, machine shop, and sign shop area (all heights), and in mechanical and storage spaces, with ceilings at less than 8 ft. above finished floor subject to mechanical damage.
4. Low ceilings (under 8 feet): **[Concealed]**
5. Wall Mounting: Sidewall sprinklers.
6. Special Applications: Use extended-coverage, flow-control, and quick-response sprinklers where indicated.

B. Finishes

1. Unfinished spaces not exposed to view: rough bronze.

2. Recessed Sprinklers: White
3. Provide escutcheons with matching color for finished spaces.
4. Exposed sprinklers subject to corrosive atmospheres shall have a factory applied corrosion resistant coating.

3.6 SYSTEM INSTALLATIONS

A. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.

B. Water supply control valves shall be electrically supervised and mechanically locked for proper position. Water flow and supervisory circuits shall be in accordance with the requirements of electrical specifications. Electric connections to sprinkler system shall be by Division 26. Furnish wiring diagrams for all equipment.

C. Fire Department Connection: A system fire department connection shall be provided on the system riser in accordance with N.F.P.A. 13. Fire department connection shall be installed in an area accessible for the first response unit. Coordinate with local fire department.

D. 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.

E. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13

3.7 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceiling in center of all ceiling tiles.

B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space or glycol per NFPA 13.

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

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

3.8 LABELING AND IDENTIFICATION

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

3.9 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. Verify that potable-water supplies have correct types of backflow preventers.

G. Verify that glycol system is correct percentage mixture per NFPA 13.

H. Verify that fire department connections have same type compatible with local fire department equipment.

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

J. Fill wet-pipe sprinkler piping with water.

K. Energize circuits to electrical equipment and devices.

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

3.10 CLEANING

A. Clean dirt and debris from sprinklers.

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

3.11 PAINTING

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

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

3.12 PROTECTION

A. Protect sprinklers from damage until Substantial Completion.

3.13 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 21 00 00

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SECTION 22 05 00 – COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

END OF SECTION 22 05 00

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SECTION 22 05 16 – BRAIDED EXPANSION LOOPS AND FITTINGS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Section 23 05 16, braided expansion loops and fittings for plumbing piping are specified in this Section.

B. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

END OF SECTION 22 05 16

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SECTION 22 05 19 – THERMOMETERS AND PRESSURE GAUGES FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Section 23 05 19 for thermometer and pressure gauges for plumbing.

B. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

END OF SECTION 22 05 19

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Section 23 05 29 for hangers and supports for plumbing piping and equipment.

B. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

END OF SECTION 22 05 29

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SECTION 22 05 53 – IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Section 23 05 53 for identification for plumbing piping and equipment.

B. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

END OF SECTION 22 05 53

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SECTION 22 07 00 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Refer to Section 23 07 00 for Mechanical Insulation.

B. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

END OF SECTION 22 07 00

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SECTION 22 08 00-COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.2 SUMMARY

A. Section includes commissioning process requirements for Plumbing systems, assemblies, and equipment.

B. Related Sections:

1. Section 01 91 13 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Plumbing Systems: Sanitary waste and vent system, service potable and non-potable water, domestic hot water systems, solar heating systems, and fuel gas systems.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Submittals shall comply with the requirements of the Construction Contract Clauses, Section 01 33 00 "Submittal Procedures" and the individual sections specifying the work.

B. Prefunctional Checklists of readiness.

C. Prefunctional Checklists of completion of installation, prestart, and startup activities.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase coordination meetings.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in Plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual Plumbing systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Plumbing systems, assemblies, equipment, and components to be verified and tested.
4. Prefunctional Checklists certifying that installation, prestart checks, and startup procedures have been completed.
5. Prefunctional Checklists certifying that Plumbing systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that Plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that Plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of Plumbing systems at the direction of the CxA.

1. Failure of an item includes a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
2. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of Plumbing testing shall include entire Plumbing installation, from service hot water systems through distribution systems to all fixtures. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA in cooperation with the Plumbing Contractor, testing and balancing Contractor, and Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Plumbing Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 22 Sections with references for interconnections to Section 23 09 00 "Instrumentation and Control for HVAC." Assist the CxA with preparation of testing plans.

B. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 22 piping Sections. Plumbing Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

C. Plumbing Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of service water distribution systems, fuel gas systems, and other distribution systems, including Plumbing equipment and fixtures.

D. Plumbing systems are shown on the contract drawings.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 22 08 00

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SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, 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 domestic water piping from locations indicated to fixtures and equipment inside the building.

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: For the following products:

1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.
5. Escutcheons.
6. Sleeves and sleeve seals.
7. Water penetration systems.

B. Field quality-control reports.

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. Qualify brazing processes for copper and copper alloy pipe and tube according to ANSI/AWS C3.4.

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

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

C. Transition Couplings for Underground Pressure Piping: AWWA C219, metal, sleeve-type coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 DUCTILE-IRON PIPING

A. From inside face of exterior wall to a distance of approximately 5 feet outside of building (coordinate with Division 2). Provide flanged and anchored connection to interior piping. Materials shall be approved by the local water utility.

B. Ductile iron pipe shall meet requirements of AWWA Standard C-151 (latest revision) and be cement lined and seal coated to meet AWWA Standard C-104 (latest revision). Joints shall meet requirements of AWWA C-111 (latest revision). Interior seal coated, bituminous paint oil cut, emulsion not acceptable, thickness minimum of 2 mils dry film thickness. Exterior bituminous coated with minimum of 2 mils dry film thickness. Class 52 wall thickness, 4-inch diameter through 12-inch diameter inclusive. Mechanical joint pipe to be furnished with gland, gaskets and Cor-Ten bolts and nuts.

C. Ductile Iron Fittings Including Bends, Reducers, Off-Sets, Tees And Sleeves: Material shall be ASTM A536 latest, grade 70-50-05, in accordance with AWWA C153 (latest revision). Fittings shall be cement lined AWWA C104 (latest revision) or fusion bonded epoxy coated with a 5 mil nominal thickness per AWWA C550 and C116. Interior seal coated AWWA C104 with minimum of 4 mils dry film thickness. Exterior bituminous coated, 4 mils minimum dry film thickness or fusion bonded epoxy coated with a 5 mil nominal thickness per AWWA C550 and C116. Mechanical joint with accessories furnished: D.I. glands, gaskets, Cor-Ten T-bolts and nuts. Pressure Rating: Class 350 pressure rating in accordance with AWWA C153.

2.3 COPPER TUBING

A. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint 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. Hard Copper Tube: ASTM B 88, Types L water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought- copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint 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.
4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
5. Copper-Tubing, Keyed Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

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

2.4 PEX DOMESTIC WATER PIPING

A. Material: Crosslinked polyethylene (PEX) manufactured by PEX-a or Engel method

B. Type: Wirsbo AQUAPEX or approved equal.

1. Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third party agency
2. Standard grade hydrostatic design and pressure ratings from PPI

C. Performance Requirements: To provide a PEX tubing hot and cold potable water distribution system, which is manufactured, fabricated and installed to comply with regulatory agencies and to maintain performance criteria stated by the PEX tubing manufacturer without defects, damage or failure.

1. Comply with ANSI/NSF Standard 14 “Plastics Piping System Components and Related Materials”.
2. Comply with ANSI/NSF Standard 61 “Drinking Water System Components - Health Effects”
3. Show compliance with ASTM F877 “Standard Specification for Cross-linked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems”
4. Show compliance with ASTM E119 “Standard Test Methods for Fire Tests of Building Construction and Materials”
5. Show compliance with ANSI/UL 263 “Standard for Safety for Fire Tests of Building Construction and Materials” through certification listings with Underwriters Laboratories, Inc. (UL).

D. Certification of flame spread/smoke development rating of 25/50 in accordance with ASTM E84 provided the installation meets one of the following requirements.

1. Tubing spacing is a minimum of 18 inches apart for the following sizes: ½ inch, ¾ inch.
2. Tubing shall be wrapped with ½” fiberglass insulation with a flame spread of not more than 20 and a smoke-developed rating of not more than 30 and a nominal density of 4.0 to 4.5 pcf. Tubing can run with three tubes separated by zero inches and then 18 inches between the next group of three tubes for the following sizes: ½ inch, ¾ inch, 1inch, 1¼ inch, 1½ inch, and 2 inch.

E. Fire-rated assembly listings in accordance with ANSI/UL 263

F. Minimum Bend Radius (cold bending): No less than six times the outside diameter. Use a bend support as supplied by the PEX tubing manufacturer for tubing with a bend radius less than stated.

G. Nominal inside diameter: Provide tubing with nominal inside diameter, in accordance with ASTM F876 as indicated.

H. Fittings: Material: Fitting assembly shall be manufactured from material listed in paragraph 5.1 of ASTM F1960. Material Standard: Comply with ASTM F1960.

I. Accessories

1. Angle stops and straight stops that are compatible with PEX tubing are supplied by the PEX tubing manufacturer.
2. Bend supports designed for maintaining tight radius bends are supplied by the PEX tubing manufacturer.
3. Expander tool to install the ASTM F1960 compatible fittings are supplied by the PEX tubing manufacturer.
4. The tubing manufacturer shall provide clips and/or PEX rails for supporting tubing runs.
5. All horizontal tubing hangers and riser clamps shall be epoxy-coated material.

2.5 VALVES

A. Ball Valves

1. Threaded Ends 4" 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 8501, Nibco T-585-70, Milwaukee BA100, Apollo 70-Series,Watts B6000 or FBV-3C series; or approved equal.
2. 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.
3. Comply with MSS SP-110.

B. Swing check valves:

1. Construct pressure containing parts of Valves as follows: Bronze Valves: 125 or 150 psi: ANSI/ASTM B 62; Iron Body Valves: ANSI/ASTM A-126, Grade B
2. Comply with the following standards for design, workmanship, material and testing: Bronze Valves: MSS SP – 80; Cast Iron Valves: MSS SP – 71
3. Construct valves of pressure casting free of any impregnating materials. Construct disc and hanger as one piece. Support hanger pins by removable side plug.
4. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB904, Nibco T-413B, Stockham B319, Milwaukee 509 or approved equal.
5. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB912, Nibco S-413-B, Stockham B309, Milwaukee 1509 or approved equal.
6. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Hammond IR1124, Nibco F918-B, Stockham G931, Milwaukee F2974, Watts 411 or approved equal.

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

2.6 FLEXIBLE CONNECTORS

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

1. Flex-Hose Co., Inc.
2. Flexicraft Industries.
3. Hyspan Precision Products, Inc.
4. Mercer Rubber Co.
5. Metraflex, Inc.
6. Universal Metal Hose; a Hyspan company

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing. Working-Pressure Rating: Minimum 200 psig. End connections compatible with piping.

2.7 WATER METERS

A. Water meter shall be furnished and installed under Division 22. Coordinate with the Augusta Water District for style and configuration requirements.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 for excavating, trenching, and backfilling.

3.2 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. Underground Domestic Water Service Piping: Use any of the following piping materials for each size range:

1. NPS 2 and Smaller: PE pipe; insert fittings for PE pipe; and banded or crimp-ring joints.
2. NPS 2-1/2 and larger: ductile-iron pipe; mechanical- or push-on-joint, ductile-iron fittings; and restrained, gasketed joints.

D. Aboveground Domestic Water: Use the following piping materials for each size range:

1. NPS 3 and Smaller: Hard copper tube, Type L; copper pressure fittings; and soldered joints.

E. Optional Above Ground Piping:

1. Concealed branch run outs to lavatory and sink fixtures in Administration Space Only: PEX is allowed; maximum length of 16 feet.

3.3 VALVE APPLICATIONS

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

1. Shutoff Duty: Use bronze ball valves for piping NPS 3 and smaller. Use cast-iron butterfly valves with flanged or grooved ends for piping NPS 4 and larger.
2. Throttling Duty: Use bronze ball or globe valves for piping NPS 3 and smaller. Use cast-iron butterfly valves with flanged ends for piping NPS 4 and larger.
3. Hot-Water-Piping, Balancing Duty: Calibrated, memory-stop balancing valves.
4. Drain Duty: Hose-end drain valves.

3.4 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.

D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Refer to Division 22 Section "Plumbing Specialties" for calibrated balancing valves.

3.5 PIPING INSTALLATION

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

B. Extend domestic water service piping to exterior water distribution piping in sizes and locations indicated.

C. Install underground ductile-iron piping according to AWWA C600 and NFPA 24. Install buried piping inside building between wall and floor penetrations and connection to water service piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

D. Install underground copper tubing according to CDA's "Copper Tube Handbook."

E. Install underground PE piping according to ASTM D 2774 and ASTM F 645.

F. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 22 Section “Common Work Results for Plumbing" for wall penetration systems.

G. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside building at each domestic water service.

H. Install water-pressure regulators downstream from shutoff valves. Refer to Division 22 Section "Plumbing Specialties" for water-pressure regulators. Install aboveground domestic water piping level and plumb.

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

J. Perform the following steps before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Remove filter cartridges from housings, and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use.

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

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

M. Water-Pressure Regulators: Set outlet pressure at 80 psig max., unless otherwise indicated.

N. Energize pumps and verify proper operation.

3.6 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.

3.7 PEX PIPING INSTALLATION

A. Install tubing in accordance with the tubing manufacturer's recommendations and as indicated in the installation handbook.

B. Ensure compliance of one- and two-hour rated through penetration assemblies in accordance with ASTM E814, Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

C. Do not install PEX tubing within 6 inches of gas appliance vents or within 12 inches of any recessed light fixtures. Do not solder within 18 inches of PEX tubing in the same waterline. Make sweat connections prior to making PEX connections. Do not expose PEX tubing to direct sunlight for more than 30 days. Ensure no glues, solvents, sealants or chemicals come in contact with the tubing without prior permission from the tubing manufacturer.

D. Use grommets or sleeves at the penetration for PEX tubing passing through metal studs. Protect PEX tubing with sleeves where abrasion may occur.

E. Use strike protectors where PEX tubing penetrates a stud or joist and has the potential for being struck with a screw or nail.

F. Use tubing manufacturer-supplied bend supports where bends are less than six times the outside tubing diameter.

G. Minimum horizontal supports are installed not less than 32 inches between hangers in accordance with model plumbing codes and the installation handbook.

H. PEX riser installations require epoxy-coated riser clamps installed at the base of the ceiling per floor. A mid-story support is required for riser applications.

I. Pressurize tubing with air in accordance with applicable codes or in the absence of applicable codes to a pressure of 25 psi above normal working pressure of the system.

J. Comply with safety precautions when pressure testing, including use of compressed air, where applicable. Do not use water to pressurize the system if ambient air temperature has the possibility of dropping below 32°F.

3.8 ROUGHING-IN FOR WATER METERS

A. Rough-in domestic water piping and install water meters according to utility company's requirements. Service water meter requirements shall be coordinated with the Augusta Water District.

3.9 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump. Domestic water temperature maintenance pumps do not require flexible connectors.

3.10 HANGER AND SUPPORT INSTALLATION

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

3.11 CONNECTIONS

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

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

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

D. Connect domestic water piping to service piping with shutoff valve, and extend and connect to the equipment and fixtures as shown on the plans.

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

F. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.12 FIELD QUALITY CONTROL

A. Follow local code requirements.

B. Inspect domestic 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 domestic 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 domestic 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.

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

3.13 CLEANING

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

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

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following: Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to

stand for 24 hours. Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

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

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

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.

b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.

c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 22 11 16

SECTION 22 11 19 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 22 Section "Common Work Results for Plumbing"

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.
2. Sanitary Waste and Vent Piping: 10-foot head of water.
3. Storm Drainage Piping: 10-foot head of water.

1.4 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.

B. Field test reports.

C. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:

1.5 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 UPC 2009 edition, subject to the exclusions and amendments set forth by the Maine Plumbers Examining Board.

D. Comply with local building and plumbing codes.

E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

F. NSF Compliance: Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components. Include marking "NSF-pw" on plastic potable-water piping and "NSF-dwv" on plastic drain, waste, and vent piping. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 1 through 9," for potable domestic water plumbing specialties.

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. Refer to Section 22 05 00.

2.2 BACKFLOW PREVENTERS

A. Manufacturers:

1. Ames Co., Inc.
2. Cla-Val Co.
3. CMB Industries, Inc.; Febco Backflow Preventers.
4. Conbraco Industries, Inc.
5. Watts Industries, Inc.; Water Products Div.
6. Zurn Industries, Inc.; Wilkins Div.

B. General: ASSE standard, backflow preventers.

1. NPS 2 and Smaller: Bronze body with threaded ends.
2. NPS 2-1/2 and Larger: Bronze, cast-iron, steel, or stainless-steel body with flanged ends.
3. Interior Components: Corrosion-resistant materials. AWWA C550 or FDA-approved
4. Exterior Finish: manufacturer's standard.
5. Strainer: On inlet.
6. Backflow preventers for hot water over 110F shall be a listed type for that application.

C. Coordinate with the local water district for specific requirements.

D. Atmospheric-Type Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.

E. Hose-Connection Vacuum Breakers: Watts Series 8FR; ASSE 1011, nickel plated, with non-removable and manual drain features, and ASME B1.20.7, garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

F. Double-Check Backflow Prevention Assemblies:

1. Watts Series 007 (2-1/2" and smaller)
2. Watts Series 709 (3" and larger)
3. ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; test cocks; and two positive-seating check valves. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

G. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013, suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet; test cocks; and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between two positive-seating check valves. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.

1. Watts Series 909 or 994

2.3 AIR-GAP FITTINGS

A. Dishwasher: ASSE 1021, fitting suitable for use with domestic dishwashers and for deck mounting; with plastic body, chrome-plated brass cover; and capacity of at least 5 gpm; and inlet pressure of at least 5 psig at temperature of at least 140 deg F. Provide ports for garbage disposal or dishwasher hoses as required; Airgap International, Inc. or approved equal.

B. Small AC condensate drain into sink trap: Airgap International, Inc. Drain Boa; Inlet port directly accepts 3/8" poly tubing. Dual plumbing code listed sink tailpiece fitting. Listed by NSF® and UPC®.

C. Fixed Air-Gap Fittings: Zurn Z1024 or Z1025; manufactured cast-iron or bronze drainage fitting with semi-open top with threads or device to secure drainage inlet piping in top and bottom spigot or threaded outlet larger than top inlet. Include design complying with ASME A112.1.2 that will provide fixed air gap between installed inlet and outlet piping.

2.4 WATER PRESSURE REGULATORS

A. Manufacturers:

1. Cashco, Inc.
2. Cla-Val Co.
3. Conbraco Industries, Inc.
4. FLOMATIC Corp.
5. Honeywell Braukmann.
6. IMI Cash Valve.
7. Watts Industries, Inc.; Water Products Div.
8. Zurn Industries, Inc.; Wilkins Div.

B. General: ASSE 1003, water regulators, rated for initial working pressure of 150 psig minimum. Include integral factory-installed or separate field-installed, Y-pattern strainer.

1. General-Duty Service: Single-seated, direct operated, unless otherwise indicated. Booster Heater Water Supply: Single-seated, direct operated with integral bypass.

2. Include AWWA C550 or FDA-approved, interior epoxy coating for regulators with cast-iron body.
3. Type: Pilot-operated, single- or double-seated, cast-iron-body main valve, with bronze-body pilot valve.
4. Interior Components: Corrosion-resistant materials.
5. Exterior Finish: Polished chrome plate if used in chrome-plated piping system.

2.5 BALANCING VALVES

A. Calibrated Balancing Valves: Adjustable, with two readout ports and memory setting indicator. Include manufacturer's standard hoses, fittings, valves, differential pressure meter, and carrying case.

1. Manufacturers:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Flow Design, Inc.
d. ITT Industries; Bell & Gossett Div.
e. Taco, Inc.
f. Tour & Andersson, Inc.
g. Watts

2. NPS 2 and Smaller: Bronze body with brass ball, adjustment knob, calibrated nameplate, and threaded or solder-joint ends.

2.6 THERMOSTATIC WATER MIXING VALVES

A. Manufacturers:

1. Lawler Manufacturing Company, Inc.
2. Leonard Valve Company.
3. Powers
4. Symmons Industries, Inc.
5. T & S Brass and Bronze Works, Inc.

B. General: ASSE 1017 listed, manually adjustable, thermostatic water mixing valve with bronze body. Include check stop and union on hot- and cold-water-supply inlets, adjustable temperature setting, and thermometer.

1. Type: Bimetal thermostat, operation and pressure rating 125 psig minimum.
2. Type: Liquid-filled motor, operation and pressure rating 100 psig minimum.

C. Thermostatic Water Mixing Valves: Unit, with the following:

1. Piping, valves, and unions. Include thermometer if not in cabinet.
2. Piping Component Finish: Rough bronze.
3. Cabinet: Surface-mounting stainless-steel box with stainless-steel hinged door and thermometer in front.

2.7 STRAINERS

A. Strainers: Y-pattern, unless otherwise indicated, and full size of connecting piping. Include ASTM A 666, Type 304, stainless-steel screens with 3/64-inch round perforations, unless otherwise indicated.

1. Pressure Rating: 125-psig minimum working pressure, unless otherwise indicated.
2. Screwed screen retainer with centered blow-down. Drain: Field-installed, hose-end drain valve.
3. NPS 2 and Smaller: Bronze body, with female threaded ends.
4. NPS 2-1/2 and Larger: Cast-iron body, with interior AWWA C550 or FDA-approved, epoxy coating and flanged ends.

2.8 HYDRANTS AND HOSE BIBBS

A. Manufacturers:

1. Josam Co.
2. Murdock, Inc.
3. Simmons Manufacturing Co.
4. Smith, Jay R. Mfg. Co.
5. Tyler Pipe; Wade Div.
6. Watts Industries, Inc.; Drainage Products Div.
7. Woodford Manufacturing Co.
8. Zurn
9. MAPA Products

B. General: ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.

1. Inlet: NPS 3/4 or NPS 1 threaded or solder joint.
2. Outlet: ASME B1.20.7, garden-hose threads.
3. Operating Keys: One with each key-operation hydrant.

C. Non-freeze Exposed-Outlet Wall Hydrants: Zurn Z1321, ASSE 1019, ¾" pipe connection; self-drainable with integral non-removable hose-connection backflow preventer, casing and operating rod to match wall thickness, projecting outlet, and wall clamp.

D. Hose Bibbs: Bronze body with replaceable seat disc complying with ASME A112.18.1M for compression-type faucets. Include NPS 3/4 threaded or solder-joint inlet, of design suitable for pressure of at least 125 psig; integral non-removable, drainable hose-connection vacuum breaker; and garden-hose threads complying with ASME B1.20.7 on outlet.

1. Equipment Rooms: Rough bronze, or chrome or nickel-plated, wheel handle.
2. Finished Rooms: Chrome or nickel-plated, operating key, with wall flange.

2.9 WATER HAMMER ARRESTORS

A. Water Hammer Arresters: Zurn Z-1700 Shoktrols, comply with ASSE 1010, PDI-WH 201, and ANSI A112.26.1M; Type 304SS metal-bellows type with pressurized metal cushioning chamber. Sizes indicated are based on ASSE 1010 or PDI-WH 201, Sizes A through F. Maximum working pressure: 125 psi.

2.10 MISCELLANEOUS PIPING SPECIALTIES

A. Deep-Seal Traps: Zurn Z1000, Cast-iron body, with inlet and outlet matching connected piping and cleanout trap seal primer valve connection. Provide 4-inch- minimum water seal.

B. Expansion Joints: ASME A112.21.2M, assembly with cast-iron body with bronze sleeve, packing gland, and packing; of size and end types corresponding to connected piping.

C. Hose-End Drain Valves: MSS SP-110, NPS 3/4 ball valve, rated for 400-psig minimum CWP. Include two-piece, copper-alloy body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.

1. Inlet: Threaded or solder joint.
2. Outlet: Short-threaded nipple with ASME B1.20.7, garden-hose threads and cap.

D. Stop-and-Waste Drain Valves: MSS SP-110, ball valve, rated for 200-psig minimum CWP or MSS SP-80, Class 125, gate valve; ASTM B 62 bronze body, with NPS 1/8 side drain outlet and cap.

2.11 CLEANOUTS

A. Manufacturers

1. Zurn
2. Smith, Jay R. Mfg. Co.
3. Josam Co.
4. Tyler Pipe, Wade Div.
5. Watts Industries, Inc., Drainage Products Div.
6. Mifab

B. 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.

C. Floor Cleanouts: Mifab C1000 Series floor cleanout with heavy-duty nickel-bronze or stainless steel adjustable top.

1. Compliance: ANSI/ASME A112.36.2M.
2. Load Rating: Up to 7,499 pounds.
3. Body: A1, 8-inch diameter body. Lacquered, ASTM A 48, Class 25 cast iron body with anchor flange. O-ring secondary gasket seal. 4-inch; 4"NPS machined integral body threads.
4. Combined Access Cover and Plug Top Assembly: Heavy-duty, round, 5-inch diameter; square, 5-inch by 5-inch (for tile insertion), adjustable, Type 304 stainless steel top assembly with No. 4 satin finish. Neoprene primary gasket seal. Vandal-resistant stainless steel screws.
5. When a waterproof membrane is used in the floor system, provide clamping collars on the cleanouts.
6. In carpeted areas, provide carpet cleanout markers.

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

E. 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; Mifab 1400 Series.

F. 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.

2.12 FLOOR DRAINS

A. Manufacturers

1. Zurn Industries, Inc
2. Jay R. Smith Mfg. Co.
3. Tyler Pipe, Wade Div.
4. Watts Industries, Inc
5. Mifab

B. Floor drains shall comply with ASME A112.21.1M.

C. Provide outlet type as required by piping system used.

D. Provide ½" trap primer connection as indicated on plans.

E. Mechanical Room Floor Drains: Zurn Z508-Y

1. Cast iron 9" diameter drain
2. Heavy duty cast iron deep flange slotted grate
3. Sediment bucket

F. Toilet Room: Smith #2010 Series, Zurn ZN415B; Dura-coated cast iron body, Flashing collar, adjustable 6" round nickel bronze top.

G. Trench Drains: Zurn-Z886-HD, Extra Heavy Duty, 6" wide trench drain system with integral pitch at 1% minimum. as indicated on the drawings. The entire trench assembly shall be constructed of high density polyethylene structural composite material. Provide cast iron dura coated slotted grate with H 20 load rating. The system shall be complete with interlocking ends and combination tie-down/leveling devices. Provide 4" no-hub outlet and piping as indicated on the drawings.: Comply with ASME A112.21.1M.

H. Trench Drains Catch Basins: Zurn-Z887-HD, Extra Heavy Duty, 6" x 20" deep x 20" long, Perma Trench Basin. The entire catch basin assembly shall be constructed of high density polyethylene structural composite material. Provide cast iron dura coated slotted grate with H 20 load rating. Provide inlet adapter and basin outlet connection for 4" pipe. Sediment bucket shall be 18 Ga stainless steel with 3/16" perforations and integral handle.

2.13 TRAP SEAL PRIMER VALVES

1. Manufacturers:

a. Precision Plumbing Products, Inc.
b. Josam Co.
c. Watts Industries, Inc.; Water Products Div.
d. Zurn Industries, Inc.; Jonespec Div.

B. Water-saver trap primer designed to be used in conjunction with a 1-1/4" sink outlet, to divert drain water: Zurn Z1021, chrome-plated polished cast brass body with cleanout, ground joint elbow with 1-1/2"

NPT outlet, 1-1/2" slip nuts and washers, flexible primer tubing and compression fitting, and escutcheons.

C. Supply-Type Trap Seal Primer Valves **(TP)**: Mifab Model MR-500 pressure drop activated, brass, trap seal primer.

1. Tested and Certified: ASSE 1018.
2. Listed: IAPMO and CSA.
3. Operating Range: 20 to 125 psi.
4. Line Pressure Drop to Activate: 3 psi.
5. Inlet Opening: 1/2-inch male NPT.
6. Outlet Opening: 1/2-inch female NPT.
7. View Holes: 4.
8. Filter Screen: Removable, fine mesh brass.
9. Seals: O-rings.
10. Floor Drain Traps Served: Maximum of 6
11. Requires no adjustments and no air pre-charge.
12. Can be disassembled in field.

2.14 ROOF DRAINS

A. Roof Drains: Comply with ASME A112.21.2M.

B. Manufacturers

1. MIFAB
2. Josam Co.
3. Froet Industries
4. Smith, Jay R. Mfg. Co.
5. Tyler Pipe, Wade Div.
6. Watts
7. Zurn

C. Roof Drains: Mifab R1200-EU large sump roof drain Coordinate Drain Type with roofer:

1. Large Sump Roof Drain for 1-3/4 inches to 7 inches insulation. Compliance: ANSI/ASME A112.21.2M. Body: A2 deep sump body. Lacquered, ASTM-A 48, Class 25 cast iron body with anchor flange. Dome Strainer: Self-locking poly dome strainer. Free area of 136 square inches. Membrane Clamp Ring: 2-5/16-inch wide, ASTM A 48, Class 25 cast iron, waterproofing membrane clamp ring with integral gravel stop. Extension Flange: Adjustable, ASTM A 48, Class 25 cast iron, extension deck flange and under deck clamp.
2. Large Sump Roof Drain with Adjustable Ballast Guard for I.R.M.A. Roofs: MIFAB R1200-HC-M lacquered cast iron deep sump roof drain with anchor flange, adjustable extension with auxiliary drainage slots, secondary clamp, large cast iron waterproofing membrane clamp ring with integral gravel stop and metal dome strainer with a free area of 136 sq. inches.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.
4. Access shall be provided for testing, maintenance and repair. Locate backflow preventer between 2 feet and 5 feet above floor.
5. Test of Backflow Prevention Assemblies: Backflow prevention assembly shall be tested using gauges specifically designed for the testing of backflow prevention assemblies. Gauges shall be tested annually for accuracy in accordance with the University of Southern California's Foundation of Cross Connection Control and Hydraulic Research or the American Water Works Association Manual of Cross Connection (Manual M-14). Report form for each assembly shall include, as a minimum, the following:

    a. Data on Device Data on Testing Firm
    b. Type of Assembly Name
    c. Manufacturer Address
    d. Model Number Certified Tester
    e. Serial Number Certified Tester No.
    f. Size Date of Test
    g. Location
    h. Test Pressure Readings Serial Number and Test Data of Gauges
    i. If the unit fails to meet specified requirements, the unit shall be repaired and retested.

C. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.

D. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve.

E. Trap primers:

1. Install trap seal primers in accordance with manufacturer's instructions.
2. Cycle trap seal primers a minimum of 6 times to ensure optimum performance.
3. Ensure flux and other debris is removed.
4. Use only Teflon tape around threads. Do not use pipe dope or paste.
5. Do not solder fittings directly onto inlet or outlet of primer.
6. Do not install trap seal primers closer than 40 feet apart when using same potable water supply line.
7. Mount trap seal primers in a vertical position 1 foot above finished floor for every 20 feet of floor drain trap make-up water line.
8. Install union connection above trap seal primers.

9. Install line shut-off valve upstream of trap seal primers to shut off water supply when performing maintenance on trap seal primers.
10. Avoid direct installation to prevent foreign material from entering directly into trap seal primers.

F. Install expansion joints on vertical risers, stacks, and conductors if indicated.

G. Cleanouts:
1. Install 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. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
3. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
4. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

H. Install floor drains in accordance with manufacturer's instructions at locations indicated on the drawings.

1. Protect installed floor drains from damage during construction.
2. Install floor drains at low points of surface areas to be drained.
3. Install floor drains plumb, level, and to correct elevation.
4. Ensure top of floor drains are flush with top of finished floor.
5. Install floor drains using manufacturer's supplied hardware.
6. Coordinate depressed/pitched slab with concrete contractor.
7. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
8. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

I. Roof Drains:

1. Coordination:

a. Roof drains installed and flashed by roofing contractor.
b. Roof drains furnished, insulated, and connected to piping by Division 22.

2. Examine areas to receive roof drains. Notify Architect of conditions that would adversely affect installation or subsequent use. Do not proceed with installation until unsatisfactory conditions are corrected.
3. Install roof drains in accordance with manufacturer's instructions at locations indicated on the drawings.
4. Install roof drains plumb, level, and to correct elevation.
5. Install roof drains using manufacturer's supplied hardware.
6. Protect installed roof drains from damage during construction.

J. 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.

K. Fasten recessed-type plumbing specialties to reinforcement built into walls.

L. Install wood-blocking reinforcement for wall mounting and recessed-type plumbing specialties.

M. Install individual shutoff valve in each water supply to plumbing specialties. Install shutoff valves in accessible locations.

N. Install air vents at piping high points. Include ball valve in inlet.

O. Install traps on plumbing specialty drain outlets.

P. Water hammer arrestors shall be installed at, flush valve water closets, as shown on the plans and as recommended by Plumbing & Drainage Institute Standard PDI-WH-201. Locate units at the end of branch lines, between the last two fixtures served. Size units based on fixture unit total of branch. All branch pipes serving flush valve water closets shall have water hammer arrestors.

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

3.2 WATER METER INSTALLATION

A. Install water meters, piping, and specialties according to AWWA M6 and utility's requirements.

B. Install roughing-in piping and specialties for water meter installation according to utility's instructions and requirements.

3.3 TRENCH DRAINS

A. Install trench drains with catch basin per manufacturer's written instructions. Coordinate drain installation with GC for structural slab and with Mechanical Contractor for radiant heat tubing layout.

3.4 CONNECTIONS

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

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

C. 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.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled trap seal primer systems and their installation, including piping and electrical connections. Report results in writing. Representative shall train Owner's maintenance personnel to adjust, operate, and maintain.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

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

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

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 22 11 19

SECTION 22 13 16 – PLUMBING SANITARY AND STORM PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, 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. This Section includes storm-drainage piping inside the building and to locations indicated.

C. 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 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.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 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 local building and plumbing codes.

D. 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 ABS PIPING

A. ABS Pipe: ASTM D 2661, Schedule 40, solid wall. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

2.5 FIRESTOP PROTECTION FOR DWV AND STORMWATER PIPING

A. All piping penetrations of fire-resistant rated construction shall be protected in accordance with the plumbing code.

B. Use ProSet, or approved equal, "Firestop Penetrators", Warnock Hersey classified and listed in the building materials directory.

C. Products shall be tested in accordance with the ASTM E-814 standards and shall be selected for all applicable pipe penetrations and plumbing fixture floor openings through Fire-Rated floors, walls or floor/ceiling assemblies, in accordance with the Manufacturer's instructions.
1. Use ProSet System "B" penetrators for cast iron DWV pipes for stacks and drains penetrating floors and walls.
2. Use ProSet System "C" penetrators for plastic DWV pipes for stacks and drains penetrating floors and walls.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 for excavating, trenching, and backfilling.

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

C. Aboveground and Underground, Soil, Waste, and Vent Piping: Use any of the following piping materials for each size range:

1. Cast iron

    a. Underground, Soil, Waste, and Vent Piping located in Mechanical Rooms and the Wash Bay, where hot water (<140°F) may be dumped down the drain

2. PVC or Cast iron

    a. Exposed to occupied space
    b. Under slab
    c. Concealed

D. Vent Piping through roof/exposed above roof: Use any of the following piping materials for each size range:
1. PVC

3.3 PIPING INSTALLATION

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31.

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

C. Install cleanouts at grade and extend to where building drains connect to site piping.

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

E. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 22 Section "Common Work Results for Plumbing" for wall penetration systems.

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

G. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

H. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

I. 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.

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

K. Install drainage and vent piping at the minimum slopes as required by the local plumbing code.

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

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

3.4 JOINT CONSTRUCTION

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

B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings." Gasketed Joints: Make with rubber gasket matching class of pipe and fittings. Hubless Joints: Make with rubber gasket and sleeve or clamp.

3.5 VALVE INSTALLATION

A. Shutoff Valves: Install full-port ball valve on each pump discharge.

B. Check Valves: Install swing check valve, downstream from shutoff valve, on each pump discharge.

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. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials. Connect storm drainage piping to roof drains and storm drainage specialties.

C. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials. Connect drainage and vent piping to fixtures and equipment as shown on the plans. Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

3.8 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.

3.9 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.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 22 13 16

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SECTION 22 13 29 - SEWAGE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 22 Section "Common Work Results for Plumbing"

1.2 SUMMARY

A. This Section includes sewage pumps for the building sanitary drainage systems.

1.3 SUBMITTALS

A. Product Data: Include performance curves, furnished specialties, and accessories for each type and size of pump indicated.

B. Shop Drawings: Show layout and connections for pumps. Include setting drawings with templates, directions for installing foundation and anchor bolts, and other anchorages.

C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

D. Maintenance Data: For each type and size of pump specified to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of pumps and are based on specific manufacturer types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

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.

1.5 DELIVERY, STORAGE, AND HANDLING

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

B. Protect bearings and couplings against damage.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Wet-Pit-Mounted, Vertical Sewage Pumps:
   a. Armstrong Pumps, Inc.
   b. Aurora Pump.
   c. Crane Pumps & Systems, Inc.; Weinman Div.
   d. PACO Pumps, Inc.
   e. Peerless Pump Co.
   f. Weil Pump Co.
   g. Yeomans Chicago Corp.

2. Quick-Disconnect-System, Submersible Sewage Pumps:

   a. ABS Pumps, Inc.
   b. Aurora/Hydromatic Pumps, Inc.
   c. Barnes Pumps, Inc.
   d. Crane Pumps & Systems, Inc.; Weinman Div.
   e. Goulds Pumps, Inc.
   f. ITT Flygt Corp.
   g. Myers: F. E. Myers Co.
   h. PACO Pumps, Inc.
   i. Weil Pump Co.
   j. Zoeller Pump Co.

3. Stationary, Submersible Sewage Pumps:

   a. ABS Pumps, Inc.
   b. Aurora/Hydromatic Pumps, Inc.
   c. Barnes Pumps, Inc.
   d. Chicago Pump Co.
   e. Crane Pumps & Systems, Inc.; Weinman Div.
   f. Goulds Pumps, Inc.
   g. ITT Flygt Corp.
   h. Little Giant Pump Co.
   i. Myers: F. E. Myers Co.
   j. PACO Pumps, Inc.
   k. Weil Pump Co.
   l. Zoeller Pump Co.

4. Submersible, Grinder Sewage Pumps:

a. Aurora/Hydromatic Pumps, Inc.
b. ITT Flygt Corp.
c. Myers: F. E. Myers Co.
d. Zoeller Pump Co.

5. Submersible, Cutter Sewage Pumps:

a. ABS Pumps, Inc.
b. Vaughan Co., Inc.

6. Sewage Pump, Reverse-Flow Attachment:

a. Chicago Pump Co.
b. Federal Pump Corp.
c. PACO Pumps, Inc.
d. Peerless Pump Co.
e. Weil Pump Co.

7. Plastic, Sewage Pump Basins:

a. ABS Pumps, Inc.
b. Goulds Pumps, Inc.
c. Peerless Pump Co.
d. Weil Pump Co.
e. Zoeller Pump Co.

8. Packaged, Sewage Pump Units:

a. ABS Pumps, Inc.
b. Goulds Pumps, Inc.
c. Liberty Pumps.
d. Little Giant Pump Co.
e. PACO Pumps, Inc.
f. Weil Pump Co.
g. Zoeller Pump Co.

9. Packaged, Wastewater Pump Units:
a. Little Giant Pump Co.
b. Myers: F. E. Myers Co.
c. Zoeller Pump Co.

2.2 SEWAGE PUMPS, GENERAL

A. Description: Factory-assembled and -tested, single-stage, centrifugal, end-suction sewage pump units complying with UL 778. Include motor, operating controls, and construction for permanent installation.

B. Discharge Pipe End Connections NPS 2 (DN50) and Smaller: Threaded. Pumps available only with flanged-end discharge pipe may be furnished with threaded companion flanges.

C. Discharge Pipe End Connections NPS 2-1/2 (DN65) and Larger: Flanged.

D. Motors: Single speed, with grease-lubricated ball bearings, and non-overloading through full range of pump performance curves.

E. Finish: Manufacturer's standard paint applied to factory-assembled and -tested units before shipping.

F. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembling and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

2.3 WET-PIT-MOUNTED, VERTICAL SEWAGE PUMPS

A. Description: Vertical, separately coupled, suspended sewage pump complying with HI 1.1-1.5 for wet-pit-volute sewage pumps.

1. Pump Arrangement: Simplex.
2. Pump Arrangement: Duplex.
3. Casing: Cast iron, with open inlet.
4. Impeller: ASTM A 48, Class No. 25 A or higher cast iron; statically and dynamically balanced, open or semiopen nonclog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
5. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, open or semiopen nonclog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
6. Impeller: ASTM A 532/A 532M, abrasion-resistant cast iron; statically and dynamically balanced, open or semiopen nonclog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
7. Pump Shaft and Sleeve Bearings: Stainless-steel shaft with bronze sleeve bearings. Include oil-lubricated, intermediate sleeve bearings at 48-inch (1200-mm) maximum intervals if basin depth is greater than 48 inches (1200 mm), and grease-lubricated, ball-type thrust bearings.
8. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
9. Pump Discharge Piping: Manufacturer's standard galvanized-steel or bronze pipe.
10. Basin Cover: Cast iron or steel and suitable for supporting pumps, motors, and controls. Refer to "Sewage Pump Basins" Article for other requirements.
11. Cover Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.
12. Motor: Mounted vertically on cast-iron pedestal.

    a. Thermal Overload Protection: Built into pump motors or starters, as appropriate, according to size.

13. Controls: NEMA 250, Type 1, pedestal-mounted float switch; with float, float rod, and rod buttons.
14. Controls: NEMA 250, Type 1, pedestal-mounted float switch; with floats, float rods, and rod buttons. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
15. Float-Guide Pipe: Guide pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
16. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.

2.4 QUICK-DISCONNECT-SYSTEM, SUBMERSIBLE SEWAGE PUMPS

A. Description: Submersible, direct-connected sewage pump complying with HI 1.1-1.5 for submersible sewage pumps. Include quick-disconnect system.

1. Pump Arrangement: Simplex.
2. Pump Arrangement: Duplex.
3. Casing: Cast iron, with cast-iron legs that elevate pump to permit flow into impeller, and discharge companion flange arranged to connect to quick-disconnect-system discharge-elbow fitting.
4. Impeller: ASTM A 48, Class No. 25 A or higher cast iron; statically and dynamically balanced, open or semiopen nonclog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
5. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, open or semiopen nonclog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
6. Impeller: ASTM A 532/A 532M, abrasion-resistant cast iron; statically and dynamically balanced, open or semiopen nonclog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
7. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
8. Seals: Double mechanical seals.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
10. Moisture-Sensing Probe: Internal moisture sensor, moisture alarm, and waterproof cable of length required, with cable-sealing assembly for connection at pump.
11. Pump Discharge Piping: Factory or field fabricated, ASTM A 53, Schedule 40, galvanized-steel pipe, bronze pipe, or copper tube.
12. Basin Cover: Cast iron or steel and suitable for supporting controls. Refer to "Sewage Pump Basins" Article for other requirements.
13. Quick-Disconnect System: Include the following:

    a. Guide Rails: Two galvanized-steel or other corrosion-resistant vertical pipes or structural members, attached to baseplate and basin sidewall or cover.
    b. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    c. Pump Yokes: Pump-motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
    d. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
    e. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
    f. Lifting Cable: Stainless-steel cable attached to pump and basin cover at manhole.

14. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with two micropressure switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables.
15. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with three micropressure switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
16. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with two mercury-float switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables.
17. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with three mercury-float switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
18. Controls: NEMA 250, Type 1 enclosure, pedestal-mounted float switch; with float, float rod, and rod buttons.

19. Controls: NEMA 250, Type 1 enclosure, pedestal-mounted float switch; with floats, float rods, and rod buttons. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
20. Float-Guide Pipe: Guide pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
21. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.
22. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with micropressure-switch alarm matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.
23. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mercury-float-switch alarm matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.

2.5 STATIONARY, SUBMERSIBLE SEWAGE PUMPS

A. Description: Submersible, direct-connected sewage pump complying with HI 1.1-1.5 for submersible sewage pumps.

1. Pump Arrangement: Simplex.
2. Pump Arrangement: Duplex.
3. Casing: Cast iron, with cast-iron legs that elevate pump to permit flow into impeller, and discharge companion flange arranged for vertical discharge.
4. Impeller: ASTM A 48, Class No. 25 A or higher cast iron; statically and dynamically balanced, open or semiopen nonclog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
5. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, open or semiopen nonclog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
6. Impeller: ASTM A 532/A 532M, abrasion-resistant cast iron; statically and dynamically balanced, open or semiopen nonclog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
7. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
8. Seals: Double mechanical seals.
9. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
10. Moisture-Sensing Probe: Internal moisture sensor, moisture alarm, and waterproof cable of length required, with cable-sealing assembly for connection at pump.
11. Pump Discharge Piping: Factory or field fabricated, ASTM A 53, Schedule 40, galvanized-steel pipe, bronze pipe, or copper tube.
12. Basin Cover: Cast iron or steel and suitable for supporting controls. Refer to "Sewage Pump Basins" Article for other requirements.
13. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with two micropressure switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables.
14. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with three micropressure switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
15. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with two mercury-float switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables.
16. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with three mercury-float switches in NEMA 250, Type 6 enclosures; mounting rod; and electric

cables. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.

17. Controls: NEMA 250, Type 1 enclosure, pedestal-mounted float switch; with float, float rod, and rod buttons.
18. Controls: NEMA 250, Type 1 enclosure, pedestal-mounted float switch; with floats, float rods, and rod buttons. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
19. Float-Guide Pipe: Guide pipe or other restraint for floats and rods in basins of depth greater than 60 inches (1500 mm).
20. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.
21. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with micropressure-switch alarm matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.
22. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mercury-float-switch alarm matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.

2.6 SUBMERSIBLE, GRINDER SEWAGE PUMPS

A. Description: Submersible, direct-connected sewage pump complying with HI 1.1-1.5 for submersible sewage pumps. Include quick-disconnect system.

1. Pump Arrangement: Simplex.
2. Pump Arrangement: Duplex.
3. Impeller: Bronze or stainless-steel impeller, with stainless-steel grinder assembly.
4. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
5. Seals: Double mechanical seals.
6. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
7. Moisture-Sensing Probe: Internal moisture sensor, moisture alarm, and waterproof cable of length required, with cable-sealing assembly for connection at pump.
8. Pump Discharge Piping: Factory or field fabricated, ASTM A 53, Schedule 40, galvanized-steel pipe, bronze pipe, or copper tube.
9. Basin Cover: Cast iron or steel and suitable for supporting controls. Refer to "Sewage Pump Basins" Article for other requirements.
10. Quick-Disconnect System: Include the following:

    a. Guide Rails: Two galvanized-steel or other corrosion-resistant vertical pipes or structural members, attached to baseplate and basin sidewall or cover.
    b. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    c. Pump Yokes: Pump-motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
    d. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
    e. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
    f. Lifting Cable: Stainless-steel cable attached to pump and basin cover at manhole.

11. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with two mercury-float switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables.

12. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with three mercury-float switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
13. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mercury-float-switch alarm matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.

2.7 SUBMERSIBLE, CUTTER SEWAGE PUMPS

A. Description: Submersible, direct-connected sewage pump complying with HI 1.1-1.5 for submersible sewage pumps. Include quick-disconnect system.

1. Pump Arrangement: Simplex.
2. Pump Arrangement: Duplex.
3. Casing: Cast iron, with cast-iron legs that elevate pump to permit flow into impeller, and discharge companion flange arranged to connect to quick-disconnect-system discharge-elbow fitting.
4. Impeller: Bronze or stainless-steel impeller, with stainless-steel cutter assembly.
5. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
6. Seals: Double mechanical seals.
7. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
8. Moisture-Sensing Probe: Internal moisture sensor, moisture alarm, and waterproof cable of length required, with cable-sealing assembly for connection at pump.
9. Pump Discharge Piping: Factory or field fabricated, ASTM A 53, Schedule 40, galvanized-steel pipe, bronze pipe, or copper tube.
10. Basin Cover: Cast iron or steel and suitable for supporting controls. Refer to "Sewage Pump Basins" Article for other requirements.
11. Quick-Disconnect System: Include the following:

    a. Guide Rails: Two galvanized-steel or other corrosion-resistant vertical pipes or structural members, attached to baseplate and basin sidewall or cover.
    b. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow.
    c. Pump Yokes: Pump-motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges.
    d. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device.
    e. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate.
    f. Lifting Cable: Stainless-steel cable attached to pump and basin cover at manhole.

12. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with two mercury-float switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables.
13. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with three mercury-float switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
14. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mercury-float-switch alarm matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.

2.8 SEWAGE PUMP, REVERSE-FLOW ATTACHMENT

A. Description: Factory-fabricated, reverse-flow pump attachment for factory or field installation in sewage pump basin.

B. Inlet Fitting: One combination inlet-overflow strainer fitting.

C. Valves: Two shutoff valves and two check valves.

D. Strainers: Two strainer housings with reverse-flow, self-flushing strainers.

E. Pipe and Fittings: Size and configuration required to connect to sewage pumps and piping.

2.9 SEWAGE PUMP BASINS

A. Description: Factory fabricated with sump, pipe connections, and separate cover.

B. Basin Sump: Fabricate watertight, with sidewall openings for pipe connections.

1. Material: Fiberglass.
2. Material: Cast iron.
3. Material: Fiberglass or cast iron.
4. Reinforcement: Mounting plates for pumps, fittings, rail systems, and accessories.
5. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

C. Basin Cover: Fabricate with openings with gaskets, seals, and bushings, for access, pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Material: Steel, with bitumastic coating.
2. Material: Cast iron.
3. Material: Steel, with bitumastic coating or cast iron.
4. Reinforcement: Steel or cast-iron reinforcement capable of supporting foot traffic for basins installed in foot-traffic areas.

2.10 PACKAGED, SEWAGE PUMP UNITS

A. Description: Packaged, automatic-operation, submersible sewage pump complying with HI 1.1-1.5 for submersible sewage pumps; with cast-iron body, brass nonclog impeller, plastic basin, control panel, and high-water-level alarm.

B. Description: Packaged, automatic-operation, duplex-arrangement, submersible sewage pumps complying with HI 1.1-1.5 for submersible sewage pumps; with cast-iron bodies, brass nonclog impellers, plastic basin, control panel with alternator, and high-water-level alarm.

C. Description: Packaged, automatic-operation, suspended-type, submersible, grinder sewage pump complying with HI 1.1-1.5 for wet-pit-volute sewage pumps; with cast-iron body, stainless-steel grinder-type impeller and shredding ring, plastic basin, and control panel.

D. Description: Packaged, automatic-operation, duplex-arrangement, grinder sewage pumps complying with HI 1.1-1.5 for wet-pit-volute sewage pumps; with cast-iron bodies, stainless-steel grinder-type impellers and shredding rings, pump alternation, two-compartment plastic basin, and control panel.

1. Pump Seals: Mechanical type.
2. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
3. Basin: Watertight with inlet pipe connection and gastight cover with vent and pump discharge connections.
4. Controls: Automatic, with mercury-float switches and 20-foot (6-m), waterproof, electrical power cables.
5. Pump Discharge Piping: ASTM A 53, Schedule 40, galvanized-steel pipe.
6. Pump Discharge Piping: Manufacturer's standard steel pipe, copper tube, or plastic pipe.
7. Valves: Factory- or field-installed check and shutoff valves on each pump discharge.

2.11 PACKAGED, WASTEWATER PUMP UNITS

A. Description: Packaged, automatic-operation, pedestal wastewater pump; with aluminum or brass impeller, welded-steel or plastic basin, and float switch with 72-inch- (1830-mm-) minimum power cord and plug.

1. Motor: Mounted vertically on sump with built-in overload protection.

B. Description: Packaged, automatic-operation, submersible wastewater pump; with cast-iron body, brass impeller, plastic basin, and motor-mounted float switch with 72-inch- (1830-mm-) minimum power cord and plug.

1. Pump Seals: Mechanical type.
2. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.

C. Description: Packaged, automatic-operation, submersible wastewater pump; with plastic body, plastic impeller, plastic basin, and motor-mounted float switch with 72-inch- (1830-mm-) minimum power cord and plug.

1. Pump Seals: Mechanical type.
2. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
3. Basin: Watertight with inlet pipe connection and gastight cover with vent and pump discharge connections.
4. Controls: Automatic, with mercury-float switches and electrical power cables.
5. Pump Discharge Piping: Manufacturer's standard steel pipe, copper tube, or plastic pipe.
6. Valves: Factory- or field-installed check and shutoff valves on each pump discharge.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of plumbing piping systems to verify actual locations of piping connections before pump installation.

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.3 CONCRETE

A. Install concrete bases of dimensions indicated for sewage pumps. Refer to Division 3 Section "Cast-in-Place Concrete" and Division 22 Section "Common Work Results for Plumbing."

3.4 INSTALLATION

A. Install pumps according to manufacturer's written instructions.

B. Install pumps and arrange to provide access for maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support piping so weight of piping is not supported by pumps.

D. Wet-Pit-Mounted, Vertical Sewage Pumps: Suspend pumps from basin covers. Make direct connections to sanitary drainage piping.

E. Submersible Sewage Pumps: Set pumps on basin floor. Make direct connections to sanitary drainage piping.

1. Anchor quick-disconnect systems to bottom of basins and basin sidewalls or covers. Install pumps so pump and discharge pipe disconnecting flanges make positive seals when pumps are dropped into place.

F. Sewage Pump Basins: Install basins and connect to drainage and vent piping. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install cover so top surface is flush with finished floor.

G. Packaged Pump Units: Install and make direct connections to drainage and vent piping.

3.5 CONNECTIONS

A. Sanitary drainage and vent piping installation requirements are specified in Division 22 Section "Plumbing Sanitary and Storm Piping." Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install discharge pipe sizes equal to or greater than diameter of pump nozzles, and connect to sanitary drainage piping.
2. Install swing check valve and gate or ball valve on each sewage pump discharge. Include spring-loaded or weighted-lever check valves for piping NPS 2-1/2 (DN65) and larger.
3. Install swing check valve and gate or ball valve on each automatic, packaged pump discharge.

B. Install electrical connections for power, controls, and devices.

C. Electrical power and control components, wiring, and connections are specified in Electrical Specification Sections.

D. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 ADJUSTING

A. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.

3.7 COMMISSIONING

A. Final Checks before Starting: Perform the following preventive maintenance operations:

1. Lubricate bearings.
2. Disconnect couplings and check motors for proper direction of rotation.
3. Verify that each pump is free to rotate by hand. Do not operate pump if it is bound or drags, until cause of trouble is determined and corrected.
4. Verify that pump controls are correct for required application.

B. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:

1. Start motors.
2. Open discharge valves slowly.
3. Check general mechanical operation of pumps and motors.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.

2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 22 13 29

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SECTION 22 14 29 - SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.2 SUMMARY

A. This Section includes:

1. Sump pumps for elevator sump pits.
2. AC condensate pumps

1.3 SUBMITTALS

A. Product Data: Include performance curves, furnished specialties, and accessories for each type and size of pump indicated.

B. Shop Drawings: Show layout and connections for pumps. Include setting drawings with templates, directions for installing foundation and anchor bolts, and other anchorages.

C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

D. Maintenance Data: For each type and size of pump specified to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of pumps and are based on specific manufacturer types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered.

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.

1.5 DELIVERY, STORAGE, AND HANDLING

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

B. Protect bearings and couplings against damage.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Weil Pump Co.
2. Little Giant Pump Co.
3. Weil Pump Co.
4. Zoeller Pump Co.
5. Liberty Pumps.
6. Myers
7. Stancor

2.2 SUMP PUMPS, GENERAL

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested units before shipping.

B. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembling and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

2.3 ELEVATOR SUMP PUMP

A. Description: Zoeller Oil Guard System submersible, direct-connected sump pump.. Approved equal: Liberty or ABS.

1. Casing: Cast iron with metal inlet strainer, stainless steel handle. Include discharge companion flange suitable for plain-end pipe connection arranged for vertical discharge.
2. Impeller: Cast iron, bronze, brass, or stainless steel.
3. Pump and Motor Shaft: Steel, with factory-sealed, grease-lubricated ball bearings.
4. Seal: ceramic carbon.
5. Motor: Hermetically sealed capacitor-start type; with built-in overload protection; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
6. Automatic reset thermal overload protected.
7. Pump Discharge Piping: 1 ½” Factory or field fabricated, ASTM A 53, Schedule 40, galvanized-steel pipe or copper tube.
8. Oil smart switch and alarm features:

    a. Audible and Light alarms with dry contacts.
    b. NEMA 4X watertight panel enclosure with lockable latch

c. Preset “On and off” points; UL508 approved switch.
d. Differentiates oil and water; 304-SS probes.
e. Alert maintenance personnel of high water or oil detection.
f. 20 foot piggyback electrical supply cord
g. 20 amp relay.
h. NEMA 3R alarm enclosure.

9. Basin: concrete, see structural plans.

B. Sump Pump Pits

a. Topp Industries, Inc Elevator Poly Basin Model B1824ELE.
b. 18”x24; 24 gallons.
c. Cover designed for quick water runoff with perforations; ¼” steel thick cover; 1-1/2” discharge flange, cord grommet, and hardware pack.
d. Rotational-molded polyethylene; 3/16” wall thickness.

2.4 WET-PIT-MOUNTED, VERTICAL SUMP PUMPS

A. Description: Vertical, separately coupled, suspended sump pump complying with HI 1.1-1.5 for wet-pit-volute sump pumps.

1. Pump Arrangement: Simplex.
2. Pump Arrangement: Duplex.
3. Casing: Cast iron, with cast-iron inlet strainer.
4. Impeller: ASTM A 48, Class No. 25 A or higher cast iron; statically and dynamically balanced, open or semi-open non-clog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
5. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, open or semi-open non-clog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
6. Impeller: ASTM A 532/A 532M, abrasion-resistant cast iron; statically and dynamically balanced, open or semi-open non-clog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
7. Pump Shaft and Sleeve Bearings: Stainless-steel shaft with bronze sleeve bearings. Include oil-lubricated, intermediate sleeve bearings at 48-inch maximum intervals if basin depth is greater than 48 inches, and grease-lubricated, ball-type thrust bearings.
8. Pump and Motor Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
9. Pump Discharge Piping: Manufacturer's standard galvanized-steel or bronze pipe.
10. Basin Cover: Cast iron or steel and suitable for supporting pumps, motors, and controls. Refer to "Sump Pump Basins" Article for other requirements.
11. Cover Shaft Seal: Stuffing box, with graphite-impregnated braided-yarn rings and bronze packing gland.
12. Motor: Mounted vertically on cast-iron pedestal.

    a. Thermal Overload Protection: Built into pump motors or starters, as appropriate, according to size.

13. Controls: NEMA 250, Type 1, pedestal-mounted float switch; with float, float rod, and rod buttons.
14. Controls: NEMA 250, Type 1, pedestal-mounted float switch; with floats, float rods, and rod buttons. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.

15. Float-Guide Pipe: Guide pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
16. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.

2.5 SUBMERSIBLE SUMP PUMPS

A. Description: Submersible, direct-connected sump pump complying with HI 1.1-1.5 for submersible sump pumps.

1. Pump Arrangement: Simplex.
2. Pump Arrangement: Duplex.
3. Casing: Cast iron with cast-iron inlet strainer, legs that elevate pump to permit flow into impeller, and discharge companion flange suitable for plain-end pipe connection arranged for vertical discharge.
4. Impeller: ASTM A 48, Class No. 25 A or higher cast iron; statically and dynamically balanced, open or semi-open non-clog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
5. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, open or semi-open non-clog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
6. Impeller: ASTM A 532/A 532M, abrasion-resistant cast iron; statically and dynamically balanced, open or semi-open non-clog design, overhung, single suction, keyed to shaft, and secured by locking cap screw.
7. Construction: Stainless steel with stainless-steel or other corrosion-resistant impeller, stainless-steel inlet strainer, legs that elevate pump to permit flow into impeller, and discharge companion flange suitable for plain-end pipe connection arranged for vertical discharge.
8. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
9. Seals: Double mechanical seals.
10. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
11. Moisture-Sensing Probe: Internal moisture sensor, moisture alarm, and waterproof cable of length required, with cable-sealing assembly for connection at pump.
12. Pump Discharge Piping: Factory or field fabricated, ASTM A 53, Schedule 40, galvanized-steel pipe, bronze pipe, or copper tube.
13. Basin Cover: Cast iron or steel and suitable for supporting controls. Refer to "Sump Pump Basins" Article for other requirements.
14. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with two micro pressure switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables.
15. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with three micro pressure switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
16. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with two mercury-float switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables.
17. Controls: NEMA 250, Type 1 enclosure, pedestal mounted, unless wall mounting is indicated; with three mercury-float switches in NEMA 250, Type 6 enclosures; mounting rod; and electric cables. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
18. Controls: NEMA 250, Type 1 enclosure, pedestal-mounted float switch; with float, float rod, and rod buttons.

19. Controls: NEMA 250, Type 1 enclosure, pedestal-mounted float switch; with floats, float rods, and rod buttons. Include automatic alternator to alternate operation of pump units on successive cycles and to operate both units if one pump cannot handle load.
20. Float-Guide Pipe: Guide pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
21. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.
22. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with micro pressure-switch alarm matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.
23. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mercury-float-switch alarm matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell, unless battery operation is indicated.

2.6 COMPACT, SUBMERSIBLE SUMP PUMPS

A. Description: Zoeller Model 57 Simplex, submersible, direct-connected sump pump.

1. Casing: Cast iron with metal inlet strainer, stainless steel handle. Include discharge companion flange suitable for plain-end pipe connection arranged for vertical discharge.
2. Impeller: Cast iron, bronze, brass, or stainless steel.
3. Pump and Motor Shaft: Steel, with factory-sealed, grease-lubricated ball bearings.
4. Seal: ceramic carbon.
5. Motor: Hermetically-sealed, capacitor-start type; with built-in overload protection; and three-conductor waterproof power cable of length required, with grounding plug and cable-sealing assembly for connection at pump.
6. Pump Discharge Piping: Factory or field fabricated, ASTM A 53, Schedule 40, galvanized-steel pipe or copper tube.
7. Cover: With holes and gaskets.
8. Controls: Integral mechanical float switch, which shall require no adjustment, nor additional equipment for operation.
9. (115V/1Ph) Zoeller A-Pak or equal complete with sensor float and Nema 1 metal enclosure (cord and plug). Solid state warning light and horn, which can be manually turned off. UL listed and CSA certified on complete alarm system. The alarm will include an alarm horn, alarm light, silence and test buttons, and a 15’ float switch.

2.7 SUMP PUMP BASINS

A. Description: Factory fabricated with sump, pipe connections, and separate cover.

B. Basin Sump: Fabricate watertight, with sidewall openings for pipe connections.

1. Material: Fiberglass.
2. Material: Polyethylene.
3. Material: Steel, with bitumastic coating.
4. Material: Cast iron.
5. Material: Fiberglass, polyethylene, steel with bitumastic coating, or cast iron.
6. Reinforcement: Mounting plates for pumps, fittings, and accessories.
7. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

C. Basin Cover: Fabricate with openings with gaskets, seals, and bushings, for access, pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.

1. Material: Fiberglass.
2. Material: Polyethylene.
3. Material: Steel, with bitumastic coating.
4. Material: Cast iron.
5. Material: Steel, with bitumastic coating or cast iron.
6. Material: Fiberglass, polyethylene, steel with bitumastic coating, or cast iron.
7. Reinforcement: Steel or cast-iron reinforcement capable of supporting foot traffic for basins installed in foot-traffic areas.

2.8 SUMP PUMP PITS

1. Select sump pump pits and covers from this Article and sump pumps from the sump pump articles. Covers are available in round, square, or rectangular design with floor openings for simplex and multiplex pump installations. Indicate size and shape on Drawings. Edit paragraph below if plastic covers or no covers are required.
2. Description: Cast-in-place concrete with steel curb frames and covers. Refer to Division 3.
3. Pit Cover: galvanized bar grate at per detail 4/S3.5. Coordinate with CM.

2.9 AUTOMATIC CONDENSATE PUMP UNITS

A. Liberty LCU-20 Series; packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls.

B. Provide anti-sweat tank sleeve.

1. High impact ABS tank
2. Wall mounts
3. Three intake holes
4. 3/8" O.D. outlet
5. Barbed and threaded discharge connection
6. Removable Check valve
7. Stainless steel shaft
8. 6' power cord with ground
9. Thermally protected
10. Fully automatic
11. Built in safety switch

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of plumbing piping systems to verify actual locations of piping connections before pump installation.

3.2 CONCRETE

A. Install concrete bases of dimensions indicated for sump pumps. Refer to Division 22 Section "Common Work Results for Plumbing."

B. Concrete for pits and sumps is specified in Division 3.

3.3 INSTALLATION

A. Install pumps according to manufacturer's written instructions.

B. Install pumps and arrange to provide access for maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support piping so weight of piping is not supported by pumps.

D. Submersible Sump Pumps:

1. Set pumps in pit. Coordinate pit size.
2. Coordinate location of GFI 3-prong grounded electrical receptacle, extension cords are not permitted.
3. Drill a 3/16” hole in the discharge pipe below the check valve and sump cover to allow proper purging of air.
4. Pit must be cleaned of debris after installation.

E. Sump Pump Basins: Install basins and connect to storm drainage piping. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install so top surface of cover is flush with finished floor.

F. Sump Pump Pits: Construct concrete pits and connect to storm drainage piping. Refer to Division 3 Section "Cast-in-Place Concrete" for concrete work. Set basin cover and fasten to top edge of concrete pit. Install so top surface of cover is flush with finished floor.

G. Packaged Drainage Pump Units: Install and make direct connections to storm drainage piping.

3.4 CONNECTIONS

A. Install discharge pipe sizes equal to or greater than diameter of pump nozzles, and connect to storm drainage piping.

B. Install swing check valve and ball valve on each pump discharge.

C. Install electrical connections for power, controls, and devices.

D. Electrical power and control components, wiring, and connections are specified in Electrical Specification Sections.

E. Ground equipment. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B

3.5 ADJUSTING

1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.

3.6 COMMISSIONING

A. Final Checks before Starting: Perform the following preventive maintenance operations:

1. Lubricate bearings.
2. Disconnect couplings and check motors for proper direction of rotation.
3. Verify that each pump is free to rotate by hand. Do not operate pump if it is bound or drags, until cause of trouble is determined and corrected.
4. Verify that pump controls are correct for required application.

B. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:

1. Start motors.
2. Open discharge valves slowly.
3. Check general mechanical operation of pumps and motors.
4. Confirm that alarm contact signals control system upon failure or high water level.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.

b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 22 14 29

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.2 SUMMARY

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

1. Compressed air Piping.
2. Compressed air Dryers.
3. Compressed air Filters.
4. Compressed air Tank.
5. Relocated existing compressors.

B. Related Sections include the following:

1. Division 22 Section "General-Service Packaged Air Compressors and Receivers" for general-service air compressors and accessories.

1.3 EFFICIENCY MAINE

A. This project intends to pursue Efficient Maine prescriptive and/or custom incentives. The contractor shall participate in the activities associated with Efficiency Maine incentive approval process including but not limited to; preparation and submission of required incentive applications and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.

1.4 DEFINITIONS

A. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Flexible pipe connectors.
3. Safety valves.
4. Automatic drain valves.
5. Specialty fittings.
6. Compressed air Piping.
7. Compressed air Dryers.
8. Compressed air Filters.
9. Compressed air storage Tank.

B. Brazing and welding certificates.

C. Qualification Data: For Installers.

D. Field quality-control test reports.

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

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Shall have minimum of one year experience installing aluminum compressed air piping systems.

PART 2 - PRODUCTS

2.1 MANUFATURERS

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

B. Piping, Tubes, fittings, and accessories shall be one of the following:

1. Prevost
2. Aircom
3. Trainsair
4. AIRnet

C. Acceptable Manufacturer's Sales Representatives:

1. Automotive Garage Tools (AGT), Westbrook Maine; contact Carlton Jackson, 207-878-881.
2. Maine Air Power, Auburn Maine, contact Barlow Morse, 800-427-3768.
3. D.L. Thurrott, Waterville Maine; contact Mike Achorn, 800-810-0983 xtn 4143.

2.2 PIPES, TUBES, AND FITTINGS

A. Aluminum

1. Ductile Aluminum Extrusion Alloy EN AW T6 UNI-EN 755-2 With Inside And Outside Titanium-Based, Chrome-Free And Rohs-Complying Treating And Electrocoated Outside Surface

designed for compressed air. Fittings; mechanical, polyamide or brass, compliant with ANSI B31.1 temperature range (-4 F to 170 F) with a minimum working pressure (188 PSI at 122 F); non corrosive system specifically designed for the compressed air piping used and by the same manufacturer.

2.3 COMPRSSED AIR ACCESSORIES

A. Ball Valves:

1. Branch and main lines isolation: full port compatible with piping system used. Brass or stainless steel, or by piping manufacturer, or type 316 stainless steel stems and balls, reinforced Teflon seats and seals, blowout proof stems and adjustable stem gland. Rated for 400# WOG and 350 F minimum.
2. Air drop drain mini ball valve: standard port compatible with piping system used. 2-piece forged brass construction, 600 PSI WOG and 370 F. Teflon seats, blowout proof brass stem, hard chrome plated brass ball, zinc die cast tee handle.

B. Tapping Flanges/Branch Drops:

1. Technopolymer body with aluminum ring nut.

C. Double & Single Outlet Manifold:

1. By piping manufacturer, aluminum body manifold, pre-assembled with the following:

   a. Drain port with mini ball valve at 150 PSI service, forged brass construction.
   b. OSHA approved pressure relieving safety quick couplers. ISI interchange.

D. Quick Couplers:

1. OSHA approved safety quick coupler, push button single push to vent. ISO 6150, industrial interchange, 1/4" body size. Couplers must carry a leak free guarantee for 3 years.

E. Air Flow Check Valves (Velocity Fuses):

1. Exhaust bleed rate of 9 SCFM at 100 PSI. Anodized aluminum housing. 1/2" size shall have a shut off range of 85 SCFM +- 10.

F. Assembly Tools:

1. Provide a set of tools for the installer, and to be left on site at job completion as owner's property.

   a. (2) deburring tools.
   b. (2) chamfer tools.
   c. (3) of each size drill bits for tapping flanges.
   d. (3) bottles of assembly fluid, by piping manufacturer.

2.4 INLET-AIR FILTERS

A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for relocated reciprocating compressor at the burn table.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.5 WATER OIL SEPARATOR (10 hp duplex compressor at burn table)

A. 2.64 gallon tank capacity. Designed to clean oil from compressed air condensate. Unit shall be equal to BEKO QWIK-PURE 25, Quincy QCS 100.

2.6 PARTICULATE & COALESCING FILTERS

A. Particulate Filter shall be 3/4" NPT, 230 cfm, 3 micron sintered bronze element, coated zinc head, coated aluminum body with sight glass, 160 F max temperature, automatic float drain.

B. Coalescing filter shall be 3/4" NPT, 110 cfm, 0.01 micron pleated fiber element, coated zinc head, coated aluminum body with sight glass, 250 Max Psig, 160 F max temperature, automatic float drain.

2.7 AIR DRYER

A. 600 CFM Dryer:

1. See "Air Dryer Schedule" on drawings for manufacturer and model specifications.

B. High Temperature Dryer for burn table air compressor.

1. See "Air Dryer Schedule" on drawings for manufacturer and model specifications.

2.8 RECEIVER TANK

A. 1060 gallon nominal capacity at 165#. ASME Code Section VIII Division 1 latest edition. Exterior surface shall be painted with one coat of standard shop primer.

B. Tank shall have 6" RFSO flange, 12" x 16" Man way, and ASME nameplate. Dimensions shall be as follows: 48" diameter by 152" high.

C. Equal to Manchester Tank Part Number 302443.

2.9 HANGERS AND SUPPORTS

A. Hangers and supports

1. All hangers and supports shall be especially manufactured for that purpose, preferably by the piping manufacturer, and shall be the design and capacity required for the location of use.
2. Use clamps to connect hangers and supports to structure as drilling and grinding is not allowed due to lead paint.
3. Keep hangers as short as possible. Provide seismic restraints bracing in accordance with the International Building Code. Piping suspended by individual hangers 12 inches or less in length, need not be braced.

2.10 EXTRA PARTS

A. Provide enough spare piping, fittings, manifolds, branch drops, couplings and all required accessories to add 2 type CA-2 drops and 2 type CA-3 .

B. Provide the Owner with one (1) standard length of each size of the piping used on the project.

2.11 SLEEVES

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

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

1. Underdeck Clamp: Clamping ring with set screws.

2.12 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.
2. Provide with automatic feed device for supplying oil to lubricator.

PART 3 - EXECUTION

3.1 Installation:

A. Compressed air piping run in conjunction with pneumatic fluid system layout shall be run in same elevation and routing of the fluid piping runs as shown on PL-300.

B. Pipes shall be installed parallel or at right angles to building walls.

C. Air piping shall be installed level or sloped slightly to low points. Provide drains at low points.

D. Nipples, unions, special fittings, etc., shall be installed with pressure ratings same as or higher than system pressure ratings.

E. Branch connections shall be installed from the top of the main or using special fittings that prevent the passage of condensate.

F. Pressure gages shall be installed on discharge piping from each compressor and on each receiver.

G. Seismic restraints shall be installed as required by the location per the International Building Code.

H. Open ends of tube shall be capped or plugged at all times or otherwise sealed until final assembly.

I. Piping shall be cut square and accurately with a tube cutter (sawing not permitted) to measurements determined at place of installation. Pipe shall be reamed and chamfered to remove burrs, being careful not to expand tube, and so no chips of metal remain in the tube. Piping shall be worked into place without springing or forcing. Tube shall be bottomed in socket so there are no gaps between tube and fitting. Care shall be exercised in handling equipment and tools used in cutting or reaming of tube to prevent debris being introduced into tubing.

J. Space of hangers shall comply with the piping manufacturer's recommendations.

K. Heavy valve and in-line equipment shall be supported to prevent strain on tube or joints.

L. Pipe fittings shall be used for all changes in direction. Tube shall not be bent or forced into place. Pre-bent tubes from the manufacturer may be used.

M. Install piping in such a manner as not to block other equipment. Readouts, controls, switches, transmitters, and gages shall be installed to be visible and easily accessed.

N. Where pipes pass through fire partitions or fire walls (if any), provide a UL listed fire stop that provides effective barrier against the spread of fire and smoke.

3.2 CLEANING AND TESTING

A. Blow out/purge piping prior to installing all manifolds.

B. Conduct a leakage test, repair leaks, and repeat until no leaks remain.

END OF SECTION 22 15 13

SECTION 22 15 14 –FUEL OIL AND LUBRICATION OIL PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.2 SUMMARY

A. This Section includes diesel fuel piping, specialties, and accessories within the building.

B. Related Sections include the following:

1. Division 22 Section "Basic Mechanical Materials and Methods" for flexible connectors.
2. Division 22 Section "Meters and Gages" for pressure gages.
3. Division 22 Section "Plumbing Specialties" for strainers.

1.3 PERFORMANCE REQUIREMENTS

A. Oils: Minimum Working-Pressure Rating: Unless otherwise indicated, minimum pressure requirement for Lubrication Fluids Piping is 2,200 psig at 2:1 safety factor.

1.4 SUBMITTALS

A. Product Data: For the following

1. Low pressure, fittings, valves, swivels, and miscellaneous connectors.
2. Hydraulic oil and motor oil tanks.
3. Motor Oil and Hydraulic Oil Pumps.
4. Fluid Dispensing Reels.
5. Fluid Dispensers.
6. Specialty high pressure fittings, valves and swivels.
7. Fluids Distribution low and high pressure Tubing.
8. Fluid Pressure Relief Kits
9. The fluid lubrication system Vendor will provide hydraulic calculations, and certification that the system is complete, with all appurtenances and equipment needed to operate as intended, the manufacturer's Design Engineer certification of calculations on manufacturer's letterhead, listing all components and their requirements, as indicated but not limited to those listed below. The lube system design engineer shall verify the equipment types/model numbers listed in this specification

and shall modify them as needed to provide a complete and operable system. The lube system design engineer shall certify that the lube system piping, valves, and other components are rated to the appropriate back pressure generated during system operation, to ensure a leak free system.

10. Final Vendor/Factory start up report.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of fuel transfer pumps and are based on the specific model indicated. Other manufacturers' products complying with requirements may be considered. Refer to Division 1 Section "Substitutions."

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 ASME B31.9, "Building Services Piping," for oil piping materials, installation, inspection, and testing.

D. All work performed shall be by the manufacturer's authorized installer/distributor stated as such in writing on manufacturer's letterhead.

1.6 FIELD QUALITY CONTROL

A. Provide the services of qualified manufacturer's representative to perform the following:

1. Supervise preparatory work performed by other trades.
2. Supervise installation.
3. Coordinate, prior to installation, the mounting requirements of the fluid pumps to tanks to assure that proper hardware has been provided.
4. Provide shut off valves at a convenient visible location for emergency shut off of fluid lines and at each reel for individual service.
5. Prior to substantial completion of the facility, supervise testing, by the Vendor/Contractor in the presence of the Engineer of Record, to ensure proper operation of the equipment.
6. Instruct Owner's personnel in the proper safe operation and maintenance of all equipment.
7. Perform all scheduled and unscheduled maintenance during warranty period; provide all labor and materials required.

PART 2 - PRODUCTS

2.1 FLUID DISPENSING MANUFACTURES

A. Fluid dispensing equipment, including but not limited to pumps, hose reels, dispensers **by Lincoln Industrial, St. Louis MO**, or Equal.

1. Lincoln qualified Manufacturer's Representative for New England:
   a. Automotive, Inc. 707 Oakwood Avenue, West Hartford, CT 06110. Tel# (800) 243-1862; email: **Sales@automationincct.com**. Contact: Robert Dodge.

2.2 PIPIING AND TUBING MANUFACTURERS

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

1. Low Pressure and High Pressure Steel Tubing.

a. Lenz Inc. (Basis of Design), or equal

2. Fluids Shutoff Valves, Fittings, Unions, Miscellaneous High Pressure Fittings.

a. Lenz Inc. (Basis of Design), or equal.

2.3 PIPING MATERIALS

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

B. Low Pressure Steel Tubing: ANSI B-93.4, 67.1 SAE J-525B, NFPA STD T-3.15; The main and branch lines shall be Seamless Steel Lenz type Tubing, 1" OD x 0.049 Wall rated at 2,200 psi working pressure with a 2:1 safety factor, with Lenz type Compression Fittings.

1. All fitting O-Ring Seal Fittings shall be rated at 8,000 at a 2:1 safety factor.
2. All Fluids Shutoff Valves, Fittings, Unions, Miscellaneous connectors shall have pressure ratings equal to low pressure operation at a minimum.

2.4 275-GALLON OIL STORAGE TANKS

A. Equal to ROTH Double Wall indoor tank: Model # 275-gallon. The outer tank is made of leak proof corrosion resistant steel, roll-seamed, containing at least 110% of the inner tank capacity. The inner tank is make of blow-molded, high-density, polyethylene that is seamless, corrosion resistant, and leak proof. The tank shall be manufactured in conformance with Underwriters Laboratories' UL-80 specifications and so labeled. Tank shall be provided with two handles, one on each end for use in handling tank during installation. Each handle shall be installed in pressed indentation designed to allow tank to be stored and shipped on end with handle installed.

B. Provide factory tank stands for tandem tank installation.

C. Tank shall include the following threaded connections: ½” leak detection indicator, four 2” on top centerline of the tank, and other fittings as required.

D. Tanks shall be air tested at the factory but MUST be retested at the jobsite by the installer prior to installation.

E. Tanks shall be for (1) Motor Oil and (1) Hydraulic Oil.

2.5 LUBRICANT PUMPS, EQUIPMENT AND ACCESSORIES.

A. Pumps: High Level Shut Off.

B. Low & High Pressure Relief Valve fastens to bottom of pump and with brass float.

C. Filter Regulator Lubricators (FRL)

D. Low Pressure Relief Valve Rated For 1,000 psi by Lincoln Industrial or equal.

E. Fluid Recovery:

F. Features and Construction for Gravity Portable Drain Pans

2.6 MOTOR OIL AND HYDRAULIC OIL PUMPS

A. Features and Construction for Standard Duty Integrated Air Motor and Pump Tube for Motor Oil, Hydraulic Oil, and 80/90 Gear Oil:

B. An 3 Inch Air motor with 40 to 150 psig of working pressure,. 3.5 inch pump stroke, Double acting pump.

C. Oil output from pump equal for both up and down stroke, Stall pressure equal for both up and down stroke.

D. Ball check seats with grade 25 quality.

E. Integrated muffler exceeds OSHA noise requirements.

F. Corrosion resistant air motor is fully pneumatic and separate modular design with only 5 moving parts for longer life and ease of maintenance.

G. Pump tube to contain carbon steel plunger case hardened to depth of .010" with polyurethane seal arrangement. Separate high pressure seals for air motor and pump tube.

H. Pumps available in 5:1 ratios and shall be wall, tank mounted. Pumps available in 6:1 ratio and shall be wall mounted.

I. Accessories: Pump pressure relief valve, low level cut off, pump shut off valve, pump suction kit, compressed air regulator.

J. Equal to Lincoln Industrial models:

1. PMV Series Pumps – V305275BB – 5:1; V40600SWM – 6:1
2. Fluid dispensing equipment shall deliver an acceptable amount of fluid as recommended by the owner with a minimum flow of 2 gpm to be provided at the reel.

2.7 HOSE REELS FOR MOTOR OIL AND HYDRAULIC OIL

A. Features and Construction for Standard Duty, Low Pressure Reels for: water, windshield wash and compressed air applications.

B. Low pressure, fully ported swivel designed to be corrosion resistant when used with air and water. Working pressure rating of 1,000 psig.

C. Spring tension adjustable without disconnected hose, control valve or ball stop.

D. Components are individually powder coat painted prior to assembly.

E. Strain relief for hose connection through reel sheave.

F. 1/2” NPT thread inlet and outlet connections with 90° swivel.

G. 3/8” and 1/4” I.D. hose 60’ in length.

H. Seven position, 270° arm adjustment at 45° increments,180° opposed double ratchet non-sparking hose reel stop mechanism. Anti-lockout hose clamp.

I. Rolled sheave edges.

J. Dual needle bearings reduce friction to rotate reels providing smooth balanced operation during both hose extension and retraction.

K. Operating temperature – 10° - 225° F.

L. Easily accessible yet fully contained power springs designed for optimum performance at various operating pressures.

M. High quality carbon steel 12 ga galvanized mounting brackets.

N. Five year limited warranty.

O. Equal Lincoln Industrial Model;

1. Lincoln 94364 Series Reels 1/2’x 60’

2.8 HOSE REELS FOR COMPRESSED AIR

A. Features and Construction for Standard Duty, Low Pressure Reels for: compressed air applications.

B. Low pressure, fully ported swivel designed to be corrosion resistant when used with air and water.

C. Working pressure rating of 1,000 psig.

D. Spring tension adjustable without disconnected hose, control valve or ball stop.

E. Components are individually powder coat painted prior to assembly.

F. Strain relief for hose connection through reel sheave.

G. 1/2” NPT thread inlet and outlet connections with 90° swivel.

H. 1/2" air hose 50’ in length.

I. Seven position, 270° arm adjustment at 45° increments.

J. 180° opposed double ratchet non-sparking hose reel stop mechanism.

K. Anti-lockout hose clamp.

L. Rolled sheave edges.

M. Dual needle bearings reduce friction to rotate reels providing smooth balanced operation during both hose extension and retraction.

N. Operating temperature – 10° - 225° F.

O. Easily accessible yet fully contained power springs designed for optimum performance at various operating pressures.

P. High quality carbon steel 12 ga galvanized mounting brackets.

Q. Five year limited warranty.

R. Equal to Lincoln Industrial Model:

1. Lincoln 94154 Series Reels 1/2" x 50’

2.9 ELECTRONIC DISPENSING CONTROL VALVES

A. Mechanical Lube (Motor Oil and Hydraulic Oil) Control Valve with Totalizing Meters: Equal to Lincoln Industrial Model(s): #982 for Motor oil and Hydraulic oil.

1. 1,000 pis maximum working pressure.
2. Motor and Hydraulic Oil nozzle: 10" flex with Lincoln Model # 84799 nozzle.
3. Dispenses up to 4 gpm (Lube system designed for 2 to 3 gpm).
4. 3 1/2" diameter meter:

a. Motor and Hydraulic Oil: 16 quart dial total with 1/4 quart graduations.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. General: Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.

B. 1" OD Low Pressure Steel Tubing: Motor and Hydraulic oils.

3.2 VALVE AND FITTINGS APPLICATIONS

A. Low Pressure Lubrication (2,200 psi) ratings.

3.3 PIPING INSTALLATION APPLICATION

A. Schedule 40 black steel pipe shall be installed for the following systems:

1. Motor and Hydraulic Oil Storage Tank Fill &Vent Piping.

B. Low pressure 2,200 psi rated tubing shall be installed for the following system:

1. All motor oil distribution piping.
2. All hydraulic oil distribution piping.

3.4 PIPING INSTALLATION

A. Refer to Division 23 Section 23 05 00 "COMMON WORK RESULTS FOR MECHANICAL" for basic piping installation requirements.

B. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

C. Install pressure gages on suction and discharge piping of each lubrication oil pump set.

D. Install Low and High Pressures steel tubing / fittings in strict conformance with manufacturer's recommendations to prevent pipes from leaks and damage from loose pipe hangers.

E. Coordinate piping with hose reel locations; make all shut off valves accessible.

F. Coordinate piping with lubrication pump(s) locations.

G. Identify all piping systems per Section 23 05 53 "Identification for Mechanical".

3.5 JOINT CONSTRUCTION

A. Refer to Manufacturer's written instruction for Low and High Pressure Steel Tubing joint construction methods.

3.6 VALVE INSTALLATION

A. Install valves in accessible locations, protected from possible damage.

B. Install valves at branch connections to supply mains and at equipment.

C. Install drain valves at piping low points.

3.7 CLEAN AND FLUSH DISTRIBUTION SYSTEM

A. Blow out all piping systems with compressed air prior to making final connections at pumps.

B. Completely flush piping systems with respective piped fluid (e.g. heavy motor oil for the heavy motor oil dispensing). The amount of fluid flushed should be approximately 2 times the pipe line capacity.

C. All dispensed fluids for flushing shall be provided by the Owner for use by the contractor. Recaptured fluids after flushing shall be recycled by the Owner.

3.8 HANGER AND SUPPORT INSTALLATION

A. Refer to Section 22 05 29 "Hangers and Supports For Piping and Equipment.

B. Support vertical steel pipe at each floor and at spacing not greater than 15 feet.

C. Support low and high pressure steel tubing with hanger types and spacing per written manufacturer's instructions.

3.9 LUBRICATION EQUIPMENT INSTALLATIONS

A. Install pumps and appurtenances in strict conformance with approved shop drawings and manufacturer' written installation instructions.

B. Coordinate hose reel mounting and location with structural documents.

C. The Vendor/Contractor shall provide all compressed air line connectors, hose, filter, regulator, and valve required at each pump per the lubrication system design engineer.

D. Work shall conform with all pertinent State of Maine Codes.

3.10 FIELD QUALITY CONTROL

A. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Provide all scheduled and unscheduled maintenance during the warranty period that includes labor and materials.

3.11 DEMONSTRATION

A. Provide Vendor/Factory authorized start up service complete with submitted startup report for operation of complete lubrication system. The Vendor/Contractor shall provide all necessary lubrication products and costs associated with the start up testing.

B. Train (8 hours total) Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining lubrication system. Training shall include demonstration on owner provided vehicles and appurtenances. Training shall also include class time for operation and safety procedures.

C. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."

D. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

E. Schedule training with Owner, through Architect, with at least seven days' advance notice.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 22 15 14

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SECTION 22 33 00 - ELECTRIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. This section shall supersede State of Maine Department of Transportation, “Standard Specifications section 502, except as noted herein.

1.2 SUMMARY

A. This Section includes the electric water heaters and accessories.

1.3 SUBMITTALS

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

B. LEED Submittal: Product Data for Prerequisite EA 2: Documentation indicating that units comply with ASHRAE/IESNA 90.1-2007, Section 7 - "Service Water Heating."

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

D. Source quality-control test reports.

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

F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

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

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated

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

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007.

E. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

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

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

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Refer to Division 22 Section “Common Work Results for Plumbing”.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period(s): From date of Substantial Completion:

a. Electric Water Heaters:

1) Storage Tank: Five years.
2) Controls and Other Components: Two years.

PART 2 - PRODUCTS

2.1 INSTANTANEOUS ELECTRIC WATER HEATERS

A. Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.

1. Manufacturers:

    a. Eemax, Inc.
    b. Hot Aqua, Inc.
    c. IMI Water Heating, Ltd.
    d. Stiebel Eltron, Inc.

2. Tankless Water Heater shall be an Eemax Thermostatic Model, with digital micro processing temperature control capable of maintaining outlet temperature of +/– 1°F accuracy, and shall use an ASSE 1070 approved integrated mixing valve.
3. Unit shall be Eemax or approved equal.
4. Construction:

    a. Pressure Rating: 150 psig.
    b. UL Listed.
    c. Element shall be replaceable cartridge insert. Unit shall have replaceable filter in the inlet connector. Element shall be iron free, Nickel Chrome material.
    d. Safety Control: High-temperature-limit cutoff device or system.
    e. Temperature: Factory set to 105°F
    f. Jacket: Steel Powder Coated

5. Capacity: As scheduled on the drawings.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

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

B. Water heaters shall be supported and restrained by the specified supports.

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

D. Install water-heater drain piping as indirect waste to spill by positive air gap into **mop basin floor drain**.

E. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Plumbing Specialties" for hose-end drain valves.

F. Install plumbing specialties as shown on the plans and in accordance with manufactures' recommendations.

G. Fill water heaters with water.

H. Charge compression tanks with air.

3.2 CONNECTIONS

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

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

C. Ground equipment according to electrical specifications.

D. Connect wiring according to electrical specifications.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

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

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

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

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.

2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 22 33 00

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SECTION 22 35 00 – INDIRECT-FIRED WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 22 Section "Common Work Results for Plumbing"

1.2 SUMMARY

A. This Section includes indirect-fired water heaters.

1.3 SUBMITTALS

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

B. Operation and Maintenance Data: For indirect-fired water heaters to include in emergency, operation, and maintenance manuals.

C. Warranty specified in this Section.

1.4 QUALITY ASSURANCE

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

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

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

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of indirect-fired water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including indirect-fired water heater, storage tank, and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period(s): From date of Substantial Completion: 5 years.

PART 2 - PRODUCTS

2.1 INDIRECT-FIRED STORAGE WATER HEATERS

A. Manufacturers

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

a. Lochinvar
b. Amtrol (Basis of Design)
c. Buderus
d. Viessmann
e. Heat Transfer Products, Inc.

B. Description: Indirect fired, Equal to Amtrol Commercial BoilerMate Model **WHS-120ZCDW**, 119 gallons, 236 gallons 90F rise first hour, 173 gallons 70F rise continuous, less circulator and controls.

C. Storage-Tank-Shell Construction: Non-ASME-code 316L stainless steel with 150-psig working-pressure rating.

1. Tappings: Factory fabricated of materials compatible with tank for piping connections, relief valve, pressure gage, thermometer, blowdown, vent, and controls as required. Attach tappings to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
2. Interior Finish: 316L Stainless steel
3. Insulation: CFC-free 2” Polyurethane Foam, Comply with ASHRAE 90.1. (less than 0.4 F/hr heat loss)
4. Outer Jacket: Polyethylene.
5. Provide factory T&P relief-valve.

D. Heat Exchanger System:

1. Double wall tubing vented to atmosphere.
2. Removable copper coil assembly for heating fluid. Include working-pressure rating equal to or greater than heating-fluid supply pressure.

PART 3 - EXECUTION

3.1 STORAGE WATER HEATER INSTALLATION

A. Install indirect-fired water heaters on concrete bases. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing"

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

C. Install seismic restraints for indirect-fired water heaters. Anchor to substrate.

D. Install temperature and pressure relief valves in top portion of storage tank shells of indirect-fired water heaters with domestic water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Fill indirect-fired water heaters with water, purge, and startup in accordance with manufactures' recommendations.

3.2 CONNECTIONS

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

B. Install piping adjacent to indirect-fired water heaters to allow service and maintenance. Arrange piping for easy removal of heat exchangers.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

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

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain indirect-fired water heaters. Refer to Division 1.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 22 35 00

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 22 Section "Common Work Results for Plumbing"
2. Division 22 Section "Domestic Water Piping": Material and installation of piping systems, valves, and piping specialties.
3. Division 22 Section "Plumbing Specialties" for backflow preventers and specialty fixtures not in this Section.

1.2 SUMMARY

A. Plumbing Fixtures

B. Electric Water Coolers

C. Emergency 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.

B. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

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. 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 UPC 2009 edition, subject to the exclusions and amendments set forth by the Maine Plumbers Examining Board.

D. Comply with local building and plumbing codes.

E. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.

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

G. 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. Fixtures shall be water conservation type in accordance with local, state, and federal requirements.
2. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws.
3. Fixture color shall be white except as specified herein.
4. Provide combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
5. Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings.
6. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap.
7. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view.
8. Fixtures with the supply discharge below the rim shall be equipped with backflow preventers.
9. Fixture supports for off-the-floor lavatories, urinals, water closets, and other fixtures of similar size, design, and use, shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab.

10. Provide access panels to concealed valves and components. All components shall have proper access in accordance with manufactures' recommendations. Refer to Section 22 05 00.

B. Temperature Mixing Valves:

1. Manufacturers

a. Powers
b. Leonard
c. Watts
d. Zurn

2. For DHW storage temperatures above 120°F provide mixing valves at sinks and lavs where hand washing occurs. Example: kitchen sinks and lavatories.
3. Water temperature limiting device shall conform to ASSE 1070-2004 "Performance Requirements for Water Temperature Limiting Devices"; integral checks with screens; adjustable temperature selection with locknut to prevent tampering, solid brass construction, factory-set to 105°F.

2.2 FLUSH VALVES

A. Manufacturers

1. Sloan
2. Toto
3. Zurn
4. Hydrotek

B. Typical for Flush Valves:

1. Valve Body, Cover, Tailpiece and Control Stop shall be in conformance with ASTM Alloy Classification for Semi-Red Brass. Valve shall be in compliance to the applicable sections of ASSE 1037, ANSI/ASME 112.19.2, and Military Specification V-29193.
2. Provide polished chrome finish.
3. Synthetic rubber diaphragm with dual filtered fixed bypass; adjustable tailpiece; high back pressure vacuum breaker flush connection with one-piece bottom hex coupling nut; spud coupling and flange for top spud; sweat solder adapter with cover tube and cast set screw wall flange; high copper, low zinc brass castings for dezincification resistance; non-hold-open handle, fixed metering bypass and no external volume adjustment to ensure water conservation; diaphragm, handle packing, stop seat and vacuum breaker molded from a special rubber compound for chloramine resistance, 1" IPS screwdriver angle stop, free spinning vandal resistant stop cap.

C. Automatic Infra-red water closet flush valve: TOTO® TET1LN32 Series. Automatic infrared sensor activated, toilet flush valve, heavy-duty zinc die cast cover with polished chrome finish. Vandal resistant hex head screws. Low water consumption of 1.28 gallons per flush. Automatic sensor adjustment on installation. Manual override button incorporated. Piston valve and solenoid with self cleaning mechanism. Automatic flush every twenty four hours if not used. Angle stop and vacuum breaker included with accessories.
Product shall include three year warranty. Bronze casting with polished chrome finish.
Power Supply: Hydropower self-generating system
Water Supply: 1" NPT
Detection time: Factory setting at six (6)seconds minimum
Detection range: Self-adjusting to environment
Discharge quantity: Preset to 1.28 gpf

Supply water pressure: 15 psi - 125 psi*
Trap seal protection: Automatically flushes once after twenty-four (24) hours of non-use

D. Automatic Infra-red urinal flush valve: TOTO® TEU1UN Series. Automatic infrared sensor activated, urinal flush valve, heavy-duty zinc die cast cover with polished chrome finish. Vandal resistant hex head screws. Low water consumption of 1/8 gallon per flush. Automatic sensor adjustment on installation. Manual override button incorporated. Piston valve and solenoid with self cleaning mechanism. Automatic flush every twenty four hours if not used. Angle stop and vacuum breaker included with accessories.
Product shall include three year warranty. Bronze casting with polished chrome finish.
Power Supply: Hydropower self-generating system
Water Supply: 3/4" NPT
Detection time: Factory setting at six (6)seconds minimum
Detection range: Self-adjusting to environment
Discharge quantity: Preset to 1/8 gpf
Supply water pressure: 15 psi - 125 psi*
Trap seal protection: Automatically flushes once after twelve (12) hours of non-use
ADA Compliant
CalGreen compliant

E. FLUSH VALVE WATER CLOSETS

F. Manufacturers

1. American Standard, Inc.
2. Kohler Co.
3. Toto
4. Zurn

G. Seats: American Standard 5905.100 elongated extra heavy duty open front seat, less cover, with stainless steel check hinge, easy-clean surface with anti-microbial agent; or approved equal by Kohler, Toto, Zurn, Bemis, Church, or Olsonite.

H. Floor mount bottom outlet white vitreous china siphon jet water closet with elongated bowl, 1-1/2" top spud, 2" passageway, closet bolt/wax ring kit.

1. 17"” ADA height 1.6 GPF fixture: American Standard "Right Width, Elongated Right Height" 3641.016.
2. Flush valve: Automatic infra-red.

2.3 URINALS

A. Manufacturers

1. Sloan
2. American Standard, Inc.
3. Kohler Co.
4. Toto
5. Eljer
6. Caroma
7. Zurn

B. Urinal Support: urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture.

C. 1/8 Gal/Flush Urinal: Sloan WEUS 1000.1201-0.13 SOLIS; vitreous china, wall-mounted; ADA-compliant; washout flushing action with water consumption of 1/8 gallon per flush; integral trap, 3/4 inch diameter inlet, 2 inch IPS outlet; for external flush meter valve; white color. Urinal shall meet ASME flush requirements at 1/8 gpf. Sensor operated, flushometer.

1. ADA Wall mount, same as above, except barrier free adjusted for ADA height as shown on the architectural plans.

2.4 LAVATORY FAUCETS

A. Faucet Manufacturers:

1. Toto
2. Chicago
3. Zurn
4. Kohler
5. American Standard
6. Symmons

B. ADA automatic infra-red sensor faucet: Toto TEL3LC10#CP automatic infra-red sensor faucet, anti-scald thermal mixing valve, automatic sensor adjustment, maximum discharge of .09 gallons/10 second cycle. Electrical components separated from spout assembly and sealed in waterproof compartments. Single hole faucet 4” centerset cover plate.

C. Certifications: IAPMO (cUPC), ASSE

D. Code Compliance: UPC, IPC, NSPC

2.5 LAVATORIES

A. Lavatory Manufacturers:

1. Zurn
2. American Standard
3. Kohler
4. Toto

B. Typical for All Lavatories:

1. Coordinate hole punchings with faucet.
2. Provide overflow.
3. Drain: cast brass, solid-top, open-grid, C/O plug with 1-1/4” diameter 17-gauge tailpiece and cast brass locknut for sink depths up to 2-1/4". Offset tailpiece for ADA applications.
4. P-trap: chrome plated, cast body p trap, tubular wall bend 10-1/2" CL, die cast nuts, shallow escutcheon with 1-1/4" compression inlet x 1-1/2" compression outlet.
5. Supply line: supplied by fixture manufacturer, or by McGuire or Brasscraft; loose key standard stop lavatory supply kit, two polished chrome, solid brass angle stops with round wheel handles,

two 12" flexible chrome-plated lavatory risers complete with two chrome-plated steel flanges; connections: 1/2" sweat x 3/8" OD.

C. Wall Hung Lavatory: American Standard Lucerne 0355.012 wall hung, ASME A112.19.2vitreous china lavatory, front overflow, vitreous china, front overflow, D-shaped bowl, self-draining deck area with contoured back and side splash shields, faucet ledge.

1. Nominal Dimensions: 20-1/2" x 18-1/4"
2. Bowl size: 15" wide, 10" front to back, 6-1/2" deep
3. Drain: 304SS grid drain
4. P-trap: Heavy cast brass 1 1/4 x 1 1/2 adjustable trap with cleanout plug and 12 inch center to end. Furnished with slip nuts, 17 gauge seamless tubular brass wall bend, and steel shallow flange.
5. 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 round 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.

D. Counter Mount Lavatory: American Standard Rondalyn 0491 vitreous china self rimming lavatory, front overflow, D-shaped bowl, self-draining deck area with contoured back and side splash shields, faucet ledge.

1. Nominal Dimensions: 19 1/8" round.
2. Drain: 304SS grid drain
3. P-trap: Heavy cast brass 1 1/4 x 1 1/2 adjustable trap with cleanout plug and 12 inch center to end. Furnished with slip nuts, 17 gauge seamless tubular brass wall bend, and steel shallow flange.
4. 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 round 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.

2.6 STAINLESS STEEL SINKS

A. Sink Manufacturers:

1. Elkay Manufacturing Co.
2. Just Manufacturing Co.
3. Kindred
4. Advance Tabco

B. Faucet Manufacturers

1. Symmons
2. Delta Commercial
3. Chicago
4. Zurn
5. Kohler
6. American Standard

C. Common requirements

1. Protective Shielding Guards: Provide for ADA installation with exposed piping.
2. Hole punchings to match faucet type.
3. Supplies: Provide stops below sink

D. Staff Room Sink: Elkay LRAD2219R, counter-mounting, single compartment, Type 304stainless-steel fixture.

1. Overall Size: 22” X 19”; Inside Size: 18"X 14".
2. Sink Faucet: Symmons Andora S-26 single handle kitchen faucet with pull-out spray spout with retractable pull-out spray hose; pull-out spray spout with spray to stream touch control; integral vacuum breaker and ceramic control components; 1/2 inch IPS connections; single hole or 3 hole installation (include\ optional escutcheon); metal construction with chrome finish; ASME A112.18.1-2005.
3. Drain Fitting: type 304 stainless steel body and removable conical basket strainer with metal stem and rubber stopper; fits 3-1/2" opening; polished finish; chrome plated brass 1-1/2" x 4" tailpiece or 1-1/2” elbow for ADA offset.

E. Coffee Station Sink: Elkay BCRA150C, counter-mounting, single compartment, Type 304stainless-steel fixture.

1. Overall Size: 15” X 16” X 6 1/8”; Inside Size: 12"X 10" X 6”.
2. Sink Faucet: Symmons Symmetrix S-245-LWG two handle kitchen faucet ; wrist blade handles; integral vacuum breaker and ceramic control components; 1/2 inch IPS connections; standard gooseneck spout; metal construction with chrome finish.

F. Drain Fitting: type 304 stainless steel body and removable conical basket strainer with metal stem and rubber stopper; fits 3-1/2" opening; polished finish; chrome plated brass 1-1/2" x 4" tailpiece or 1-1/2” elbow for ADA offset.

2.7 HAND WASH SINK

A. Manufacturers:

1. Bradley (Basis of Design)
2. Intersan
3. Acorn

B. Work Bay 2 Hand Wash Sink: Bradley, Hand Wash-Up Sink, Terrazzo classic wash fountain, Model WF2603, 36” semi-circular three user wash fountain.

C. Furnish with the following:

1. Infra-red hands free control with solenoid valve and non-sectional spray head.
2. Centrally rising vent with supplies from above.
3. Standard height
4. Liquid soap dispenser
5. Thermostatic mixing valve
6. Drain: LK8, Chrome plated stamped brass perforated strainer grid. 1 1/2" OD x 4" tail piece.
7. Trap: LK500, Chrome plated cast brass 1 1/2" OD "P" trap with cleanout.

2.8 MOP SERVICE BASIN

A. Manufacturers:

1. Zurn
2. Fiat
3. Mustee

B. Install check valves at HW and CW connections.

C. 24 x 24 x 12” H Neo corner Mop Service Basin: Fiat TSBC 6010. Terrazzo basin; QDC quick drain connector, stainless steel drain body, stainless steel strainer. Certifications: Meets ANSI Z124.6, CSA listed, and IAPMO listed under file # 3561.

1. Wall Guard (MSG) Provide 20 gage type 304 stainless steel bumpers used to protect walls adjacent to mop basin. Two stainless steel panels shall be supplied for corner installation.
2. Mop holder: Stainless steel 24" long x 3" wide with three rubber tool grips
3. Threshold Caps/Guards: Provide 20 gage type 304 stainless steel bumper guards to protect top edge of basin.
4. Manufacturer supplied silicone sealant.

D. Faucet: Chicago Faucets No. 897-CP, Polished chrome plated solid cast brass construction. Atmospheric vacuum breaker spout with pail hook, wall brace and 3/4" male garden hose thread outlet. 2-3/8" metal lever handles with eight point tapered broach and secured color coded index buttons. Quaturn™ quarter-turn renewable compression cartridge designed to close with water pressure with square tapered broach feature to help facilitate handle removal. Inlet supply arms with adjustable centers from 7 5/8" – 8 3/8". Integral supply stops in body for servicing cartridges. Mounting hardware included. Fixture shall meet ADA requirements and shall be tested and certified to ASME A112.18.1.

2.9 EMERGENCY PLUMBING FIXTURES

A. Manufacturers

1. Bradley Corporation
2. Encon Safety Products
3. Guardian Equipment Co.
4. Haws Corporation.
5. Speakman Co.
6. Chicago Faucets

B. ANSI Standard: Comply with ANSI Z358.1-1998, "Emergency Eyewash and Shower Equipment."

C. Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Standard, Plumbed Emergency Shower with Eye/Face wash Combination Units,

1. Piping:

a. Material: Chrome-plated brass or stainless steel.
b. Unit Supply: NPS 1-1/4.

c. Unit Drain: Outlet at back or side near bottom.

2. Shower:

a. Capacity: Not less than 20 gpm for at least 15 minutes.
b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Pull rod.
d. Shower Head: 8-inch- minimum diameter, plastic.
e. Mounting: Pedestal.

3. Eyewash Unit:

a. Capacity: Not less than 3 gpm for at least 15 minutes.
b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two receptor-mounted spray heads.
e. Receptor: Plastic bowl.
f. Mounting: Attached shower pedestal.

2.10 ELECTRIC WATER COOLER **(EWC)**

A. Manufacturers

1. Halsey Taylor.
2. Elkay Manufacturing Co.
3. Haws Corporation.
4. Oasis Corporation.
5. Sunroc Corp.

B. Refrigeration system shall employ high efficiency, positive start compressor using R134A, non-pressurized tank with totally encapsulated insulation and be controlled by positive sensing thermostat. Shall have push-bar water controls. Automatic stream height regulator: Self-closing assembly is located inside unit to prevent tampering; unit shall resist corrosion and liming; a constant stream height shall be automatically maintained under line pressures that vary from 20 to 105 psi. Cooler shall comply with ANSI 117:1 and ADA for visual and motion disabilities. The manufacturer shall certify the unit to NSF/ANSI 61, and the Safe Drinking Water Act. Capacity: 7.5 to 8.0 gph. At 50 degrees F. delivered based upon 90 degrees F. ambient temperature.

C. Electrical: 120 Volt / 60 Hz units furnished with plug-in, 3 wire grounding type service cord. Coordinate with electrical contractor to provide a 120 volt receptacle rated at 15-amp minimum to receive 3-wire parallel blade grounding type male plug.

D. Exposed electric water cooler shall have stainless steel basin with integral drain strainer. Bubbler shall be two-stream, mound building type. Cabinet: Molded two-tone gray space-age polymer with softly rounded edges. Resistant to impact, wear, corrosion, heat and sunlight. Include hydro-boost bottle filling station.

1. Exposed; Single Level, Halsey Taylor **HTHB-HAC8WF**.
2. Exposed; Bi-Level, Halsey Taylor **HTHB-HAC8BLWF**.

E. Provide the following accessories:

1. Easy flex bubbler

2. Vandal resistant kit
3. Water filter

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.

E. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 22 Section "Common Work Results for Plumbing" for escutcheons.

F. Set shower receptors, and mop service basins in leveling bed of cement grout. Refer to Division 22 Section "Common Work Results for Plumbing" for grout.

G. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.3 WATER CLOSETS AND URINALS

A. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

3.4 SINKS AND LAVATORIES

A. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

B. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

C. Install hot-water dispensers in back top surface of sink or in counter with spout over sink.

3.5 CONNECTIONS

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

B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

C. 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.

D. 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.

3.6 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.

E. Water-Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

F. Install fresh batteries in sensor-operated mechanisms.

3.7 ADJUSTING

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

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

C. Adjust tempering devices to a maximum outlet temperature of 110 degrees F.

D. Emergency plumbing fixtures: adjust to approximately 85 deg F temperature. Allowable Variation: Plus or minus 5 deg F.

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

F. Water coolers: Adjust fixture flow regulators for proper flow and stream height. Adjust water-cooler temperature settings.

3.8 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts. Remove sediment and debris from drains.

3.9 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities unless allowed in Division 1.

3.10 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 22 40 00

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SECTION 23 05 00 – COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, 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. The drawings show the general arrangement of systems and equipment but do not show all required fittings and offsets that may be necessary to connect pipes and ductwork to equipment, and to coordinate with other trades. Provide all necessary fittings, offsets and runs based on field measurements and at no additional cost. Coordinate with other trades for space available and relative location of equipment and accessories. Pipe and duct location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.

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

1.3 EFFICIENCY MAINE

A. This project intends to pursue Efficient Maine prescriptive incentives. The contractor shall participate in the activities associated with Efficiency Maine incentive approval process including but not limited to; preparation and submission of required incentive applications 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. Contractor must contact EM prior to submittals to review the project equipment and scope. As a minimum, obtain rebates for the following:

1. _____
2. _____

1.4 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.

C. "Provide": Furnish and install, complete and ready for the intended use.

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, crawlspaces, and attics.

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

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

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

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

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

1.5 SUBMITTALS

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

1.6 SUBSTITUTIONS

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

1.7 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. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications." Comply with provisions in ASME B31 Series, "Code for Pressure Piping." Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

E. 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.

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

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

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

1.8 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.

1.9 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. 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.

1.10 TEST ADJUST AND BALANCE READINESS

A. The Contractor shall provide and coordinate the services of qualified, responsible sub-contractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting, and balancing period.

B. In order that all systems may be properly tested, balanced, and adjusted as required herein by these Specifications, the Contractor shall operate the systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB.

C. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The Contractor shall allow adequate time for the testing and balancing activities of the Owner provided services, during the construction period, and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.

D. The Drawings and Specifications indicate valves, dampers, and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB Firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.

E. Complete operational readiness of the HVAC systems also requires that the following be accomplished:

1. Distribution Systems:

a. Verify installation for conformity to design. All supply, return, and exhaust ducts shall be terminated and tested as required by the Specification.
b. Dampers shall be properly located and functional. Dampers shall have tight closure and open fully with smooth and free operation.
c. Supply, return, exhaust, and transfer grilles, registers, diffusers, and terminal devices shall be installed and secured in a full open position.

d. Air handling systems, units, and associated apparatus shall be sealed to eliminate uncontrolled bypass or leakage of air. Final clean filters shall be in place, coils shall be clean with fins straightened, bearings properly greased, and the system shall be completely operational. The Contractor shall verify that all systems are operating within the design pressure limits of the piping and ductwork.
e. Under normal operating conditions, check condensate drains for proper connections and functioning. Cooling coil drain pans have a positive slope to drain. Cooling coil condensate drain trap maintains an air seal.
f. Check for proper sealing of air-handling unit components.
g. Fans shall be operating and verified for freedom from vibration, proper fan rotation and belt tension; heater elements in motor starters to be of proper size and rating, as per the starter manufacturer; record motor amperage and voltage on each phase at start-up, and verify they do not exceed nameplate ratings.
h. Thermal overload protection is in place for fans and other equipment. Bearings shall be greased. Belts shall be aligned and tight
i. Terminal units shall be installed and functional (i.e. controls functioning).

2. Water Circulating Systems:

a. Verify installation for conformity to design. Hydronic systems are pressure tested, flushed, filled, and properly vented. Service and balance valves are fully open. Examine HVAC system and equipment installations to verify that indicated balancing devices are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation
b. All valves shall be set to their full open position. After the system is flushed and checked for proper operation, all strainers shall be removed and cleaned. The Contractor shall repeat the operation until circulating water is clean and then the start-up strainers shall be discarded. Bearings shall be greased.
c. Record pump motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating. Verify that the electrical heater elements are of the proper size and rating as per the starter manufacturer.
d. In preparation of TAB, water circulating systems shall be full and free of air, expansion tanks shall be set for proper water level, and all air vents shall be installed at high points of systems and operating freely. Chemicals shall be added to closed systems to treat piping and inhibit corrosion. The system static pressure shall be adequate to completely fill the system without operating the pumps.
e. Check and set operating parameters of the heat transfer and control devices to the design requirements.
f. Proper balancing devices shall be in place and located correctly. These devices include but are not limited to flow meters, pressure taps, thermometer wells, balancing valves, etc. Heat transfer coils shall be checked for correct piping connections.

3. Automatic Controls

a. The BAS shall verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, high and low temperature thermostats, safeties, etc.
b. The BAS Contractor shall verify that all controlling instruments are calibrated and set for design operating conditions with the exception of components that require input from the TAB Agency, but a default shall be set. The Control Contractor shall cooperate with the TAB Agency and provide all software and interfaces to communicate with the system.
c. The BAS Contractor shall thoroughly check all controls, sensors, operators, sequences, etc. before notifying the TAB Agency that the BAS is operational. The BAS Contractor shall provide technical support (technicians and necessary computers) to the TAB Agency for a complete check of these systems.

d. Prior to occupancy, each ventilation system shall be tested to ensure that OA dampers operate properly in accordance with system design.
e. Fire Alarm: Division 26 hall thoroughly check all detection devices, sequences, inter-locks, etc. before notifying the TAB Agency that the system is operational. Division 26 shall certify that the systems are totally operational to the Contractor prior to the TAB beginning.

1.11 RENOVATION PROJECTS

A. Project Conditions: No Owner Occupancy until final acceptance: The Owner intends to occupy the building only after construction is 100% complete and the building has been accepted.

B. The Contractor shall study all drawings and specifications, visit the site, and get acquainted 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 be familiarized with the conditions and extent of the proposed work. 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.

C. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated.

D. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize use of driveways and entrances. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

E. Follow the recommended procedures of the SMACNA IAQ Guidelines for Occupied Buildings under Construction.

1. Dust partitions and depressurization of the work are performed under Division 1.
2. The return side of an HVAC system is, by definition, under negative pressure and thus capable of drawing in nearby construction dust and odor. When possible, the entire system shall be shut down during heavy construction or demolition. The system shall be isolated from the surrounding environment as much as possible (e.g., all tiles in place for a ceiling plenum, duct and air handler leaks repaired) to prevent induction of pollutants.
3. Return system openings in (and immediately adjacent to) the construction area shall be sealed with plastic.
4. When the system must remain operational during construction, temporary filters shall be added to return grilles. All filters must receive frequent periodic maintenance and be replaced at end of project.
5. When the general system must remain operational, the heaviest work areas shall be dampered off or otherwise blocked if temporary imbalance of the return air system does not create a greater problem.
6. The mechanical room shall not be used to store construction or waste materials.
7. Diffusers, VAV boxes, and ducts may be adequately protected in most cases where the above measures are implemented. When the system is off for the duration of construction, diffusers shall also be sealed in plastic for further protection. Ducts, diffusers, and window units shall be inspected upon completion of the work for the amount of deposited particulate present and cleaned where needed. If significant dust deposits are observed in the system during construction, some particulate discharge can be expected during start-up. When such a discharge is only minor, delaying re-occupancy long enough to clean up the dust may be sufficient. In more severe cases, installing temporary coarse filters on diffusers or cleaning the ducts may be necessary. The

condition of the main filters shall be checked whenever visible particulates are discharged from the system.

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.

F. Asbestos products or equipment or materials containing asbestos shall not be used.

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

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

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

E. Mechanical Coupling Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents and exterior environment. Gasket design shall be such that the entire coupling housing is isolated from the system contents to prevent galvanic action and inhibit galvanic corrosion.

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

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

H. 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.

I. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

J. Solvent Cements for Joining Plastic Piping: CPVC Piping: ASTM F 493. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling. 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.

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

2.4 DIELECTRIC FITTINGS

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

B. Fittings shall match piping specifications. Threaded dielectric union, ANSI B16.39. Watts Series 3000 or approved equal. Flange union with dielectric gasket and bolt sleeves, ANSI B16.42.

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 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve; Thunderline Link-Seal, or approved equal.

1. Sealing Elements: Nitrile interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Glass-reinforced nylon.
3. Connecting Bolts and Nuts: Stainless steel, of length required to secure pressure plates to sealing elements.

2.6 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.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout. Characteristics: Post-hardening, volume adjusting, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications. Design Mix: 5000-psi, 28-day compressive strength. Packaging: Premixed and factory packaged.

2.8 MOTORS

A. Motor Characteristics

1. Motors 1/2 HP and Larger: Three phase.
2. Motors smaller than 1/2 HP: Single phase.
3. Frequency Rating: 60 Hz.
4. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
5. Service Factor: 1.15 for open drip proof motors; 1.0 for totally enclosed motors.
6. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
7. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
8. Enclosure: as specified.

B. Polyphase Motors

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium efficiency ratings shall meet or exceed the NEMA Premium qualifying efficiencies. Efficiencies shall be eligible for utility rebates. For example, 1800-RPM ODP minimum required efficiency for a 7.5 HP motor is 91.0%
3. Stator: Copper windings, unless otherwise indicated. Multispeed motors shall have separate winding for each speed.
4. Rotor: Squirrel cage, unless otherwise indicated.
5. Bearings: Double-shielded, pre-lubricated ball bearings suitable for radial and thrust loading.
6. Temperature Rise: Match insulation rating, unless otherwise indicated.
7. Insulation: Class F, unless otherwise indicated.
8. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

C. Single-Phase Motors

1. Type: One of the following, to suit starting torque and requirements of specific motor application: Permanent-split capacitor, Split-phase start, capacitor run, Capacitor start, capacitor run.
2. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
3. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
4. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, pre-lubricated-sleeve type for other single-phase motors.

D. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

E. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

F. Bearing Protection Ring

1. All motors to be operated with a Variable Frequency Drive shall be equipped with a bearing protection ring (shaft grounding ring).

2. The bearing protection ring shall be manufactured by Aegis, model SGR.

3. Ring shall be factory installed where available, installed per manufacturer's recommendations. Where not available as a factory installed option, the ring shall be field installed in strict accordance with the motor and ring manufacturer's recommendations.

4. For motors up to 100 hp, ring shall be mounted on either the drive end or the non-drive end of the motor. For motors larger than 100 hp, insulate one bearing journal or install a ceramic bearing on the non-drive end of the motor and install the bearing protection ring on the opposite end.

2.9 VIBRATION ISOLATION

A. All equipment shall be isolated to prevent vibration transmission to the building structure.

PART 3 - EXECUTION

3.1 DEMOLITION AND REMOVALS

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

B. Disconnect, demolish, and remove plumbing and mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap and seal remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap and seal ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

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

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

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

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8. Only brazing alloys having a liquid temperature above 1000°F shall be used.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows: Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

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

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

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

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. 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.

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

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

3.4 PIPE PENETRATIONS

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

B. Refer to Section 23 07 00 “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. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install steel pipe sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
4. Sleeves are not required in drywall construction.
5. Sleeves are not required for core-drilled holes.

E. To prevent accidental liquid spills from passing to a lower level, provide the following:

1. For sleeves: Extend sleeve 1-1/2 inch above finished floor and provide sealant for watertight joint.
2. For blocked out floor openings: Provide 1-1/2 inch angle set in silicone adhesive around opening.
3. For drilled penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

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

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

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

H. 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.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated: Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment. Install flanges or Victaulic couplings, in piping NPS 2-1/2 and larger, adjacent to flanged or grooved-ended valves and at

final connection to each piece of equipment. Provide dielectric fittings at connection between copper and ferrous metal.

B. Swing Connections for Expansion: Connect risers and branch connections to mains with at least five pipe fittings, including tee in main. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.6 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.

3.7 GROUTING

A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors. Clean surfaces that will come into contact with grout. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment. Place grout around anchors. Cure placed grout.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

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

3.9 FIRESTOPPING

A. Firestop protection for DWV and storm water piping is specified in Section 22 13 16.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Refer to Division 7 for materials. Seal all penetrations through fire-or smoke-rated wall, partition, ceiling, or roof assemblies with firestopping system. Refer to Architectural plans for location of rated assemblies. Refer to Division 7 for firestopping systems.

3.10 PAINTING

A. Painting of plumbing and mechanical systems, equipment, and components is specified in Division 9.

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

3.11 CONCRETE BASES

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

B. Concrete, reinforcement, and formwork requirements are specified in Division 3. Coordinate with Division 3: construct concrete bases not less than 4 inches larger in both directions than supported unit.

3.12 ROOFING

A. Coordinate roof penetrations with Division 7.

3.13 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work. Remove liquid spills promptly. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

C. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

D. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

E. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

F. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

G. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

H. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

3.14 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.15 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to their specified condition.

C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.

c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 05 00

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SECTION 23 05 16 – BRAIDED EXPANSION LOOPS AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Division 23 Section “Common Work Results for Mechanical”

1.2 SUMMARY

A. This Section includes braided pipe expansion loops.

B. Provide swing fittings at branches to terminal equipment for mechanical piping systems as specified in Section 23 05 00.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products suitable for piping system fluids, materials, working pressures, and temperatures.

1.4 SUBMITTALS

A. Product Data: For each type of expansion fitting indicated.

B. Schedule: Indicate manufacturer's number, size, location, and features for each expansion fitting and loop.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Metraflex Co.
2. Flex Hose Co., Inc.
3. Flexicraft

2.2 BRAIDED EXPANSION LOOPS

A. Provide flexible expansion loops of size and type noted on drawings; Metraflex Metraloop expansion joints, or approved equal. Flexible loops shall consist of two flexible sections of hose and braid, two 90° elbows, and a 180° return assembled in such a way that the piping does not change direction, but maintains its course along a single axis. Flexible loops shall have a factory supplied, center support nut located at the bottom of the 180° return, and a drain/air release plug.

B. Flexible loops shall impart no thrust loads to system support anchors or building structure. Loops shall be installed in a neutral, pre-compressed or pre-extended condition as required for the application.

C. Materials of construction and end fitting type shall be consistent with pipe material and equipment/ pipe connection fittings.

D. Size for 4” end-to-end movement.

2.3 ANCHORS

A. Metraflex Model PA anchor clamp, or approved equal. Provide light weight anchor for low load; compatible with braided expansion loop manufactures recommendations for "no thrust" expansion joints. Clamps to pipe.

2.4 GUIDES

A. Metraflex Model PGIV shall be of the radial type employing a heavy wall guide cylinder with weld down or bolt down anchor base. A two section guide spider, having 1/8" maximum diametrical clearance with guide cylinder inside diameter, bolted or welded tight to the carrier pipe which slides through the guide cylinder I.D. Cylinder shall be of sufficient size to clear pipe insulation and long enough to prevent over travel of the spider.

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head; ASTM F 844, steel, plain, flat washers.

C. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, and tension and shear capacities appropriate for application. Stud: Threaded, zinc-coated carbon steel. Expansion Plug: Zinc-coated steel. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 BRAIDED EXPANSION LOOP INSTALLATION

A. Install expansion fittings according to manufacturer's written instructions.

B. Install expansion fittings in sizes matching pipe size in which they are installed.

C. Align expansion fittings to avoid end-loading and torsional stress.

D. Loops can be installed in a neutral, pre-compressed or pre-extended condition as required for the application.

E. A pipe guide shall be installed anywhere within 15 pipe diameters on each side of the braided expansion loop. Loops anchored on one side need only one guide on the traveling side. Attach guides to pipe and secure to building structure.

F. Install pipe anchors according to expansion fitting manufacturer's written instructions.

1. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
2. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
3. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

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END OF SECTION 23 05 16

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SECTION 23 05 19 – THERMOMETERS AND PRESSURE GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for Mechanical"
2. Mechanical equipment Sections that specify meters and gauges as part of factory-fabricated equipment.

1.2 SUMMARY

A. This Section includes thermometers and pressure gauges.

1.3 SUBMITTALS

A. Product Data: Include scale range, ratings, and calibrated performance curves for each gauge, fitting, specialty, and accessory specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Ashcroft
2. Weksler
3. Ernst Gauge Co.
4. Trerice: H. O. Trerice Co.
5. Weiss Instruments, Inc.

2.2 THERMOMETERS

A. Liquid-In-Glass Industrial Thermometers: shall be a blue reading (Fill Type Spirit: Blue colored, organic) liquid-in-glass adjustable angle type, 9" scale, cast aluminum case with cured polyester powder coating, clear acrylic window and brass separable thermowell. Thermometers will be Trerice BX9 Series or approved equal.

B. Scale Range: Temperature ranges for services listed are as follows: The proper range will be selected so that the operating temperature of the material being measured will fall approximately in the middle of the scale.

1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 1-degree scale divisions.
3. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.

C. Thermowells: Provide fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.

1. Material: Brass, for use in copper piping.
2. Material: Stainless steel, for use in steel piping.
3. Where insulation thickness exceeds 2", a longer stem thermometer will be used with an extension neck brass separable thermowell. The extension neck will be at least 2" long.
4. Thermometers for measuring fluid temperatures will have stems with insertion lengths of roughly half of the pipe diameter; minimum insertion length will be 2".
5. Thermometers installed on tanks will have a minimum insertion length of 5".
6. Cap: Threaded, with chain permanently fastened to socket.
   a. Heat-Transfer Fluid: Oil or graphite.

2.3 PRESSURE GAUGES

A. Pressure gauges shall be 3½" dial size with a flangeless cast aluminum case, stainless steel friction ring and glass window. Movement will be brass with a bronze bourdon tube and brass socket. Dial face will be white with black figures; pointer will be friction adjustable type. Accuracy shall be ±1% of scale range, ASME B40.1 Grade 1A. Pressure gauges will be Trerice No. 600CB approved equal.

1. Connector: Brass, NPT 1/4.
2. Units of Measure: PSI
3. Provide silicone-damped movement.
4. Range: The proper range shall be selected so that the average operating pressure falls approximately in the middle of the scale selected.
5. Install pressure-gauge needle valve and snubber (Trerice No. 872 pressure snubbers) in piping to pressure gauges; ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.
6. Needle Valves: Trerice 735 Series; NPS 1/4 brass or 316 stainless steel needle type.
7. Install siphon instead of snubber in piping to steam pressure gauges; Trerice No. 885 steel coil siphons; NPS 1/4 coil of brass tubing with threaded ends.

PART 3 - EXECUTION

3.1 GAUGE INSTALLATION, GENERAL

A. Install according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

A. Install thermometers and adjust vertical and tilted positions.

B. Install separable sockets in vertical position in piping tees.

3.3 PRESSURE-GAUGE INSTALLATION

A. Install pressure gauges in piping tees with pressure-gauge valve located on pipe at most readable position.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping and specialties. Install adjacent to machines and equipment to allow service and maintenance. Connect per manufacturers recommendations.

3.5 ADJUSTING AND CLEANING

A. Calibrate according to manufacturer's written instructions, after installation.

B. Adjust faces to proper angle for best visibility.

C. Clean windows and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
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1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
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END OF SECTION 23 05 19

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, 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.

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

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

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 5: Adjustable steel swivel J-hanger, B-Line B3690.
4. Type 12: Malleable iron ring hanger, B-Line B3198R or hinged ring hanger, B3198H.
5. Type 1: Adjustable steel clevis hanger, B-Line B3100.
6. Type 1: Adjustable steel clevis hanger, copper piping, B-Line B3104CT.
7. Type 1 V-Bottom clevis hanger with galvanized 18-gauge continuous support channel, B-Line B3106 and B3106V, to form a continuous support system for flexible plastic pipe (example: PEX) or tubing.

D. Uninsulated pipes 2-1/2 inch and larger:

1. Type 1: Adjustable steel clevis hanger, B-Line B3100.
2. Type 41: Pipe roll with sockets, B-Line B3114.
3. Type 43: Adjustable steel yoke pipe roll, B-Line B3110.

E. Insulated pipe- carrying fluid temperature of 60°F or warmer:

1. 2 inch and smaller pipes: 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).
2. 2-1/2 inch and larger pipes: Adjustable steel yoke pipe roll with pipe covering protection saddle. Type 43 with Type 39 (B-Line B3160 series) pipe covering protection saddles. Pipe roll with sockets with pipe covering protection saddle, Type 41 with Type 39 pipe covering protection saddles.

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 23 07 00 "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.
4. For pipes with Armaflex insulation: The pipe support system shall be of high compressive strength material inserts imbedded in closed-cell elastomeric foam and covered with metal cladding. Pipe clamp assemblies for strut mounting shall consist of B-Line Armafix inserts attached with two-piece pipe clamps such as Cooper B-Line B2000 series clamps. Two-piece pipe clamps shall be provided with pre-installed friction tape and elastic stop nuts.
5. For vibrating system applications: use a clamp that has a vibration dampening insert and nylon inserted locknut. For copper and steel tubing use B-Line BVT series Vibraclamps, for pipe sizes use BVP series. For insulated piping, use Armafix inserts or similar.

I. Wall Supports: Pipes 4 inches and smaller: Type 5 J Hanger. B-Line B3690.; pipes larger than 4 inch: Type 32; B-Line B3066.

J. Floor Supports

1. Hot piping under 6 inch and all cold piping: Carbon steel adjustable pipe saddle and nipple attached to steel base stand sized for pipe elevation. Type 38 B-Line B3093 support and B3088T threaded base stand or Type 37 B3090 and B3088 unthreaded base stand. Pipe saddle shall be screwed or welded to appropriate base stand.
2. Hot piping 6 inch and larger: Adjustable Roller stand with base plate, Type 46 B-Line B3118SL.

K. 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.
3. For vertical mid-span supports of piping 4" and under, use Hubbard Enterprises/Holdrite Stout Brackets™ with Hubbard Enterprises/Holdrite Stout Clamps or two-hole pipe clamps (MSS Type 26) or B-Line B-3180.

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.

B. Wood Beam Attachments

1. Type 34 side beam connector; Figure B3058 or B3062
2. Provide hex lag screws; size as per manufacturers recommendations.

C. Concrete Inserts

1. Type 18: Cast in place spot concrete inserts shall be used where applicable; either steel or malleable iron body, B-Line B2500 or B3014. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rod sizes, B-Line N2500 or B3014N series.
2. Continuous concrete inserts shall be used where applicable. Channels shall be 12-gauge, ASTM A1011 SS Grade 33 structural quality carbon steel, complete with Styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert shall have a load rating of 2,000 lbs/ft. in concrete, B-Line B22I, 32I, or 52I. Select channel nuts suitable for strut and rod sizes.

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. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications. Properties: Non-staining, non-corrosive, and nongaseous. Design Mix: 5000-psi, 28-day compressive strength.

E. 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.

2.5 FINISHES

A. Indoor Finishes

1. Hangers and clamps for support of bare copper piping shall be coated with copper colored epoxy paint, B-Line Dura-Copper®. Additional PVC coating of the epoxy painted hanger shall be used where necessary.
2. Hangers for other than bare copper pipe shall be zinc plated in accordance with ASTM B633 OR shall have an electro-deposited green epoxy finish, B-Line Dura-Green®.

3. Strut channels shall be pre-galvanized in accordance with ASTM A653 SS Grade 33 G90 OR have an electro-deposited green epoxy finish, B-Line Dura-Green®.

B. Outdoor and Corrosive Area Finishes

1. Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.
2. Hangers and strut located in corrosive areas shall be type 316 stainless steel with stainless steel hardware.

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 steel piping with the following maximum horizontal spacing and minimum rod sizes:

1. NPS ¾ to 1-1/4": Maximum span, 7 feet; minimum rod size, 3/8 inch.
2. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
4. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
5. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2 inch.
6. NPS 4: Maximum span, 14 feet; minimum rod size, 5/8 inch.
7. NPS 5: Maximum span, 16 feet; minimum rod size, 5/8 inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 3/4 inch.

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

1. NPS ½ and 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2 to 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 1/2 inch.

6. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
7. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
8. Maximum vertical steel and copper pipe attachment spacing: 10 feet.

D. 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.
    c. NPS 3: 6 feet with 1/2-inch rod.
    d. NPS 4: 6.5 feet with 5/8-inch rod.
    e. NPS 6 and 8: 8 feet with 3/4-inch rod.

5. Install supports for vertical piping every 10 feet.

E. 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.

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

G. Horizontal pipe isolation:
1. The first four pipe hangers in the main lines near mechanical equipment shall be Mason Type PC30N, or approved equal. Brace hanger rods with SRC clamps.
2. Floor supported piping shall rest on Type SLR isolators.
3. Hanger locations that also have seismic restraints attached must have type RW Rebound Washers to limit uplift.
4. Where piping connects to mechanical equipment install expansion joints stainless hoses if expansion joints are not suitable for the service.
5. Adjust active height of spring isolators. Adjust isolators after piping systems have been filled and equipment is at operating weight. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

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 CONCRETE INSERTS

A. Provide inserts for placement in formwork before concrete is poured. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams. Where concrete slabs form finished ceilings, provide inserts to be flush with slab surface. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inch.

3.5 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.6 METAL FABRICATION

A. All attachments welded to the pipe shall be in accordance with MSS SP-58 and Pipe Fabrication Institute Standard ES-26.

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

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

3.7 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.

3.8 PAINTING

A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

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

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 05 29

SECTION 23 05 48 - MECHANICAL SEISMIC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 7 Section for materials and methods for sealing pipe penetrations through fire and smoke barriers.
2. Division 23 Section "Common Work Results for HVAC".
3. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.

1.2 SUMMARY

A. It is the intent of the seismic portion of this specification to keep building system components in place during a seismic event.

B. All such systems must be installed in strict accordance with seismic codes, component manufacturer's and building construction standards. Whenever a conflict occurs between the manufacturers or construction standards, the most stringent shall apply.

C. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements.

D. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

1.3 SCOPE

A. The work in this section includes, but is not limited to the following:

1. Seismic restraints for fuel gas piping.

1.4 PERFORMANCE REQUIREMENTS

A. Manufacturer of seismic control equipment shall have the following responsibilities:

1. Determine seismic restraint sizes and locations.
2. Provide seismic restraints as scheduled or specified.
3. Provide calculations and materials if required for restraint of un-isolated equipment.
4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

B. Seismic restraints shall be designed in accordance with seismic force levels as detailed herein.

C. Applicable Code: IBC 2009

D. Seismic Design Category C

E. Design Spectral Response at Short Periods (S_{DS}): See Drawing S-000.

F. Short Period Spectral Response Acceleration (S_S): See Drawing S-000.

G. Building Use Group or Occupancy Category II

H. Equipment Schedule: The following list indicates individual equipment importance factors, Ip=1.5:

1. Natural gas piping

2. Flue gas piping

1.5 SUBMITTALS

A. The manufacturer of seismic restraints shall provide submittals for products as follows:

1. Catalog cuts or data sheets on specific restraints detailing compliance with the specification.
2. Detailed schedules of flexible and rigidly mounted equipment, showing seismic restraints by referencing numbered descriptive drawings.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:

1. Design Calculations: Calculate requirements for selecting seismic restraints.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
4. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.

C. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:

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

1.6 QUALITY ASSURANCE

A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "R" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to the weakest mode.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Section 23 05 00. The contractor shall ensure that all housekeeping pads used are adequately reinforced and are properly attached to the building structural flooring, so to withstand anticipated seismic forces. In addition, the size of the housekeeping pad is to be coordinated with the seismic restraint manufacturer so to ensure that adequate edge distances exist in order to obtain desired design anchor capabilities.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINTS

A. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cables must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Preapproval “R" Number from OSHPD in the State of California verifying the maximum certified load ratings. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, Type SCBH between the hanger rod nut and the clevis or Type SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.

B. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval "R" number from OSHPD in the state of California verifying the maximum certified load ratings. Solid seismic brace assemblies shall be Type SSB as manufactured by Mason Industries, Inc.

C. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.

D. Note: seismic cable restraints, seismic solid braces, and steel angles above apply to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze.

E. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California. Clevis cross brace shall be Type CCB as manufactured by Mason Industries, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 INSTALLATION

A. All seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

B. All mechanical equipment shall be vibration isolated and seismically restrained as specified.

C. Installation of seismic restraints must not cause any change of position of equipment or piping resulting in stresses or misalignment.

D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor’s expense.

G. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor’s expense.

H. Correct, at no additional cost, all installations that are deemed defective in workmanship and materials at the contractor’s expense.

I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:

1. Flanges of structural beams.
2. Upper truss cords in bar joist construction.
3. Cast in place inserts or wedge type drill-in concrete anchors.

J. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, piping or conduit. Cable assemblies shall be installed taut on non-isolated systems. Seismic solid braces may be used in place of cables on rigidly attached systems only.

1. The support rods must be braced when necessary to accept compressive loads with steel angles and rod clamp assemblies.
2. At all locations where restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with pipe clevis cross bolt braces.

3.3 SEISMIC RESTRAINT OF PIPING

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."

B. Piping shall be provided with seismic restraints in accordance with Seismic Restraint Manual – Guidelines for Mechanical Systems dated 1998, as published by SMACNA.

1. Seismically restrain the following piping.

   a. Gas piping that is 2" I.D. or larger.

2. Piping exclusions:

   a. Gas piping less than 2" inside diameter.
   b. All piping suspended by individual hangers 12" or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 12" limit is exceeded by any hanger in the run, seismic bracing is required for the run.
   c. The 12" exemption applies for trapeze-supported systems if the top of each item supported by the trapeze qualifies.
   d. The trapeze bar is supported by 3/8-16 UNC, or larger, hanger rods. b. The maximum hanger spacing is 10 ft. on center.
   e. The total weight supported by the trapeze bar is 15 lbs/ft or less.

3. Transverse piping restraints shall be at 20' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
5. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or tee or combined stresses are within allowable limits at longer distances.
6. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
7. Branch lines may not be used to restrain main lines.

3.4 SEISMIC RESTRAINT OF PIPING

1. HVAC Ductwork (ASCE 7-05 Section 13.6.7), provide seismic restraints:

a. Ductwork systems designated as having a Component Importance Factor, IP, greater than 1.0.

2. Seismically restrain ductwork using seismic cable restraints. Restraint Spacing For Ductwork:

a. Transverse supports a maximum of 30’ o.c.
b. Longitudinal supports a maximum of 60’ o.c.

3.5 ADJUSTING

A. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 05 48

SECTION 23 05 53 – IDENTIFICATION FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, 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.

B. Valve numbering scheme. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals.

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 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Markers: Engraved, color-coded laminated plastic; attach with screws or contact-type, permanent adhesive. Size: 2-1/2" x 1" or as applicable.

1. Terminology: Match schedules as closely as possible.
2. Data: Name and plan number, equipment service, design capacity, and other design parameters such as pressure drop, entering and leaving conditions, and speed.

B. Equipment located above the ceiling that requires servicing shall be labeled on the ceiling using self-adhesive colored-coded dots (*Inventory Labels*), 3/4" diameter; Seton, or approved equal.

2.2 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. In buildings where non-potable water systems are installed, color code as follows:

   a. Potable water: green background and white lettering.
   b. Non-potable water: Yellow background with black lettering: "CAUTION: NON-POTABLE WATER, DO NOT DRINK."

3. 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.
4. Pipes with OD, Including Insulation; Full-band snap-around pipe markers extending 360 degrees around pipe at each location.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.
6. Minimum length of color field and size of letters shall be in accordance with Uniform Plumbing Code requirements.

B. Types:

1. Self-adhesive type: Seton Opti-Code.
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.

2.3 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved 1-1/2 round with 1/4-inch letters for piping system legend and 1/2-inch black-filled numbers, with numbering scheme; 3/16" hole for fastener; Material: 19-gauge brass; Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

2.5 VALVE SCHEDULES

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

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.6 WARNING TAGS

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

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

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 EQUIPMENT IDENTIFICATION

A. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:

    a. All scheduled equipment.

B. Equipment located above the ceiling that requires servicing shall be labeled on the ceiling using self-adhesive colored dots.

1. Red: Smoke detectors (SD), Fire dampers (FD), and similar fire protection items.
2. Green: Terminal HVAC units such as VAV boxes (VAV- #)
3. Orange: HVAC shutoff valves; example: heating main shutoff valves (HWS, HWR)
4. Locate dots on the ceiling grid, adjacent to the ceiling tile that provides the best access to the valve or item that requires servicing.
5. Label with a permanent marker as indicated. Example, neatly write SD on a red dot; locate on ceiling grid below a smoke detector.

C. GAS monitor/transmitter for Methane (CH4), Carbon Monoxide (CO), Nitrogen Dioxide (NO2), and Propane (LP): shall have engraved tag mounted to device showing “Installed xx/xx/xx (date)” and “Replacement xx/xx/xx (date)”. The replacement date shall be specific for the gas being monitored.

3.3 PIPING IDENTIFICATION

A. Piping Identification Types:

1. Piping or Insulation 5-7/8 inch OD or smaller: Snap-around marker or self-adhesive marker.
2. Piping or Insulation 6 inch OD and Larger: Strap-around with nylon ties or self-adhesive marker.
3. Provide wrap-around pipe markers for outdoor pipes. Install wrap-around pipe markers completely around pipe.

B. Install manufactured pipe markers indicating service on EACH piping system; including, but not limited to: Compressed Air, Lubrication Fluids, Below Slab Vapor Capture System, and Refrigerant Piping Systems.

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, manholes, and similar access points that permit view of concealed piping.
6. At least one per room.

C. Apply “Electric Traced” labels to the outside of heat-traced insulation.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room. Provide (2) copies of valve schedules burned to a CD or DVD; Word or Excel format.

3.6 WARNING-TAG INSTALLATION

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

3.7 ADJUSTING

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

3.8 CLEANING

A. Clean faces of mechanical identification devices.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.

c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Division 23 Section "Basic Mechanical Materials and Methods"

1.2 SUMMARY

A. This Section includes testing, adjusting, and balancing (TAB) of mechanical systems.

1.3 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm. Warranties specified in this Section.

C. Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing." TAB firm's forms approved by Architect. TABB "Contractors Certification Manual."

1.4 QUALITY ASSURANCE

A. TAB Firm Qualifications: Perform all work in accordance with AABC, TABB, or NEBB procedures.

B. TAB Firm Qualifications: Engage a TAB firm certified by AABC, TABB, or NEBB. Provide a guarantee on NEBB, AABC, or TABB forms stating that the balancing contractor will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

3. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following: Review field data reports to validate accuracy of data and to prepare certified TAB reports. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".

D. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

E. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.5 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - GENERAL

2.1 EXAMINATION AND PREPARATION

A. Prior to commencing testing adjusting and balancing of environmental systems, verify the following HVAC Operational Readiness conditions, if deficiencies are evident, submit Deficiency Report to Architect. Do not begin testing, adjusting, and balancing of environmental system until deficiencies have been remedied.

B. Mechanical contractor shall prepare the systems as required by the Section 23 05 00 Paragraph “Test Adjust and Balance Readiness”.

C. 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.

2.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, and similar controls and devices, to show final settings. Permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

D. Report on noise problems to the Contractor, A/E, and Owner which are discovered during balancing.

2.3 TOLERANCES

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

1. Fans: -5% to +10%
2. Supply Air Outlets: 0% to +10%.
3. Exhaust/Return Air Inlets: -10% to 0%
4. Heating-Water Flow Rate: -10% to 0%

2.4 ADDITIONAL TESTS

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

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

2.5 FINAL REPORT

A. The TAB activities described shall culminate in a report neatly typed and arranged. Include with the data the date tested, personnel present, and a list of all measurements taken. The intent of the final report is to provide a reference of actual operating conditions for the Owner’s operations personnel.

B. Include a list of instruments used for procedures, along with proof of calibration. Include instrument calibration report data: instrument type and make, serial number, application, dates of use, and dates of calibration.

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

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

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following: Indicated versus final performance, Notable characteristics of systems; Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports varies from indicated values.

E. Provide report data for procedures described herein.

PART 3 - TAB PROCEDURES

3.1 PROCEDURES FOR MOTORS – THIS APPLIES TO ALL HVAC SYSTEM MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Full-load amperage and service factor.
6. Nameplate and measured voltage, each phase.
7. Nameplate and measured amperage, each phase.
8. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data. Adjust VFDs to skip critical frequencies.

3.2 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

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

1. Quantities of outside, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Terminal units.
4. Volume dampers.

B. Test and adjust fan RPM to design requirements. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

C. Test and record motor full load nameplate rating and actual ampere draw.

D. Test and record system static pressures, fan suction, and discharge; static pressure across each component that makes up an air system. Measure static pressures entering and leaving other devices under final balanced conditions.

E. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur.

F. Recommend corrective action to align design and actual conditions. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in all operating modes to determine the maximum required brake horsepower.

G. Adjust all main supply and return air duct to within tolerances of proper design CFM. Make air velocity measurements in ducts by Pitot tube traverse entire cross sectional area of duct in accordance with SMACNA equal area method or Log Linear method. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved. Where sufficient space in sub-main and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone. Re-measure each sub-main and branch duct after all have been adjusted. Continue to adjust sub-main and branch ducts to indicated airflows within specified tolerances.

H. Test and adjust each diffuser, grille, and register. Reading and tests of diffusers, grilles, and registers shall include design CFM and adjusted CFM.

I. Adjust patterns of adjustable outlets for proper distribution without drafts.

J. Test and record outside, mixed air, and discharge temperatures (D.B. for heating cycle, D.B. and W.B. for cooling cycle). Where modulating dampers or economizers are provided, take measurement at full return air, minimum outside air, and100 percent outside air mode of operation.

K. In coordination with the ATC contractor, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.

L. Adjust outside air automatic and manual dampers for design conditions within specified tolerances.

M. Procedures for Variable-Air-Volume Systems

1. Develop a plan to simulate diversity. When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
2. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

    a. Set outside-air dampers at minimum and return- and exhaust-air dampers at a position that simulates full-cooling load.

b. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
c. Measure total system airflow. Adjust to within indicated airflow.
d. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
e. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
f. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
g. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
h. Record the final fan performance data.

N. Air-Handling Unit Test Reports: For air-handling units, include the following:

1. Test conditions for fan performance forms including the following:

a. Settings for outside-, return-, and exhaust-air dampers.
b. Conditions of filters.
c. Fan drive settings including settings and percentage of maximum pitch diameter.
d. Settings for supply-air, static-pressure controller.
e. Other system operating conditions that affect performance.

2. Unit Data: Include the following:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
j. Number of belts, make, and size.
k. Number of filters, type, and size.

3. Motor Data: as specified hereinbefore.
4. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Coil static-pressure differential for each coil in inches wg.

g. Outside airflow in cfm.
h. Return airflow in cfm.
i. Outside-air damper position.
j. Return-air damper position.
k. Fan VFD Hz.

O. Fan Test Reports:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
i. Number of belts, make, and size.

2. Motor Data: as specified hereinbefore.
3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

P. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

Q. Air-Terminal-Device Reports:

1. Unit Data:

a. Manufacturer, type size, and fittings.
b. System and air-handling unit identification.
c. Location and zone.
d. Test apparatus used.
e. Area served.

f. Air-terminal-device manufacturer and model.
g. Air-terminal-device number from system diagram.
h. Air-terminal-device type and model number.
i. Air-terminal-device size.
j. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

R. Procedures for Heat-Transfer Coils

1. Coil Test Reports:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft.
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Face area in sq. ft.
c. Average face velocity in fpm.
d. Air pressure drop in inches wg.
e. Entering & leaving air dry-bulb temperatures in deg F.
f. Entering & leaving air, wet-bulb temperatures in deg F.
g. Water flow rate in gpm.
h. Water pressure differential in feet of head.
i. Entering-water temperature in deg F.
j. Leaving-water temperature in deg F.

3.3 PROCEDURES FOR RADIANT HEATING

A. Balance each manifold per circuit flows indicated in the Radiant Floor Circuit Schedule

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.

d. Make and type.
e. Model and serial numbers.
f. Ratings.

2. Water and Test Data (Indicated and Actual Values, each tube circuit):

a. Entering-water temperature in deg F.
b. Leaving-water temperature in deg F.
c. Entering-water pressure in feet of head or psig.
d. Water pressure differential in feet of head or psig.
e. Water flow rate in gpm.

3.4 PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

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

1. Water flow rates.
2. Pipe and valve sizes and locations.
3. Terminal units.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set system controls so automatic valves are wide open.
6. Check air vents for a forceful liquid flow exiting from vents when manually operated.

D. Hydronic balancing shall include the following minimum data:

1. Prepare itemized equipment schedules, listing all hydronic elements and equipment in the systems to be balanced. List in order on equipment schedules, by pump or zone according to the design, all hydronic elements, all zone balancing valves, and circuit pumps, ending with the last items of equipment or transfer element in the respective zone or circuit. Include on schedule sheet column titles listing the location, type of element or apparatus, design conditions, and measured conditions. Prepare individual pump report sheets for each zone or circuit.
2. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
3. Effect system balance with automatic control valves fully open to heat or cooling transfer elements.
4. Adjust balancing valves at each coil and balancing valve for design flow. Adjust hydronic distribution systems by means of balancing valve; do not use service or shut-off valves for balancing unless indexed for balance point.
5. Water pressure shall be recorded at all gauge connections

E. For primary-secondary-flow hydronic systems, balance the primary system crossover flow first, and then balance the secondary system.

F. For coils equipped with three-way valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then be adjusted on each coil until an equal pressure drop between supply and return connections is the same as with the flow through the coil.

G. Pumps:

1. Adjust balancing valves or VFD at pumps to obtain design water flow. Record pressure rise across pumps and GPM flow from pump curve. Permanently mark the balanced position for each valve. (Note: If discharge valves on the pumps are used for balancing, record the head being restricted by the valves).
2. Where available pump capacity is less than total flow requirements or individual system parts, proportional balancing must be performed.
3. Do not deadhead the pumps. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded. Running amps and brake horsepower of pump motor under full flow and no flow conditions.
4. Calculate impeller size by plotting the shutoff head on pump curves and include the following pump test report data:
5. Unit Data:

    a. Unit identification.
    b. Location.
    c. Service.
    d. Make and size.
    e. Model and serial numbers.
    f. Water flow rate in gpm.
    g. Water pressure differential in feet of head or psig.
    h. Required net positive suction head in feet of head or psig.
    i. Pump rpm.
    j. Impeller diameter in inches.
    k. Seal type.
    l. Motor Data: as specified herein before.

6. Test Data (Indicated and Actual Values):

    a. Static head in feet of head or psig.
    b. Pump shutoff pressure in feet of head or psig.
    c. Actual impeller size in inches.
    d. Full-open flow rate in gpm.
    e. Full-open pressure in feet of head or psig.
    f. Final discharge pressure in feet of head or psig.
    g. Final suction pressure in feet of head or psig.
    h. Final total pressure in feet of head or psig.
    i. Final water flow rate in gpm.
    j. Voltage at each connection.
    k. Pump VFD Hz.

H. Procedures for Boilers

1. Measure entering- and leaving-water temperatures and water flow.
2. Boiler Test Reports:

    a. Unit Data:

1) Unit identification.
2) Location.
3) Service.
4) Make and type.
5) Model and serial numbers.
6) Fuel type and input in Btuh.
7) Voltage at each connection.
8) Amperage for each phase.

b. Test Data (Indicated and Actual Values):

1) Operating pressure in psig.
2) Operating temperature in deg F.
3) Water pressure differential in feet of head or psig.
4) GPM flow
5) Number of safety valves and sizes in NPS.
6) Voltage at each connection.
7) Amperage for each phase.

3.5 PROCEDURES FOR DOMESTIC HOT WATER RECIRCULATION SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system.

B. System Diagrams: Include schematic layouts of as-built domestic hot water systems. Present each system with single-line diagram and include the following:

1. Water flow rates.
2. Pipe and valve sizes and locations.
3. Recirculation valve settings/flows

C. Balancing shall include the following minimum data:

1. Pump flow
2. Balancing valve flows: proportionally balance flow to each recirculation loop.

D. Pumps:

1. Adjust balancing valves at pumps to obtain design water flow. Record pressure rise across pumps and GPM flow from pump curve. Permanently mark the balanced position for each valve. (Note: If discharge valves on the pumps are used for balancing, record the head being restricted by the valves).
2. Do not deadhead the pumps. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded. Running amps and brake horsepower of pump motor under full flow and no flow conditions.
3. Calculate impeller size by plotting the shutoff head on pump curves and include the following pump test report data:
4. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model and serial numbers.

f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Pump rpm.
i. Impeller diameter in inches.
j. Seal type.
k. Motor Data: as specified herein before.

5. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.

3.6 TESTING OF BUILDING AUTOMATION SYSTEMS

A. Assist the BAS Contractor as follows:

1. Work with the Temperature Control Contractor to ensure the most effective total system operation is within the design limitations, and to obtain mutual understanding of intended control performance.
2. Verify that all control devices are properly connected and operated by the intended controller.
3. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.
4. Observe the calibration of all controllers.
5. Verify the proper application of all normally opened and normally closed valves.
6. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. The Control Contractor shall relocate as deemed necessary by the TAB Agency.
7. Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications.
8. Verify the operation of all interlock systems.
9. Perform variable volume system verification to assure the system and its components track with changes from full flow to minimum flow.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.

2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 05 93

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SECTION – 23 07 00 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 7 for firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Division 23 Section "Common Work Results for Mechanical"
3. Division 23 Section "Hangers and Supports for Piping and Equipment" for pipe insulation shields and protection saddles.
4. Division 23 Section "Metal Ducts" for duct liner.

1.2 SUMMARY

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

1.3 ACTION 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. Domestic Hot Water Temperature Maintenance System Submittals: Copy of UL, CSA and FM file indicating the heating cable is specifically intended to provide supplementary heating to hot water service supply systems utilizing thermally insulated metal or plastic pipe; Manufacturer’s catalog cuts showing materials and performance data; Project list of at least 20 projects, installed for at least five years, with at least 2,000 ft of heating cable in each project.]

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 certified 25 % minimum recycled content.

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, or Johns Manville's Micro-Lok® *HP* meeting ASTM C547, Type I, maximum service temperature of 850 ^{o}F meeting the other requirements.. 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 or Johns Manville Zeston® polyvinyl chloride (PVC) parts 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 Zeston® or LoSMOKE® grade PVC, 25/50 rated per ASTM E-84. Thermal Value of fiberglass insert: K value of 0.26 at 75°F; resistance to fungi and bacteria. (ASTM G 21, ASTM G 22): does not promote growth of fungi or bacteria.

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

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
3. Materials shall have a maximum thermal conductivity of 0.27 Btu-in/h-ft2- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
4. Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure-A, latest revision.
5. Materials shall have a flame spread index of less than 25 and a smoke developed index of less than 50 when tested in accordance with ASTM E 84, latest revision.
6. Provide Armaflex WB finish for outdoor exposed piping.

D. Closed Cell Pipe Insulation: Pittsburgh Corning Foamglas, or approved equal; a lightweight, rigid insulating material composed of millions of completely sealed glass cells, each an insulating space. ASTM C 552-00 "Specification for Cellular Glass Thermal Insulation"' operating temperatures from -450°F to +900°F; water permeability 0.00 perm-inch.

E. Pipe & Tank Insulation: Glass Fiber, Knauf with ECOSE Technology or equivalent; semi-rigid, limited combustible meeting requirements of NRC 1.36; ASTM C 795 and MIL-I-24244 C; k value: ASTM C 177, 0.25 at 75°F mean temperature. Maximum Service Temperature: 850°F. Compressive Strength: not less than 150 PSF @ 10% deformation for 2 inch thickness per ASTM C 165. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type II. Johns Manville Micro-Flex® Large Diameter Pipe and Tank Wrap meeting ASTM C1393, Type III. Limited combustible meeting k value : ASTM C 177, 0.25 at 75°F mean temperature. Maximum Service Temperature: 850°F. Compressive Strength: not less than 150

PSF @ 10% deformation for 2 inch thickness per ASTM C 165. Vapor Retarder Jacket: ASJ conforming to ASTM C 1136 Type II

2.3 DUCTWORK INSULATION MATERIALS

A. Flexible Fiber Glass Blanket: Johns Manville's Microlite® XG Duct Wrap or 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.

B. Rigid Fiber Glass Board: Johns Manville's 817 Series Spin-Glas® or Knauf Insulation Board with ECOSE Technology meeting ASTM C 612 Type IA and IB; rigid. Maximum Service Temperature: 450°. Density: Minimum 6 PCF; k value: ASTM C177, 0.22 at 75°F mean temperature. Vapor Retarder Jacket: ASJ conforming to ASTM C1136 Type I, or FSK or PSK conforming to ASTM C1136 Type II in combination with protective jacket where necessary.

C. Flexible Elastomeric: Closed-cell, foam- or expanded-rubber materials containing an EPA-approved anti-microbial additive. Comply with ASTMC 534, Type I, Grade 1, for tubular materials and Type II, Grade 1, for sheet materials. Provide product recognized under Underwriters Laboratories "UL 94 - Plastic Component Classification" and listed in Factory Mutual "FM Approval Guide."

D. John Mansville ENRGY 3 Foil Face and ISO 3 Foil Face are rigid roof insulation boards composed of a closed cell polyisocyanurate foam core bonded in the foaming process to a tri-lam foil facer on both sides. ENRGY 3 Foil Face and ISO 3 Foil Face shall meet the physical requirements of ASTM C 1289, Type I, Class I and Federal Specifications HH-I-1972/Gen and HH-I-1972/2. Water Absorption, % by: 1.0 max (ASTM C 209); Moisture Vapor Transmission: <1 perm (ASTM E 96); Service Temperature: -100°F to 250°F.

2.4 EXTERIOR DUCTWORK

A. Rigid roof insulation board, thickness as scheduled; with high-performance jacketing: Flex Clad 400, or approved equal; high performance jacketing product shall perform well over a wide temperature range; -30°F to +175°F service temperature. Prefabricated self-adhering sheet type protective membrane with outer layer of embossed, UV resistant aluminum weathering surface, multiple layers of high density cross linked polymer film, and an inner layer of aggressive rubberized asphalt adhesive.

1. Zero permeability, absolute vapor barrier
2. High puncture and tear resistance
3. Contain tested and approved mold inhibiting agents
4. A 5-ply self adhesive material shall install easily with no off-site fabrication required
5. The cold weather acrylic adhesive shall apply easily at temperatures as cold as -10°F.
6. Flame spread/smoke developed: 25/50
7. Finish to be as selected by Architect.

2.5 FIELD-APPLIED JACKETS FOR PIPING

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. PVC: Johns Manville's Zeston® PVC Fittings, Jacketing , and accessories or Proto Corporation 25/50 or Indoor/Outdoor, UV-resistant fittings, jacketing and accessories, white. Fitting cover system consists of pre-molded, high-impact PVC materials with fiber glass inserts. Fiber glass insert has a thermal conductivity (k value) of 0.26 at 75° F mean temperature. Closures: stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.

2.6 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.

C. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

2.7 ELECTRICAL HEAT TRACING SYSTEM (Basis of Design is NELSON Heat Trace)

A. Heat-Tracing Cables: Self-regulating, electric heating cables suitable for freeze protection of metal or plastic piping. Install on piping serving hose bibs located at the exterior wall as indicated on the drawings.

1. Nelson model #**LT23-JT**, 3watts/ft, 120v, with over jacket.
2. Cables: Pair of parallel No. 16 AWG tinned-copper bus wires embedded in cross-linked conductive polymer core, which varies power output in response to temperature along its length.
3. Cable shall be capable of crossing over itself without overheating.
4. Heat Output: At least 90 percent of rating over a temperature range from 40 to 150 deg F pipe temperature.
5. Cable Cover: Fabricated of cross-linked, modified, polyolefin dielectric jacket; tinned-copper braid; and polyolefin outer jacket with ultraviolet inhibitor.

B. ACCESSORIES

1. Thermostat: Nelson model **#TF4X40**, 40 F preset, Nema 4X enclosure, 3 ft Copper capillary with bulb, 22 amp rated switch, SPST Switching.
2. Power Connection Kit: Nelson model **# PLT-BC-J-03**
3. Cable Installation Accessories: Tapes, cable ties, warning labels, end seals and splices, and installation clips.

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.

3.4 PENETRATIONS

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

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

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

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

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

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

E. Insulation Installation at Fire-Rated Penetrations:

1. Fire Dampers: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
2. Pipe or duct penetrations (no fire damper): Install insulation continuously through penetrations of fire-rated walls and partitions. Comply with requirements in Division 7 for firestopping and fire-resistive joint sealers.

3.5 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. Insulation inserts shall be no less than the following lengths:

1. 1½″ to 2½″ IPS: 10″ long
2. 3″ to 6″ IPS : 12″ long
3. 8″ to 10″ IPS: 16″ long
4. 12″ and over IPS: 22″ long

D. For piping exposed in mechanical rooms or high traffic areas, insulation shall be protected from abuse by the use of appropriate thickness of PVC jacketing, metal jacketing or laminated self-adhesive water and weather seals.

3.6 EQUIPMENT INSULATION-FIBER GLASS

A. Apply insulation to the equipment surface with joints firmly butted and as close as possible to the equipment surface. Insulation shall be secured as required with mechanical fasteners or banding material. Fasteners shall be located a maximum of 3″ from each edge and spaced no greater than 12″ on center.

B. For below ambient systems, vapor retarder jacketing shall overlap a minimum of 2″ at all seams and be sealed with appropriate pressure-sensitive tape or mastic. All penetrations and facing damage shall be covered with a minimum 2″ overlap of tape or mastic.

C. Equipment insulation exposed to the elements shall be finished with minimum 0.030-inch thick, outdoor, weather resistant PVC; laminated self-adhesive water based weatherproof mastic and glass cloth; or metal. All longitudinal joints shall be positioned so as to shed water; with a minimum 3″ overlap, and completely weather sealed. Laminated systems shall be applied per manufacturer's recommendations.

3.7 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. The longitudinal seam of the vapor retarder must be overlapped a minimum of 2 inches.

C. 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.

D. 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.

3.8 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.

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

D. Install removable insulation covers at fittings and equipment that require servicing and locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.9 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

E. After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating. Prior to applying the finish, the insulation shall be wiped clean with denatured alcohol. The finish shall not be tinted. To insure good adhesion, the temperature should be above 50 °F during application and drying. Outdoor exposed piping shall have the seams located on the lower half of the pipe.

F. Outdoor exposed piping shall be painted with two coats of Armaflex WB Finish. Prior to applying the Finish, the insulation shall be wiped clean with denatured alcohol. The Finish shall not be tinted. Outdoor exposed piping shall have the seams located on the lower half of the pipe.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturers recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.11 INSTALLATION OF HEAT TRACING

A. The system shall be installed according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a functional system, installed in accordance with applicable national and local requirements. Each circuit shall be protected with a 30 mA ground-fault protection device.

B. Plumber shall purchase material, and shall be responsible for entire system, including testing before and after insulation. Installation, including all splices, tees and end terminations, shall be performed by plumbing contractor, with the exception of any power connections, which shall be installed and connected to power by the electrical sub contractor.

C. Provide coverage for ALL pipes, valves, fittings, etc. exposed to freezing temperatures.

D. For pipe 1 ¼ inches and smaller, use insulation that is oversized by ¼ inch to allow room for installing over the heating cables. For pipes three inches and larger, the thickness of insulation can be equal to the pipe diameter with one heating cable or 1/3 the pipe diameter with two runs of heating cable.

E. Apply the heating cable linearly on the pipe after piping has been successfully pressure-tested. Secure the heating cable to piping with cable ties or fiberglass tape.

F. Apply "**Electric Traced**" labels to the outside of the thermal insulation.

G. Manufacturer's representative of the tracing shall supervise tests. Submit "test Certificates of Approval" for all tests, including test values of each circuit, signature of manufacturer's representative, and manufacturer's representative's approval of test results.

1. Procedure: Measure the heater circuit continuity and the insulation resistance between the braid and the bus wires with a 2500 Vdc megohmmeter (megger).
2. Timing: The tests shall be performed after the pipe insulation has been installed and prior to the installation of wall or ceiling panels, and shall be witnessed by the Construction Manager and the manufacturer or the manufacturer's representative.
3. Acceptable results: The heater circuit shall be continuous and megger readings shall be at least 1000 megohms regardless of the heater length. Circuits yielding unacceptable readings must be repaired or replaced.
4. Submittal of results: Submit records of the test data to the Construction Manager. Self-regulating heating cables and components shall have a limited 10-year warranty extension from the date of installation if a properly completed online warranty form is completed within 30 days from the date of installation.

3.12 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. 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.

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

E. Provide **PVC jackets** in the following locations:

1. For insulated piping exposed in mechanical rooms (including mezzanine) within 6 feet above finished floor.
2. Exposed insulated piping in Garage Bays from finished floor to 10 feet above finished floor.
3. Exposed vertical piping in finished spaces.

F. Piping where heat tracing is installed:

1. Pipe size 2-1/2" and less: Glass Fiber, 1-½" thickness; Jacket: PVC.
2. Pipe size 3" and larger: Glass Fiber, 2" thickness; Jacket: PVC.

G. Domestic hot and recirculated hot water:

1. Pipe size 1-1/4" and less: Glass Fiber, ½" thickness.
2. Pipe size 1-1/2 and larger: Glass Fiber, 1" thickness.

H. Domestic cold water

1. Pipe size 1-1/4" and less: Glass Fiber, 1" thickness.
2. Pipe size 1-1/2 and larger: Glass Fiber, 1.5" thickness.

I. Refrigerant suction piping: Flexible Elastomeric, 1" thickness.

J. Refrigerant liquid lines: Not required. Exception: Piping exposed to direct rays of the sun for more than 15 feet; piping in boiler rooms, other locations where the liquid line can pick up a considerable amount of heat; add the following: Flexible Elastomeric; 1" thickness.

K. Heating supply and return:

1. Pipe size 3" and less: Glass Fiber; 1" thickness.
2. Pipe size 4" and larger: Glass Fiber; 1.5" thickness.
3. Insulation is not required for unions, flexible connectors, control valves, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 1-inch of un-insulated items.
4. Insulation is not required between the heating control valve and coil on run-outs when the control valve is located within 4 ft of the coil and the pipe size is 1 in or less.
5. Heating hot-water manual shutoff valves and balance valves 4"Ø and larger: same as water piping; no insulation required 3"Ø and smaller.

3.13 EQUIPMENT INSULATION

A. For equipment not indicated, insulate to with a similar thickness and type as those specified.

B. Install insulation over entire surface of tanks and vessels. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive. Seal longitudinal seams and end joints.

C. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

D. Omit insulation from the following, except for cold surfaces, which shall be provided with removable covers:

1. Hot water expansion tanks
2. Hot water pumps
3. Vibration-control devices.
4. Testing agency labels and stamps.
5. Nameplates and data plates.
6. Manholes, hand holes, or cleanouts.

E. Heating hot-water air separators: same as water piping.

3.14 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.

3.15 DUCT AND PLENUM APPLICATION SCHEDULE

A. Supply Ducts: Flexible Fiber Glass Blanket

1. Concealed or Unconditioned Space: R-6, 1.5” thickness.
2. Exposed to Conditioned Space: None

B. Return ducts within conditioned space: None required.

C. Ducts subject to damage from maintenance personnel: Rigid Fiber Glass Board, R-6, with 16 gauge sheet metal covering (provided by Section 23 31 13) on top and both vertical sides. Covering shall be 48” in width (when possible) where personnel will cross duct to access valves, etc.

D. Concealed outside air intake, relief, or exhaust ducts and plenums within 20 feet of exterior: Flexible Fiber Glass Blanket; R-8, 2” thickness.

E. Exposed outside air intake, relief, or exhaust ducts and plenums within 20 feet of exterior: Rigid Fiber Glass Board; R-8, 2” thickness.

F. Exterior Supply Ducts, (Paint Booth Supply Air) 3” rigid exterior insulation board with high performance jacket

G. Exterior Exhaust/Re-Circulation Ducts (Blast Area Exhaust, Blast Area Re-circulated Supply): 1 ½" rigid exterior insulation board with high performance jacket.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 07 00

SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Section 01 91 13 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R Subcontractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R systems, subsystems, and equipment Testing Procedures

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 23 09 00 "Instrumentation and Control for HVAC" and Section 23 09 93 "Sequence and Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R Subcontractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of gas hot-water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of split system air conditioning and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
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B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
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    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 08 00

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SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

a. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.2 SUMMARY

A. The intent of this specification is to provide an open source Building Automation Control System (BACS) based on the Tridium Niagara AX Platform and a network of freely programmable interoperable open protocol BACnet digital controllers. The Interoperable BACnet controllers shall be fully programmable via the embedded Niagara WorkBench tool requiring only a web browser to complete the programming process.

B. Products requiring a licensed, non-embedded, off site programming tool are not acceptable. Open source as referred to herein shall mean that the Tridium Niagara Network Area Controller and the Interoperable Digital BACnet Controllers (IDC) products are available from multiple contractor and vendor sources, affording the owner freedom of choice and competitive bidding for the initial installation of the (BACS) and future system expansions and modifications not limited by contractor, vendor or networking protocol. No territorially restricted OEM brands, single vendor or "branch only" products are acceptable. All products must be available for purchase by any qualified contractor that the owner chooses to do the initial installation and any future expansion or modifications.

C. The successful bidder shall demonstrate to the owner via a product website dealer/contractor locator, that there are multiple contractors and vendors in the project geographic area to choose from. No exceptions to this requirement will be allowed.

D. Furnish all labor, materials, equipment, and service necessary for a complete and operating Building Automation Control System (BACS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only.

E. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.

F. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s).

1.3 SYSTEM DESCRIPTION

A. The entire Building Automation Control System shall be comprised of a network of interoperable, stand-alone digital controllers communicating via BACnet™ communication protocols to a Network Area Controller (NAC). Temperature Control System products shall be by approved manufacturers. Equivalent BACnet™ products must be approved in writing by the consulting Engineer and be submitted for approval ten (10) days prior to the date of the bid submittal.

B. The Building Automation Control Systems (BACS) consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and perform functions specified.

C. The Building Automation Control System shall be comprised of Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the owner's local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each NAC shall communicate to BACnet™ (IBC) controllers and other open protocol systems/devices provided under Division 23 or Division 26.

D. The BACS as provided in this Division shall be based on a hierarchical architecture incorporating the Niagara AX Framework™. Equivalent products must be approved in writing by the consulting Engineer and be submitted for approval ten (10) days prior to the date of the bid submittal. Systems not developed on the Niagara AX Framework™ platform are unacceptable.

E. The BACS shall monitor and control equipment as called for by the "Sequence of Operation" and points list.

F. The BACS shall provide full graphic software capable of complete system operation for up to 34 simultaneous Thin-Client workstations.

G. The BACS shall provide full graphic operator interface to include the following graphics as a minimum:

1. Home page to include a minimum of six critical points, i.e. Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW etc.
2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
3. Detail graphics for each mechanical system to include; AHUs (Air Handling Units), ERUs (Energy Recovery Units), TUs (Terminal Units), EFs (Exhaust Fans), Chillers and associated controls, Boilers, and Converters as a minimum.
4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.

H. The BACS shall provide the following data links to electronically formatted information for operator access and use.

1. Project control as-built documentation; to include all BACS drawings and diagrams converted to Adobe Acrobat .pdf filers.
2. TCS Bill of Material for each system, i.e. AHU, RTU, FCU, Boiler etc.
3. Technical literature specification data sheets for all components listed in the BACS Bill of Material.

I. The BACS shall provide automated alarming software capable of sending messages to email compatible cellular telephones and pagers via the owner's e-mail service. The email alarm paging system shall be able to segregate users, time schedules, and equipment, and be capable of being programmed by the owner.

J. It is preferable that any dedicated configuration tool required for controller configuration have the capability to be launched from within the applicable Network Management Software. If the configuration tool(s) can not be launched from the Network Management Software, any software required for controller configuration shall be included as a leave-behind tool with enough license capability to support the installation.

K. The contractor shall provide the appropriate quantity of legal copies of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be generally available in the market. No closed and/or unavailable tools will be permitted. Contractor shall convey all software tools and their legal licenses at project close out.

1.4 SUBMITTAL

A. Four copies of shop drawings of the components and devices for the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions for all controllers, valves, dampers, sensors, routers, etc. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation shall also be included with the submittal package. Division 26 contractors supplying products and systems, as part of their packages shall provide catalog data sheets, wiring diagrams and point lists to the Division 23 contractor for proper coordination of work.

B. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media, and protocol. Though the Division 23 and 26 contractors shall provide these diagrams for their portions of work, the Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire Wide Area Network (WAN) and/or Local Area Network (LAN) utilized by the BACS.

1. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system expansion with minimal infrastructure modifications.

C. Submittal shall also include a complete point list of all points to be connected to the BACS. Division 23 and 26 contractors shall provide necessary point lists, protocol documentation, and factory support information for systems provided in their respective divisions but integrated into the BACS.

D. Submittal shall also include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete at this stage with the only remaining changes to be based on review comments from the A/E design team and/or Owner.

E. Upon completion of the work, provide a complete set of ‘as-built’ drawings and application software on compact disk. Drawings shall be provided as AutoCAD™ or Visio™ compatible files. Eight copies of the ‘as-built’ drawings shall be provided in addition to the documents on compact disk. Division 23 and 26 contractors shall provide as-builts for their portions of work. The Division 23 contractor shall be responsible for as-builts pertaining to overall BACS architecture and network diagrams. All as-built drawings shall also be installed into the BACS server in a dedicated directory.

1.5 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:

DDCS	Direct Digital Control System Building Automation Control System
GUI	Graphical User Interface
IBC	Interoperable BACnet Controller
IDC	Interoperable Digital Controller
LAN	Local Area Network
NAC	Network Area Controller
OOT	Object Oriented Technology
PICS	Product Interoperability Compliance Statement
PMI	Power Measurement Interface
POT	Portable Operator's Terminal
TCS	Temperature Control System
WAN	Wide Area Network
WBI	Web Browser Interface

1.6 DIVISION OF WORK

A. The Division 23 and 26 (if applicable) contractors shall be responsible for all controllers (IDC and IBC), control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.

B. The Division 23 contractor shall be responsible for the Network Area Controller(s) (NAC), software and programming of the NAC, graphical user interface software (GUI), development of all graphical screens, Web browser pages, setup of schedules, logs and alarms, LonWorks network management and connection of the NAC to the local or wide area network.

1.7 RELATED WORK SPECIFIED ELSEWHERE

A. Division 26, Electrical:

1. Providing motor starters and disconnect switches (unless otherwise noted).
2. Power wiring and conduit (unless otherwise noted).
3. Provision, installation and wiring of smoke detectors (unless otherwise noted).
4. Other equipment and wiring as specified in Division 26.

1.8 AGENCY AND CODE APPROVALS

A. All products of the BACS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.

1. UL-916; Energy Management Systems
2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 “signal Equipment”
3. CE
4. FCC, Part 15, Subpart J, Class A Computing Devices

1.9 SOFTWARE LICENSE AGREEMENT

A. The Owner shall agree to the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

B. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, BACS, and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.

C. The owner, or his appointed agent, shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and /or configured for use within Niagara AX Framework (Niagara) based controllers and/or servers and any related LAN / WAN / Intranet and all connected routers and devices.

1.10 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.11 QUALITY ASSURANCE

A. Proven Experience: Provide a list of no less than ten similar projects which have building control systems specified. These projects must be on-line and functional such that the Owner's Representative would observe a direct digital control system in full operation. The Contractor must be a direct, wholly owned branch of a national control's manufacturer, or a representative not a wholesale distributor.

B. Quality of Compliance: Control systems shall be installed by trained control mechanics regularly employed in installation and calibration of BACS equipment by the manufacturer of temperature control equipment.

C. Contractor Requirements

1. Longevity: The BACS contractor shall have a minimum of ten years experience installing, and servicing computerized building systems. All subcontractors utilized by the BACS contractor shall have a minimum of five-year experience within their appropriate trades.
2. Past Projects: The BAS contractor shall have completed a minimum of ten projects within the last five years that are at least equal in dollar value and scope to this project. A list of similar projects, dollar volume, scope, contact name and contact number shall be provided by the BAS contractor if asked for by the owner.
3. Personnel, Coverage and Response Capabilities: The BACS contractor shall have a minimum of ten full time electronic service personnel and two factory trained DDC control technicians within a 140 mile radius of the project location
4. The BACS contractor shall have an established 24-hour emergency service organization. A dedicated telephone number shall be provided to the owner for requesting emergency service. A maximum of four hour, electronic service technician on sight, response time shall be guaranteed by the BACS contractor.
5. The Potential Low Bidder will submit with Bid Documents a qualification statement demonstrating how the above Contractor requirements shall be achieved. Any Potential Low Bidder that does not meet all of the criteria shall not be considered and shall be rejected for not complying with the specifications.

1.12 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

PART 2 - MATERIALS

2.1 GENERAL

A. The Building Automation Control System (BACS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.

B. The installed system shall provide secure password access to all features, functions and data contained in the overall BACS.

2.2 ACCEPTABLE MANUFACTURERS

A. Basis-of-Design: Tridium Niagara-AX™. Subject to compliance with requirements, provide either the product named or an alternate product by one of the other manufacturers specified. System must operate on an open licensed JACE with the AX Workbench. No Appliance may be used. All JACE controllers shall operate with the Brand ID set to “none”, and compatibility modes set for “all”.

1. Alerton
2. Honeywell
3. Johnson Controls
4. Siemens Building Technologies
5. Vykon

2.3 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet™ technology, MODBUS ™, OPC, and other open and proprietary communication protocols into one open, interoperable system.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-2001 and BACnet to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP,) and/or RS-485 (BACnet MSTP) as specified.

C. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

D. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. Systems requiring proprietary database and user interface programs shall not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for local network connected user interfaces.
2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.4 NETWORKS

A. The Local Area Network (LAN) shall be a 100 Megabit/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

B. Local area network minimum physical and media access requirements:

1. Ethernet; IEEE standard 802.3
2. Cable; 100 Base-T, UTP-8 wire, category 5
3. Minimum throughput; 100 Mbps.

2.5 NETWORK ACCESS

A. Remote Access.

1. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the

customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

2.6 NETWORK AREA CONTROLLER (NAC)

A. The contractor shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices provided under Divisions 23 and 26. It is the responsibility of the contractor to coordinate with the Division 23 and 26 contractors to determine the quantity and type of devices.

B. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization
6. Integration of BACnet controller data
7. Network Management functions for BACnet based devices

C. The Network Area Controller shall provide the following hardware features as a minimum:

1. One Ethernet Port – 10/100 Mbps
2. One RS-232 port
3. One RS-485 port if BACnet controllers are used.
4. Battery Backup
5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
6. The NAC must be capable of operation over a temperature range of 32 to 122°F
7. The NAC must be capable of withstanding storage temperatures of between 0 and 158°F
8. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing

D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

E. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.

F. Event Alarm Notification and actions

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network, or remote via dial-up telephone connection or wide-area network.
3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:

   a. In alarm
   b. Return to normal
   c. Fault condition

4. Provide for the creation of a minimum of eight alarm classes for the purpose of routing types and/or classes of alarms, i.e.: security, HVAC, Fire, etc.
5. Provide timed (schedule) routing of alarms by class, object, group, or node.
6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

G. Controller and network failures shall be treated as alarms and annunciated.

H. Alarms shall be annunciated in any of the following manners as defined by the user:

1. Screen message text
2. Email of the complete alarm message to multiple recipients via the owner's e-mail service. Provide the ability to route and email alarms based on:

   a. Day of week
   b. Time of day
   c. Recipient

3. Pagers via paging services that initiate a page on receipt of email message via the owner's e-mail service
4. Graphic with flashing alarm object(s)
5. Printed message, routed directly to a dedicated alarm printer

I. The following shall be recorded by the NAC for each alarm (at a minimum):

1. Time and date
2. Location (building, floor, zone, office number, etc.)
3. Equipment (air handler #, access way, etc.)
4. Acknowledge time, date, and user who issued acknowledgement.
5. Number of occurrences since last acknowledgement.

J. Alarm actions may be initiated by user defined programmable objects created for that purpose.

K. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

L. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

M. Provide a "query" feature to allow review of specific alarms by user defined parameters.

N. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

O. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.7 DATA COLLECTION AND STORAGE

A. The NAC shall have the ability to collect data for any property of any object and store this data for future use.

B. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:

1. Designating the log as interval or deviation.
2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

C. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.

D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

E. All log data shall be available to the user in the following data formats:

1. HTML
2. XML
3. Plain Text
4. Comma or tab separated values
5. PDF

F. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

G. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:

1. Archive on time of day
2. Archive on user-defined number of data stores in the log (buffer size)
3. Archive when log has reached it’s user-defined capacity of data stores
4. Provide ability to clear logs once archived

2.8 AUDIT LOG

A. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:

1. Time and date
2. User ID
3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.9 DATABASE BACKUP AND STORAGE

A. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

B. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.

C. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.10 ADVANCED UNITARY CONTROLLER

A. The controller platform shall be designed specifically to control HVAC – ventilation, filtration, heating, cooling, humidification, and distribution. Equipment includes: constant volume air handlers, VAV air handlers, packaged RTU, heat pumps, unit vents, fan coils, natural convection units, and radiant panels. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions.

B. Minimum Requirements:

1. The controller shall be capable of either integrating with other devices or stand-alone operation.
2. The controller shall have an FTT transformer-coupled communications port interface for common mode-noise rejection and DC isolation.
3. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.

    a. Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
    b. Accuracy: ±1 minute per month at 77° F (25° C).
    c. Power Failure Backup: 24 hours at 32° to 122° F (0° to 50° C).

4. The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.

5. The controller shall have an internal DC power supply to power external sensors.

    a. Power Output: 20 VDC ±10% at 75 mA.

6. The controller shall have a visual indication (LED) of the status of the devise:

    a. Controller operating normally.
    b. Controller in process of download.
    c. Controller in manual mode under control of software tool.
    d. Controller lost its configuration.
    e. No power to controller, low voltage, or controller damage.
    f. Processor and/or controller are not operating.

7. The minimum controller Environmental ratings

    a. Operating Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
    b. Storage Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
    c. Relative Humidity: 5% to 95% non-condensing.

8. The controller shall have the additional approval requirements, listings, and approvals:

    a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
    b. CSA (LR95329-3) Listed
    c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
    d. Meets Canadian standard C108.8 (radiated emissions).
    e. Conforms to the following requirements per European Consortium standards: EN 61000-6-1; 2001 (EU Immunity) EN 61000-6-3; 2001 (EU Emissions)

9. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
10. The controller shall have sufficient on-board inputs and outputs to support the application.

    a. Analog outputs (AO) shall be capable of being configured to support 0-10 V, 2-10 V or 4-20 mA devices.
    b. Triac outputs shall be capable of switching 30 Volts at 500 mA.
    c. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring. Input and Output wiring terminals shall be designated with color coded labels.
    d. Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20 mA).

11. The controller shall provide for “user defined” Network Variables (NV) for customized configurations and naming using Niagara AX Framework™.

    a. The controller shall support 62 Network Variables with a byte count of 31 per variable.
    b. The controller shall support 1,922 separate data values.

12. The controller shall provide “continuous” automated loop tuning with an Adaptive Integral Algorithm Control Loop.
13. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized “sequence of operations” as outlined in Section 4.

    a. Discharge air control and low limit
    b. Pressure-dependent dual duct without flow mixing.
    c. Variable air volume with return flow tracking.
    d. Economizer with differential enthalpy.
    e. Minimum air flow coordinated with CO2.
    f. Unit ventilator cycle (1,2,3) 2-pipe.
    g. Unit ventilator cycle (1,2,3) 2-pipe with face/bypass.
    h. with EOC valve.

2.11 GRAPHICAL USER INTERFACE SOFTWARE

A. Operating System:

1. The Workstation with GUI shall run on Microsoft Windows XP Professional.

B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimal knowledge of the HVAC Control System and basic

computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of, a graphic background the GUI shall support the use of scanned pictures.
2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
3. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.

    a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
    b. Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.

5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No text entry shall be required.
6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No text entry shall be required.

D. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:

1. Create, delete, or modify control strategies.
2. Add or delete objects to the system.
3. Tune control loops through the adjustment of control loop parameters.
4. Enable or disable control strategies.
5. Generate hard copy records or control strategies on a printer.
6. Select points to be alarmable and define the alarm state.
7. Select points to be trended over a period of time and initiate the recording of values automatically.

E. On-Line Help. Provide a context sensitive on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for the currently displayed screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

F. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off the system if no keyboard or mouse activity is detected for a specified time. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

G. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

H. Alarm Console

1. The system shall be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console may be enabled or disabled by the system administrator.
2. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and unacknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.12 WEB BROWSER CLIENTS

A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BACS, shall not be acceptable.

C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface (if used). Systems that require different graphic views, different means of graphic generation, or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

D. The Web browser client shall support at a minimum, the following functions:

1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
5. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

    a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

        1. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
        2. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No text entry shall be required.
c. View logs and charts
d. View and acknowledge alarms
e. Setup and execute SQL queries on log and archive information

7. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to set a specific home page for each user. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.13 SYSTEM CONFIGURATION TOOL

A. The Workstation Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.

B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.14 LIBRARY

A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

D. All control objects shall conform to the control objects specified in the BACnet specification.

E. The library shall include applications or objects for the following functions, at a minimum:

1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.
2. Calendar Object. . The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals
4. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
5. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.
6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

F. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.

1. Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
2. Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.
3. Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
4. Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
5. PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
6. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
7. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
8. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
9. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
10. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
11. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the

appropriate parameters of the "contained" application that are represented on the graphical shell of this container.

G. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:

1. For BACnet devices, provide the following objects at a minimum:

a. Analog In
b. Analog Out
c. Analog Value
d. Binary
e. Binary In
f. Binary Out
g. Binary Value
h. Multi-State In
i. Multi-State Out
j. Multi-State Value
k. Schedule Export
l. Calendar Export
m. Trend Export
n. Device

2. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
3. For BACnet devices, provide the following support at a minimum

a. Segmentation
b. Segmented Request
c. Segmented Response
d. Application Services
e. Read Property
f. Read Property Multiple
g. Write Property
h. Who-has
i. I-have
j. Who-is
k. I-am
l. Media Types
m. Ethernet
n. BACnet IP Annex J
o. MSTP
p. BACnet Broadcast Management Device (BBMD) function
q. Routing

2.15 DDE DEVICE INTEGRATION

A. The Network Area Controller shall support the integration of device data via Dynamic Data Exchange (DDE), over the Ethernet Network. The Network Area Controller shall act as a DDE client to another software application that functions as a DDE server.

B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of these devices into the BACS. Objects provided shall include at a minimum:

1. DDE Generic AI Object
2. DDE Generic AO Object
3. DDE Generic BO Object
4. DDE Generic BI Object

2.16 MODBUS SYSTEM INTEGRATION

A. The Network Area Controller shall support the integration of device data from Modbus RTU, ASCII, or TCP control system devices. The connection to the Modbus system shall be via an RS-232, RS485, or Ethernet IP as required by the device.

B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the Modbus system data into the FPMS. Objects provided shall include at a minimum:

1. Read/Write Modbus AI Registers
2. Read/Write Modbus AO Registers
3. Read/Write Modbus BI Registers
4. Read/Write Modbus BO Registers

C. All scheduling, alarming, logging and global supervisory control functions, of the Modbus system devices, shall be performed by the Network Area Controller.

D. The BACS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment utilizing Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning

2.17 OPC SYSTEM INTEGRATION

A. The Network Area Controller shall act as an OPC client and shall support the integration of device data from OPC servers. The connection to the OPC server shall be Ethernet IP as required by the device. The OPC client shall support third party OPC servers compatible with the Data Access 1.0 and 2.0 specifications.

B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the OPC system data into the BAS. Objects provided shall include at a minimum:

1. Read/Write OPC AI Object
2. Read/Write OPC AO Object
3. Read/Write OPC BI Object
4. Read/Write OPC BO Object
5. Read/Write OPC Date/Time Input Object
6. Read/Write OPC Date/Time Output Object
7. Read/Write OPC String Input Object
8. Read/Write OPC String Output Object

C. All scheduling, alarming, logging and global supervisory control functions, of the OPC system devices, shall be performed by the Network Area Controller.

D. The BACS supplier shall provide an OPC client communications driver. The equipment system vendor that provided the equipment utilizing OPC shall provide documentation of the system's OPC server interface and shall provide factory support at no charge during system commissioning.

2.3 OTHER CONTROL SYSTEM HARDWARE

A. Alternate device manufacturers will be considered with the approval of the engineer.

B. Space Temperature Wall Module: Temperature sensing modules mounted on the wall in occupied spaces. Optional setpoint, indication, and override switches must be provided as specified.

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

    a. Alerton
    b. ACI
    c. Honeywell
    d. Johnson Controls
    e. Novar
    f. Siemens Building Technologies
    g. Trend

2. Sensor shall contain digital display and user function keys along with temperature sensor. Sensor shall function as occupant control unit. It shall allow occupant to raise and lower setpoint and activate terminal unit for night override use all within limits as programmed by building operator.

3. Provide means for occupant to view room setpoint, room temperature and outside air temperature at each controller. Override time may be set and viewed in 0.1 hour increments. Override time countdown shall be automatic, but may be reset to zero using function keys on unit. Display shall be blank in unoccupied mode unless a function button is pressed.

4. Space temperature sensors shall be accurate to plus or minus 0.5 deg. F at 77 deg. F.

C. Duct Mount, Pipe Mount, and Outside Air Temperature Sensors:

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

    a. Alerton
    b. ACI
    c. Honeywell
    d. Johnson Controls
    e. Novar
    f. Siemens Building Technologies
    g. Trend

2. Outside air sensors shall include an integral sun shield.
3. Temperature sensors shall have an accuracy of plus or minus 1.0 deg. F. over operating range.
4. Duct sensors shall have sensor approximately in center of the duct, and shall have selectable lengths of 6, 12, and 18 inches.
5. Multipoint averaging element sensors shall be provided where specified, and shall have a minimum of one foot of sensor length for each square foot of duct area (provide multiple sensors if necessary).
6. Pipe mount sensors shall have copper, or stainless steel separable wells.

D. Current Switches: Solid state, split core, current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point shall be provided where specified. Current switches shall include an integral LED for indication of trip condition.

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

    a. ACI
    b. Honeywell
    c. RIB, Inc.
    d. Veris Industries

2. Sensing range 0.5 – 250 Amps.
3. Output 0.3 A @ 200 VAC/VDC / 0.15 A @ 300 VAC/VDC
4. Operating frequency 40 Hz -1 kHz.
5. Operating Temperature 5-104 deg. F (-15 – 40 deg. C), Operating Humidity 0-95% non-condensing
6. Approvals CE, UL.

E. Current Sensors: Solid state, split core linear current sensors shall be provided where specified.

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

    a. ACI
    b. Honeywell
    c. RIB, Inc.
    d. Veris Industries

2. Linear output of 0-5 VDC, 0-10 VDC, or 4-20 mA.
3. Scale sensors so that average operating current is between 20-80% full scale.
4. Accuracy plus or minus 1.0% (5-100% full scale)
5. Operating frequency 50-600 Hz.
6. Operating Temperature 5-104 deg. F (-15 – 40 deg. C), Operating Humidity 0-95% non-condensing
7. Approvals CE, UL.

F. Low Temperature Limit Switches. Safety low limit shall be manual reset twenty foot limited fill type responsive to the coolest section of its length.

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

    a. Honeywell
    b. Johnson Controls
    c. Siemens Building Technologies
    d. TAC

2. Low Limit Setpoint shall be adjustable between 20 and 60 deg. F. (-5 and 15 deg. C.)
3. Switch enclosure shall be dustproof and moisture-proof.
4. Switch shall break control circuit on temperature fall. Contact ratings shall be 10.2 FLA at 120 VAC, and 6.5 FLA at 240 VAC.
5. Ambient Temperature range -20 to 125 deg. F. (-11 to 52 deg. C.)

6. Operating Temperature Range 20 to 60 deg. F. (-5 to 15 deg. C.)

G. High Temperature Limit Switches. Safety high limit (fire stats) shall be manual reset type.

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

   a. Honeywell
   b. Johnson Controls
   c. Siemens Building Technologies
   d. TAC

2. High Limit Setpoint shall be adjustable between 100 and 240 deg. F. (38 and 116 deg. C.)
3. Switch enclosure shall be dustproof and moisture-proof.
4. Switch shall break control circuit on temperature fall. Contact ratings shall be 10 FLA at 120 VAC, and 5 FLA at 240 VAC.
5. Ambient Temperature range -20 to 190 deg. F. (-28 to 88 deg. C.) at case, and 350 deg. F (177 deg. C.) at the sensor.
6. Operating Temperature Range 100 to 240 deg. F. (38 to 116 deg. C.)

H. CO2 Sensors.

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

   a. Honeywell
   b. TelAire
   c. Vaisala

2. Carbon Dioxide sensors shall be 0-10 Vdc, 2-10 Vdc, or 4-20 mA linear analog output type, with corrosion free gold-plated non-dispersive infrared sensing, designed for duct or wall mounting.
3. Sensor shall incorporate internal diagnostics for power, sensor, analog output checking, and automatic background calibration algorithm for reduced maintenance. Sensor range shall be 0-2000 PPM with +/- 75 PPM accuracy at full scale.
4. Where specified, sensor shall have an LCD display that displays the sensor reading and status.

I. NOx Gas Detection

1. Natural Gas (Ch4), or Propane (LP) Monitor / Transmitter; Kele Model GMT gas monitor/transmitter or equal. Microprocessor-based system for continuous effective monitoring of *combustible* gases. Provide 4-20 mA output in proportion with DPDT alarm contacts; Gas concentration display: 10-step progressive LED; Visual Indicators shall be Green light “normal operation”; Provide audible alarm: 65 dbA at 3 ft; Catalytic combustion S1-type sensor; UL listed; 2 year warranty

   a. Detection range: 0-100% L.E.L. (Lower Explosive Limit)
   b. Accuracy 3%
   c. Alarm set point: 1.25% Methane by volume (25% L.E.L).

2. Gas Monitor Calibration Kit: provide calibration kit equal to Kele model UCK, and provide all necessary components and fittings for calibrating gas sensor. Gas cylinders: provide (1) 17 liter cylinder for each type of gas that is monitored.

J. Carbon Monoxide (CO) Monitor / Transmitter: Kele Model GMT gas monitor/transmitter or approved equal. Microprocessor-based system for continuous effective monitoring of *toxic* gases. Provide 4-20 mA output in proportion with DPDT alarm contacts; Gas concentration display: 10-step progressive LED; Visual Indicators shall be Green light "normal operation"; Provide audible alarm: 65 dbA at 3 ft.; Electromechanical S1-type sensor; UL listed; 2 year warranty

1. Detection range: 0-500 ppm
2. Accuracy 3%
3. Alarm set point 35 ppm

Gas Monitor Calibration Kit: provide calibration kit equal to Kele model UCK, and provide all necessary components and fittings for calibrating gas sensor. Gas cylinders: provide (1) 17 liter cylinder for each type of gas that is monitored.

K. Differential Pressure Sensors

1. Manufacturers:

   a. ACI
   b. Honeywell
   c. RIB, Inc.
   d. Veris Industries

2. Sensor shall have four field selectable ranges: 0.1, 0.24, 0.5, 1.0 in w.c. for low pressure models, and 1.0, 2.5, 5, 10 for high pressure models.
3. Sensor shall provide zero calibration via pushbutton or digital input.
4. Sensor shall have field selectable outputs of 0-5 VDC, 0-10 VDC, and 4-20 mA
5. Where specified, sensor shall have and LCD display that displays measured value.
6. Sensor overpressure rating shall be 3 PSID proof, and 5 PSID burst.
7. Sensor accuracy shall be plus or minus 1% FS selected range.

   a. Temperature Sensor Details

      1) Room Type: Provide the sensing element components within a decorative protective cover suitable for surrounding decor. Provide room temperature sensors with:

         a) Timed override button
         b) Setpoint adjustment lever or knob.
         c) Digital temperature display.
         d) Insulating Bases: For temperature sensors/thermostats located on exterior walls.
         e) Blank wall stainless steel sensor for (Wash Bay).

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

   a. Honeywell
   b. Johnson Controls
   c. Siemens Building Technologies
   d. TAC

L. Enthalpy Sensors.
(Option 1 – Changeover type – Select one) Duct mounted enthalpy sensor shall include a temperature

sensor and a humidity sensor constructed to close an electrical contact upon a drop in enthalpy (total heat) to enable economizer modes of operation where specified.
(*Option 2 – Proportional analog signal– Select one*) Provide duct mounted sensor including solid state temperature and humidity sensors with electronics which shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling .

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

    a. Honeywell
    b. Siemens Building Technologies

M. Annular Pitot Tube Flow Meter. Annular pitot tube shall be averaging type differential pressure sensors with four total head pressure ports and one static port made of austenitic stainless steel.

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

    a. Air Monitor Corporation
    b. Ultratech
    c. Wetmaster Co., Ltd.
    d. Johnson Controls

2. Sensor shall have an accuracy of ± .25% of full flow and a repeatability of ± .05% of measured value.
3. Transmitter shall be electronic and shall produce a linear output of 0-10 Vdc, 0-5 Vdc, or 4 to 20 mA dc corresponding to the required flow span.
4. The transmitter shall include non-interacting zero and span adjustments.

N. Standard Automatic Control Dampers. Provide all automatic control dampers not specified to be integral with other equipment.

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

    a. Greenheck
    b. Honeywell
    c. Johnson Controls
    d. Ruskin

2. Frames shall be 5 inches wide and of no less than 16-gauge galvanized steel. Inter-blade linkage shall be within the frame and out of the air stream.
3. Blades shall not be over 8 inches wide or less than 16-gauge galvanized steel triple V type for rigidity.
4. Bearings shall be acetyl, oilite, nylon or ball-bearing with ½ inch diameter plated steel shafts.
5. Dampers shall be suitable for temperature ranges of -40 to 180F.
6. All proportional control dampers shall be opposed or parallel blade type as hereinafter specified and all two-position dampers shall be parallel blade types.
7. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6". Dampers with dimensions of 24 inches and less shall be rated for 3,000 fpm velocity and shall withstand a maximum system pressure of 5.0 in. w.c. Dampers with dimensions of 36 inches and less shall be rated for 2,500 fpm velocity and shall withstand a maximum system pressure of 4.0 in. w.c. Dampers with dimensions of 48 inches and less shall be rated for 2,000 fpm velocity and

shall withstand a maximum system pressure of 2.5 in. w.c. Damper blade width shall be no greater than 8 inches, and dampers over 48 inches wide by 74 inches high shall be sectionalized.

8. Maximum leakage for dampers in excess of sixteen inches square shall be 30 CFM per square foot at static pressure of 1 inch of WC. Testing and ratings to be in accordance with AMCA Standard 500.

O. Low Leakage Automatic Control Dampers. Provide all automatic control dampers not specified to be integral with other equipment.

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

    a. Greenheck
    b. Honeywell
    c. Johnson Controls
    d. Ruskin

2. Frames shall be 5 inches wide and of no less than 16-gauge galvanized steel. Inter-blade linkage shall be within the frame and out of the air stream.
3. Blades shall not be over 8 inches wide or less than 16-gauge galvanized steel triple V type for rigidity.
4. Bearings shall be acetyl, oilite, nylon or ball-bearing with ½ inch diameter plated steel shafts.
5. Dampers shall be suitable for temperature ranges of -40 to 180F.
6. All proportional control dampers shall be opposed or parallel blade type as hereinafter specified and all two-position dampers shall be parallel blade types.
7. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6". Dampers with dimensions of 24 inches and less shall be rated for 3,000 fpm velocity and shall withstand a maximum system pressure of 5.0 in. w.c. Dampers with dimensions of 36 inches and less shall be rated for 2,500 fpm velocity and shall withstand a maximum system pressure of 4.0 in. w.c. Dampers with dimensions of 48 inches and less shall be rated for 2,000 fpm velocity and shall withstand a maximum system pressure of 2.5 in. w.c.
8. Side seals shall be stainless steel of the tight-seal spring type.
9. Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage data for all low leakage control dampers with the temperature control submittal.
10. Maximum leakage for low leakage dampers in excess of sixteen inches square shall be 8 CFM per square foot at static pressure of 1 inch of WC.
11. Low leakage damper blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage.
12. Testing and ratings shall be in accordance with AMCA Standard 500.
13. Damper blade width shall be no greater than 8 inches, and dampers over 48 inches wide by 74 inches high shall be sectionalized. Testing and ratings to be in accordance with AMCA Standard 500.

P. Round Motorized Dampers. Round dampers shall be provided where specified and shall be factory mounted in a section of round duct a minimum of 12 inches long, but no less than one inch longer than the duct diameter.

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

    a. Greenheck
    b. Honeywell
    c. Johnson Controls

d. Ruskin

2. Duct shall be sleeve type spiral duct crimped on the downstream end, 24 gage galvanized minimum except duct over 12 inches in diameter shall be 22 gage.
3. Duct shall have an integral galvanized steel actuator mounting plate and a ½ inch zinc-coated steel blade shaft extending a minimum of 2 inches beyond the actuator mounting plate.
4. Shaft bearings shall be flanged bronze oilite pressed into the frame.
5. The blade shall be a minimum 16 gage galvanized steel, and damper frame shall be provided with closed-cell neoprene seals with silicone rubber bead. Damper shall be designed for a 2500 ft/min approach velocity and a 4 inch minimum static pressure.
6. Damper shall be suitable for operation from 32 to 130F temperatures.
7. Damper and actuator combination shall be designed for leakage rates less than 13 cfm per square foot at one inch w.c. differential and 25 cfm at four inches w.c. Actuator shall have an external declutch lever to allow manual blade positioning during equipment and power malfunctions.

Q. Control Valves: *(Globe Type)* Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.

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

   a. Honeywell
   b. Johnson Controls
   c. Siemens Building Technologies
   d. TAC

2. Two-position valves shall be line size.
3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's specified maximum differential pressure shall not be exceeded in order to prevent cavitation.
4. Two-way proportional valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through, and linear through the bypass. Rangeability shall be 50:1 or greater.
5. Provide valve position indicator and a method to operate valves manually during system start-up, or actuator power loss or failure on all valves.
6. Leakage rate shall be no more than ANSI Class III (for heating) or ANSI Class IV (for cooling).
7. Valves 1/2 inch through 3 inches shall be screwed pattern except where solder connections are specified for valves 1/2 or 3/4 inches.
8. Three-way valve bypass ports shall be of Cv to provide constant flow through the control loop.
9. Two-way valves shall close off against the net differential pressure resulting from the maximum head pressure of the system pumps less all loop pressure losses. Three-way valves shall close off against the difference in head pressure between the controlled load and the bypass line.
10. Valves 2-1/2 inch and larger shall be flanged and ANSI/ASME-rated to withstand the pressures and temperatures specified.
11. Valves shall have stainless-steel stems and spring loaded Teflon packing with replaceable discs.

R. Control Valves: *(Characterized Ball Valves)* Control valves 1/2 to 3 inches shall be 2-way or 3-way forged brass screwed pattern constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.

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

   a. Honeywell
   b. Johnson Controls

c. Siemens Building Technologies
d. TAC
e. Griswold Controls

2. Two-position valves shall be line size.
3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's specified maximum differential pressure shall not be exceeded in order to prevent cavitation.
4. Two-way proportional valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through and linear flow through the bypass.
5. Leakage rate shall be ANSI Class IV (no more than 0.01% of Cv).
6. Fluid temperature range shall be between -22 and +250 degrees F. water or glycol solutions up to 50%. Piping and valves shall be properly insulated to prevent formation of ice on moving parts.
7. Valves shall be rated for no less than 360 psig at 250 degrees F.
8. Provide a method to operate valves manually during system start-up, or actuator power loss or failure on all valves.
9. Two-way valves shall close off against 70 psi minimum, and three-way valves shall close off against 40 psi minimum.
10. Valves shall have stainless-steel or chemically nickel-plated brass stem and throttling port.
11. Actuator shall be available with NEMA 3R (IP54) rated enclosure suitable for outdoor installation.
12. Valves shall be tagged with Cv rating and model number.

S. Control Valves: *(Characterized Ball Valves)* Control valves 4 to 6 inches shall be 2-way or 3-way cast iron ANSI Class 125 flanged connections as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.

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

a. Honeywell
b. Johnson Controls
c. Siemens Building Technologies
d. Griswold Controls

2. Two-position valves shall be line size.
3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's maximum differential pressure shall not be exceeded in order to prevent cavitation.
4. Two-way water valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through and linear with 20% reduced flow through the bypass. Rangeability shall be 100:1 or greater.
5. A-port leakage rate shall be ANSI Class IV (no more than 0.01% of Cv) or better.
6. Fluid temperature range shall be between -22 and +250 degrees F. water or glycol solutions up to 50%. Piping and valves shall be properly insulated to prevent formation of ice on moving parts.
7. Valves shall be rated for no less than 240 psig at 250 degrees F.
8. Provide a method to operate valves manually during actuator power loss or failure.
9. Two-way valves shall close off against 70 psi minimum, and three-way valves shall close off against 40 psi minimum.
10. Valve ball and stem shall be 316 stainless-steel.
11. Actuator shall be available with NEMA 3R (IP54) rated enclosure suitable for outdoor installation.
12. Valves shall be tagged with Cv rating and model number.

T. Actuators, General. All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off. Valves shall be provided with actuators suitable for floating or analog signal control as required to match the controller output. Actuators shall be power failure return type where valves or dampers are required to fail to a safe position and where specified.

U. Non-Spring Return Low Torque Direct Coupled 35 & 70 lb-in Actuators. Actuators shall be 35 or 70 lb-in. with strokes adjustable for 45, 60, or 90 degree rotation applications and designed for operation between 20 and 125 F.

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

    a. Honeywell
    b. Johnson Controls
    c. Siemens Building Technologies
    d. TAC

2. Each actuator shall also have a minimum position adjustable rotation of 0 to 30 degrees.
3. Actuators shall be for floating or two position (ML 6161 or ML6174) control, or for 4-20 mA or 2-10Vdc (ML7161 or ML7174) input signals.
4. Analog control actuators shall have a cover mounted direct/reverse acting switch.
5. Actuator motor shall be magnetically coupled or shall have limit switch stops to disengage power at the ends of the stroke.
6. Actuators shall be direct connected (no linkages) and provided with a manual declutch for manual positioning.
7. Actuators shall have NEMA 1 environmental protection rating and be 24 volt and UL listed with UL94-5V plenum requirement compliance.
8. Minimum design life of actuators shall be for 1,500,000 repositions and 35 lb-in. models shall be designed for 50,000 open-close cycles and 70 lb-in. models shall be designed for 40,000 open-close cycles.
9. Actuator options shall include 1) Auxiliary feedback potentiometers, 2) open-closed indicator switches, 3) actuator timings of 90 seconds, 3 minutes, or 7 minutes, one or two auxiliary switches, and 4) torque of 35 or 70 lb-in.

V. Non-Spring Return High Torque 177 and 300 lb-in Actuators. Actuators shall be UL listed 24 Vac in NEMA 2 enclosures designed for operation between -5 and 140 F.

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

    a. Honeywell
    b. Johnson Controls
    c. Siemens Building Technologies
    d. TAC

2. Rotation direction shall be switch selectable.

3. Minimum design life of actuators shall be for 1,500,000 repositions and for 60,000 open-close cycles.
4. Actuators shall be suitable for the controller output signals encountered, floating or analog, and shall have full cycle timing of 95 seconds.
5. Actuators shall be direct connected (no linkages) and provided with a manual declutch for manual positioning.

(Select one or more of the following descriptions required)

Actuators shall have 300 lb-in. torque.

Actuators shall have 177 lb-in. torque with adjustable stroke, 30 to 90 degrees.

Actuators shall have 177 lb-in. torque with adjustable stroke, 30 to 90 degrees, and shall auxiliary end switches to annunciate full open and full closed positions.

W. Spring Return Direct Coupled Actuators. Actuators shall have torque ratings of 44lb-in., 88 lb-in., or 175 lb-in. Actuators shall be modulating 90 seconds nominal timing or two-position 45 seconds nominal timing types with strokes for 90 degree rotation applications and designed for operation between -40 and 140 F.

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

    a. Honeywell
    b. Johnson Controls
    c. Siemens Building Technologies
    d. TAC

2. Each torque rating group shall have optionally selected control types, floating control, 2-position 24 Vac, 2-position line voltage, or analog input which is switch selectable as 0-10Vdc, 10-0 Vdc, 2-10 Vdc, or 10-2 Vdc.
3. Actuator spring return direction (open or closed) shall be easily reversed in the field, and actuators shall spring return in no greater than 20 seconds.
4. Actuators shall be direct connected (no linkages), and shall have integral position indication.
5. Actuators shall have NEMA 2 environmental protection rating, and UL approved and plenum rated per UL873.
6. Minimum design life of modulating actuators shall be for 1,500,000 repositions and 60,000 spring returns, except 2-position actuators shall be for 50,000 spring returns.
7. Each actuator shall be provided with a manual power-off positioning lever for manual positioning during power loss or system malfunctions, including a gear-train lock to prevent spring action.
8. Upon power restoration after gear lock, normal operation shall automatically recur.

X. Fast Acting Two Position Fire & Smoke Actuators. Fire/smoke damper actuators shall be direct connected (no linkages) two-position spring return types with stroke for 90 degree nominal rotation applications and designed for 60,000 full stroke cycles and normal operation between 0 and 130 F.

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

    a. Honeywell
    b. Siemens Building Technologies

2. Actuators control shall be compatible with SPST control switch and with torque ratings of 30 lb-in.
3. Actuator timing shall be 25 seconds maximum in powered instances and shall spring-return in 15 seconds.

4. Actuators shall be UL listed with UL873 plenum rating with die-cast aluminum housing with integral junction box and conduit knockouts, and designed to operate reliably in smoke control systems requiring UL555S ratings up to 350F.
5. The actuator shall be designed to operate for 30 minutes during a one-time excursion to 350F.
6. Actuator shall require no special cycling during long-term holding, and shall "hold" with no audible noise at a power consumption of approximately half of the driving power.
7. Actuators shall be 24 volt or 120 volt with models for clockwise (add a B suffix) and counter-clockwise (add an A suffix) spring return.

Y. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Control panels shall meet all requirements of Title 24, California Administrative Code. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels. A complete set of 'as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All work described in this section shall be performed by system integrators or contractors that have a successful history in the design and installation of integrated control systems. The installing office shall have a minimum of five years of integration experience and shall provide documentation in the submittal package verifying the company's experience.

B. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

C. Drawings of the BACS network are diagrammatic only and any apparatus not shown, but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.

D. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by this contractor in accordance with these specifications.

E. Equipment furnished by the HVAC Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by this contractor.

3.2 WIRING

A. All electrical control wiring and power wiring to the control panels, NAC, computers and network components shall be the responsibility of the this contractor.

B. The electrical contractor (Div. 26) shall furnish all power wiring to electrical starters and motors.

C. All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. All BACS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 26) unless otherwise allowed by the National Electrical Code or applicable local codes. Where BACS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 WIRING CRITERIA

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

B. 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.

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

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

E. Do not bury aluminum-sheathed cable or aluminum conduit in concrete.

F. 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.

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

H. 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.

I. 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.

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

K. 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.

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

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

3.4 COMPONENT IDENTIFICATION LABELING

A. Using an electronic hand-held label maker with white tape and bold black block lettering, provide an identification label on the exterior of each new control panel, control device, actuator, and sensor. Also provide labels on the exterior of each new control actuator indicating the (full) open and (full) closed positions. For labels located outdoors, use exterior grade label tape, and provide labels on both the inside and outside of the panel door or device cover. Acceptable alternatives are white plastic labels with engraved bold black block lettering permanently attached to the control panel, control device, actuator, and sensor. Have the labels and wording approved by the BAS Owner prior to installation

3.5 WARRANTY

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this contractor at no expense to the Owner.

3.6 WARRANTY ACCESS

A. The Owner shall grant to this contractor, reasonable access to the TCS and FMCS during the warranty period.

B. The owner shall allow the contractor to access the BACS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.7 ACCEPTANCE TESTING

A. Upon completion of the installation, this contractor shall load all system software and start-up the system. This contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

B. This contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

D. System Acceptance: Satisfactory completion is when this contractor and the Division 26 contractor have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner’s Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.8 OPERATOR INSTRUCTION, TRAINING

A. During system commissioning and at such time acceptable performance of the BACS hardware and software has been established this contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. This contractor shall provide 24 hours of instruction to the owner's designated personnel on the operation of the BACS and describe its intended use with respect to the programmed functions specified. Operator orientation of the systems shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

C. The training shall be in three sessions as follows:

1. Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.
2. First Follow-Up Training: Two days (8 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
3. Warranty Follow Up: Two days (8 hours total) in no less than 4 hour increments, to be scheduled at the request of the owner during the one year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    1) Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    2) Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    3) Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 230900

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SECTION 230901 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.2 SUMMARY

A. This Section includes solid-state, PWM, VFDs for speed control of three-phase, squirrel-cage induction motors.

B. Related Sections include the following:

1. Division 23 Section “Common Work Results for Mechanical”
2. Division 26

1.3 SUBMITTALS

A. Product Data: For each type of VFD. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFD.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Nameplate legends.
c. Short-circuit current rating of integrated unit.
d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

C. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for VFDs and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

E. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Comply with NFPA 70. 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 DELIVERY, STORAGE, AND HANDLING

A. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.6 COORDINATION

A. Coordinate power wiring to VFD with Division 26.

B. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

C. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Honeywell NXS
2. Eaton Corporation; Cutler-Hammer Products HVX9000
3. ABB ACH550
4. Danfoss VLT
5. GE AF-300 P11
6. Allen-Bradley PowerFlex
7. Square D E-Flex
8. Toshiba FS1
9. Yaskawa E7 Series
10. Siemens

2.2 VARIABLE FREQUENCY DRIVES

A. The VFDs shall be rated for voltage as scheduled. The VFD shall provide microprocessor based control for three-phase induction motors. The controller's full load output current rating shall be based on Variable Torque application at 40° C ambient and 1-16 kHz switching frequency below 50 HP and 1-10 kHz 50 HP and above to reduce motor noise and avoid increased motor losses.

B. The VFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source VFD are not accepted. Insulated Gate Bipolar Transistors (IGBT's) shall be used in the inverter section. Bipolar Junction Transistors, GTO's or SCR's are not accepted. The VFD shall run at the above listed switching frequencies.

C. The VFD shall have an efficiency at full load and speed that exceeds 95% for VFD below 15 HP and 97% for drives 15 HP and above. The efficiency shall exceed 90% at 50% speed and load.

D. The VFD shall maintain a minimum line side displacement power factor of 0.96, regardless of speed and load. The VFD shall have a one (1) minute overload current rating of 110% for variable torque applications.

E. The VFD shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.

F. The VFD shall have an integral EMI/RFI filter as standard.

G. The VFD shall limit harmonic distortion reflected onto the utility system to voltage and current levels as defined by IEEE 519-1992 for general systems applications, by utilizing the standard 3% nominal impedance integral AC three-phase line reactor. DC link chokes are not accepted.

H. Any harmonic calculations shall be done based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, as noted on the drawings, and the total system load. The calculations shall be made with the point of common coupling (PCC) being the point where the utility feeds multiple customers.

I. Total harmonic distortion shall be calculated under worst case conditions in accordance with the procedure outlined in IEEE 519-1992. Copies of these calculations are to be made available upon request. The contractor shall provide any needed information to the VFD supplier three (3) weeks prior to requiring harmonic calculations.

J. The system containing the VFD shall comply with the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-1992. If the system cannot meet the harmonic levels with the VFD provided with the standard input line reactor or optional input isolation transformer, the VFD manufacturer shall supply an eighteen pulse, multiple bridge rectifier, AC to DC conversion section with phase shifting transformer for all drives above 75 HP. This eighteen pulse rectifier converter shall result in a multiple pulse current waveform that will more nearly approximate a true sine wave to reduce voltage harmonic content on the utility line. The phase shifting transformer shall be of a single winding type to optimize its KVA rating and harmonic cancellation capability. Harmonic filters are not accepted above 75 HP.

K. The VFD shall be able to start into a spinning motor. The VFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.

L. Standard operating conditions shall be:

1. Incoming Power: Three-phase, VAC as scheduled (+10% to -15%) and 50/60 Hz (+/-5 Hz) power to a fixed potential DC bus level.
2. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
3. Speed regulation of +/- 0.5% of base speed.
4. Load inertia dependant carryover (ride-through) during utility loss.
5. Insensitive to input line rotation.
6. Humidity: 0 to 95% (non-condensing and non-corrosive).
7. Altitude: 0 to 3,300 feet (1000 meters) above sea level.
8. Ambient Temperature: -10 to 40 °C (VT).
9. Storage Temperature: -40 to 70 °C.

M. Control Functions

1. Frequently accessed VFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the VFD. The VFD shall have a 3 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not accepted, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.
2. The keypad shall include a Hand-Off-Auto membrane selection and an Inverter/Bypass membrane selection. When in “Hand” the VFD will be started and the speed will be controlled from the up/down arrows. When in “Off”, the VFD will be stopped. In “Auto”, the VFD will start via an external contact closure or a communication network and the VFD speed will be controlled via an external speed reference.
3. The keypad shall have copy / paste capability.
4. Upon initial power up of the VFD, the keypad shall display a start up guide that will sequence all the necessary parameter adjustments for general start up.
5. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer’s RS-232 port and Windows™ based software. In addition the software shall permit control and monitoring via the VFD’ RS232 port. The manufacturer shall supply a diskette with the required software. An easily understood instruction manual and software help screens

shall also be provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this section through Section 18.

6. The operator shall be able to scroll through the keypad menu to choose between the following:

    a. Parameter Menu
    b. Keypad Control
    c. System Menu
    d. Expander Boards
    e. Monitoring Menu
    f. Operate Menu

7. The following setups and adjustments, at a minimum, are to be available:

    a. Start command from keypad, remote or communications port
    b. Speed command from keypad, remote or communications port
    c. Motor direction selection
    d. Maximum and minimum speed limits
    e. Acceleration and deceleration times, two settable ranges
    f. Critical (skip) frequency avoidance
    g. Torque limit
    h. Multiple attempt restart function
    i. Multiple preset speeds adjustment
    j. Catch a spinning motor start or normal start selection
    k. Programmable analog output

N. The VFD shall have the following system interfaces:

1. Inputs – A minimum of six (6) programmable digital inputs, two (2) analog inputs and serial communications interface shall be provided with the following available as a minimum:

    a. Remote manual/auto
    b. Remote start/stop
    c. Remote forward/reverse
    d. Remote preset speeds
    e. Remote external trip
    f. Remote fault reset
    g. Process control speed reference interface, 4-20mA DC
    h. Potentiometer or process control speed reference interface, 0 -10VDC
    i. RS-232 programming and operation interface port

2. Outputs – A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following available at minimum.

    a. Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available at minimum:

        1) Fault
        2) Run
        3) Ready
        4) Reversing
        5) Jogging
        6) At speed
        7) In torque limit
        8) Motor rotation direction opposite of commanded

9) Over-temperature

b. Programmable open collector output with available 24 Vdc power supply and selectable with the following available at minimum:

1) Fault
2) Run
3) Ready
4) Reversing
5) Jogging
6) At speed
7) In torque limit
8) Motor rotation direction opposite of commanded
9) Overtemperature

c. Programmable analog output signal, selectable with the following available at minimum:

1) Output frequency
2) Frequency reference
3) Motor speed
4) Output current
5) Motor torque
6) Motor power
7) Motor voltage
8) DC link voltage
9) PID controller reference value
10) PID controller actual value 1
11) PID controller actual value 2
12) PID controller error value
13) PID controller output

3. Capability of two additional expandable I/O interface cards. Upon installation, software shall automatically identify the interface card and activate the appropriate parameters. This should be done without adding any new software.

O. Monitoring and Displays

1. The VFD display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators:

a. Run
b. Forward
c. Reverse
d. Stop
e. Ready
f. Alarm
g. Fault
h. Input/Output (I/O) Terminal
i. Keypad
j. Bus/communication
k. Hand
l. Auto
m. Off

2. The VFD keypad shall be capable of displaying the following monitoring functions at a minimum:

a. Motor Speed (RPM and %)
b. Frequency reference
c. Output frequency
d. Motor current
e. Motor torque
f. Motor power
g. Motor voltage
h. DC-link voltage
i. Heat sink temperature
j. Motor run time (resettable)
k. Total operating days counter
l. Operating hours (resettable)
m. Total megawatt hours
n. Megawatt hours (resettable)
o. Voltage level of analog input
p. Current level of analog input
q. Digital inputs status
r. Digital and relay outputs status
s. Motor temperature rise
t. PID references

P. Protective Functions

1. The VFD shall include the following protective features at minimum:

a. Over-current
b. Over-voltage
c. System fault
d. Under-voltage
e. Input line supervision
f. Output phase supervision
g. Under-temperature
h. Over-temperature
i. Motor stalled
j. Motor over temperature
k. Motor under-load
l. Logic voltage failure
m. Microprocessor failure
n. Brake chopper supervision
o. DC Injection braking

2. The VFD shall provide ground fault protection during power-up, starting, and running. VFD with no ground fault protection during running are not accepted.

Q. Diagnostic Features

1. Active Faults
2. The last 10 faults shall be recorded and stored in sequential order
3. Fault code and description of fault shall be displayed on the keypad.
4. Fault or alarm LED shall blink
5. Display drive data at time of fault
6. In the event several faults occur simultaneously, the sequence of active faults shall be viewable.
7. During a fault, the drive must be able to identify the following:

a. Drive Speed

b. Running hours
c. Running Days
d. Amps during fault
e. Motor Power
f. Motor Torque
g. DC bus Voltage
h. Drive Temperature

8. Fault History

a. The last 30 faults shall be recorded and stored in sequential order.
b. Display drive data at time of fault

R. Additional features included in the VFD:

1. The following indicating lights shall be provided on the keypad.

a. Drive Ready
b. Drive Run
c. Drive Fault

2. The current withstand rating of the drive shall be 100,000 AIC. The rating of the complete drive assembly shall be UL tested and listed at 65kAIC.
3. Communication card for interface with BACnet control system.
4. The VFD shall have a cooling fan that is field replaceable using non-screw accessibility.

S. Enclosure

1. The VFD shall be designed in a NEMA Type 12-drip tight enclosure. Packaging of the drive shall be designed and manufactured by the manufacturer of the drive for quality assurance.
2. The VFD shall have complete front accessibility with easily removable assemblies.
3. Cable entry shall be bottom entry.

T. Disconnect Switch: allows a convenient means of disconnecting the drive from the line; operating mechanism can be padlocked in the OFF position; factory-mounted in the enclosure.

U. Three contactor bypass includes an additional contactor to isolate the drive from line power for servicing while the bypass is operating. This bypass shall include a drive input disconnect, an VFD input isolation contactor, bypass contactor and an VFD output contactor that is electrically and mechanically interlocked with the bypass contactor. This circuit shall include control logic, status lights and motor overcurrent relays. The complete bypass system [Inverter-Off-Bypass] [Hand-Off-Auto with Inverter-Bypass] selector switch(s), and Inverter/Bypass pilot lights shall be packaged with the VFD. The unit may be set up for [manual] [automatic] bypass operation upon an VFD trip.

V. The VFD manufacturer shall maintain, as part of a national network, engineering service facilities within 250 miles of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

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

3.2 APPLICATIONS

A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Anchor each VFD assembly to steel-channel sills or unitstrut arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Comply with mounting and anchoring requirements specified in Division 26.

C. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26.

3.4 IDENTIFICATION

A. Identify VFDs, components, and control wiring according with labeling that indicates the controlled device.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices according to Division 26.

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

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

3.7 FIELD QUALITY CONTROL

A. Provide the services of a qualified manufacturer's employed Field Service Engineer or authorized service representative to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD's on the job site. Sales representatives will not be accepted to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependant adjustments, and verification of proper VFD operation.

B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative.

1. Inspection and final adjustments.
2. Operational and functional checks of VFDs and spare parts.
3. The contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the VFD in accordance with those instructions.

C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.8 ADJUSTING

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

3.9 DEMONSTRATION

A. The Contractor shall provide a training session for one normal workday with a maximum of one trip. Training and instruction time shall be in addition to that required for start-up service. The training shall be conducted by the manufacturer's qualified representative. The training program shall consist of the following:

1. Instructions on the proper operation of the equipment.
2. Instructions on the proper maintenance of the equipment.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 230901

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SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for Mechanical"
2. Division 23 Controls Section for control equipment and devices and submittal requirements.
3. Division 23 Boiler Section for control interface
4. Division 23 Air Handler Section for control interface
5. Division 23 RTU Section
6. Division 23 Gas Fired Makeup Air Unit Section
7. Division 23 Energy Recovery Ventilator Schedule
8. Division 23 Section "Testing, Adjusting, and Balancing"
9. 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.

1. Provide automatic control for system operation as described herein, although word "automatic" or "automatically", is not used.
2. Manual operation is limited only where specifically described; however, provide manual override for each automatic operation.
3. Where manual start-up is called for, also provide scheduled automatic start-stop capabilities.

B. The system is DDC 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 DDC 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

E. Provide Sequenced starting of all motors, whether or not specifically mentioned in each Sequence of Operation:

1. At initial start-up
2. For automatic starting on emergency power after power blackout

F. All setpoints shall be monitored and adjustable. Setpoints listed herein are approximate. It is the responsibility of the DDC contractor to calibrate the system and all setpoints to actual working conditions once the system is on line.

G. Variable Frequency Drives:

1. Damper control typically consists of a requirement to open a damper (such as an outdoor air damper, smoke damper, isolation damper, etc.) before the motor is to operate in any mode (drive or bypass). This means that a "start" or "run" command can come from the BAS, an operator at the VFD provides a local "start" command at the VFD keypad, or the command can come from the serial communication connection.
2. After a run command is received, but before the VFD actually runs the motor, the VFD shall close a relay contact to actuate the damper. When the damper is fully open, an end switch from the damper will close and then the VFD will be allowed to operate the motor. The damper end-switches shall be mounted such that they can be adjusted during start-up so the open indication is only provided when the damper is in the fully open position.
3. Ensure that the VFD has an input that when activated, will stop the motor in any VFD operating mode as well as bypass.

H. Where dampers operate in conjunction with fan operation, the damper open signal shall precede the fan start signal by 10-23 seconds. The damper close signal shall be delayed 10-23 seconds after the fan stop signal.

I. Normal positions for controlled devices:

1. Unless noted, the following valves and dampers shall fail closed:

a. Outside air dampers
b. Relief air dampers
c. Exhaust air closure dampers
d. Domestic hot water heat source.

2. Unless noted, the following valves and dampers shall fail open:

a. Heating coils.

1.3 BUILDING DISTRIBUTION PUMPS

A. Secondary pumping distribution:

1. Pumps shall be enabled based on the programmed schedule.
2. Locate a differential pressure sensor at the most hydraulically remote location. Pump flow will modulate as terminal unit two-way valves open and close. The pump VFD shall modulate as required to maintain pressure setpoint.
3. Pump operates continuously thru integral VFD.
4. Provide automatic lead-lag pump control. If lead pump fails, backup pump shall start and a lead-pump failure alarm shall be initiated.
5. Lead pump shall rotate weekly to equalize run time.
6. The DDC system shall use status wired to each VFD to confirm the pumps are in the desired state (i.e. on or off) and generates an alarm if status deviates from DDC start/stop control.

B. Display the following thru BAS:

1. Differential Pressure
2. Secondary loop pumps status/failure (Print out Alarm)
3. VFD fault
4. VFD Hz.

1.4 HEATING-WATER SUPPLY TEMPERATURE-CONTROL SEQUENCES

A. Refer to Building Distribution Pumps paragraph.

B. Reset Schedule: The BAS system shall accept a signal from a sun-shielded outside air temperature sensing element and transmitter. Control secondary heating loop water supply temperature in straight-line relationship for the following conditions: 140° F (adj) heating water when outside temperature is 0°F; 100°F heating water when outside temperature is 60°F (adj).

C. Primary/Secondary Boiler Plant

1. Boiler plant shall be enabled between October and May at anytime the OA temperature drops to 60F (adj) for more than 30 minutes and a zone is calling for heat. Dedicated DHW generation boiler operates anytime the DHW generator calls for heat.
2. The BAS shall include a software ON-OFF-AUTO function.
3. Each boiler shall run subject to its own internal safeties and controls and control its own factory provided injection pump.
4. System is based on a “primary-secondary pumping scheme. A temperature sensor placed in the common header shall stage boilers as required to maintain loop temperature.
5. Anytime the boiler plant is enabled, the lead boiler primary pump shall start and as flow is proven, the boiler shall fire under its factory controls to maintain reset water setpoint. If the lead boiler status does not change to 'on', or if flow is not proven within 5 minutes, the lag boiler shall be enabled.
6. The boiler flame failures shall be monitored and alarmed.
7. The boiler staging order shall be user definable. The designated lead boiler (user definable) shall rotate weekly.
8. On failure of any boiler, the failed boiler shall be "removed" from operation and the next available piece of equipment as defined by the user shall be staged on in its place.
9. Dedicated DHW heating boiler shall ramp up output temperature to 180F on priority via boiler controls for DHW generation.

D. Domestic hot water generation pump: Domestic water heating pump pull in parallel with the dedicated boiler heating pump. This pump shall cycle as required by the DHW system aquastat, delivering 180-F boiler water to heat the domestic water.

1. Pump operates continuously.
2. Prove pump operation by current switch.
3. Stop pump if domestic supply from hot water tank sensor rises to 142ºF (adj). Manual reset is required to start pump.

E. BAS: Display the following data:

1. Outside temperature.
2. Reset water temperature
3. Heating-water supply temperature.
4. Heating water return temperature
5. Heating-water supply temperature set point.
6. Boiler status for each boiler.
7. Operating status of primary circulating pumps.
8. Domestic hot water generation pump status/failure (Print out alarm)

1.5 PACKAGED ROOFTOP AC UNITS

A. RTU's are supplied with factory-packaged controls. Provide all necessary monitoring points and additional control points to perform the following sequences defined for each unit.

B. Ensure that all coil controls have common inputs and do not overlap in function. Provide a deadband between heating and cooling stages.

C. Occupied mode:

1. Occupied mode shall be determined by a user defined occupancy schedule.
2. With the H-O-A starter in the automatic position, system starts supply fan to run continuously. During occupied mode, the outside air damper shall open to its minimum positions.
3. Morning warm up shall be based on "optimal start" control based on building temperature and lag time to reach each zone's setpoint. During warm up the OA and EA dampers are 100% closed, RA damper is 100% open, and gas heat is staged on (Units with VAV terminals shall have reheat coil control valves at 100% open). After each zone has reached setpoint, air system shall revert to normal occupied mode.
4. Gas Heating Stages: The packaged RTU controls shall operate the gas heating stages.
5. Cooling Mode: Packaged RTU controls shall operate the mechanical cooling stages.
6. Rest Supply Air Temperature: During occupied mode, the setpoint is reset from T-min (53°F) when the outdoor air temperature is 70°F and above, proportionally up to T-max when the outdoor air temperature is 65°F and below. T-max shall be reset using trim and respond logic within the range 55°F to 65°F. When fan is off, lock T-max at the maximum value (65ºF). While fan is proven on, every 2 minutes, increase the setpoint by 0.2ºF if there are no zone cooling requests. If there are more than two (adjustable) cooling requests, decrease the setpoint by 0.3ºF. A cooling request is generated when the cooling loop of any zone served by the system is >99%. All values adjustable from fan graphic.
7. Economizer cooling (RTU-1 and RTU-2): Packaged RTU economizer controls.

    a. Power exhaust fan shall be activated by the packaged RTU controls.

8. Outside Air Control for RTU-3/ERU-1 System:

a. When in the occupied mode, the ERU shall energize and provide minimum outside air to the space. OA damper is closed at RTU, RA damper 100% open, power vent is off, ERU fan speed at 20%-minimum.
b. As CO2 levels rise in the spaces (provide one sensor in each of the Meeting Room Spaces), The supply and exhaust fan speeds at the ERU modulate from 20% to 100% to maintain CO2 at setpoint.

1) All zones shall be polled and the highest CO2 sensor reading shall be sent to the AHU OA damper controller. This CO2 reading shall be compared to the CO2 setpoint at the AHU damper controller. If no zones are calling for max airflow from their VAV box and the reading is below the CO2 set point, the AHU OA damper shall be closed (ERU shall continue to run to provide a base minimum).
2) If any VAV box is at maximum airflow and requires more ventilation air and the CO2 reading is above the set-point for more than 5 minutes, the AHU OA damper controller shall modulate the OA dampers open (from zero to peak OA as scheduled) utilizing a PI loop to reduce the CO2 level in the space. Once the space CO2 level drops below the AHU CO2 set point, the OA dampers shall modulate toward set base ventilation rate.

9. Economizer cooling (RTU-3/ERU-1):

a. Air economizer system shall be capable of modulating OA and RA to provide up to 100% of the design SA quantity as OA for cooling.
b. During economizer mode the ERU supply fan shall be OFF (power vent fan shall energize). RTU-3 OA and RA dampers shall modulate to increase OA to provide economizer cooling through the package RTU controls.

D. Unoccupied mode:

1. OA, and EA dampers 100% closed, RA damper 100% open.
2. Associated exhaust fans and ERU do not operate.
3. Supply fan cycles and each zone terminal unit will modulate heating output to maintain night set back temperature at 62°F (adj). Note: due to the building's heavy construction the temperature will drop slowly at night ("thermal flywheel"). If is likely that minimal night setback heating will be required.
4. Systems shall have 2 hour (adj) unoccupied override ability. Associated exhaust fans shall also operate in override mode.

E. Variable Air Volume Control

1. Supply air fan shall modulate via a variable frequency drive to maintain supply duct static pressure at setpoint.
2. The static pressure sensor shall be located in the main supply duct approximately 2/3 of the way to the farthest supply point.
3. If the controller does not receive a valid duct static-pressure value, it shall generates a diagnostic and shut down the unit.

F. Safeties:

1. The supply fan and all BAS Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit. BAS Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.
2. Shall stop the supply fan; cause the system valves and dampers to return to their normal positions.

3. A capillary freezestat shall initiate a low temperature alarm if the temperature drops below the freezestat's setpoint. Return to the normal mode of operation shall require manual reset at the freezestat. The BAS system shall monitor the freezestat through auxiliary contacts and shall indicate an alarm condition when the freezestat trips.
4. Duct smoke detectors: detector wired to the fire alarm system by the Electrical Contractor. Activated when products of combustion are detected in air stream.

G. Display of input points thru BAS:

1. System graphic
2. System occupied/unoccupied mode.
3. Coldest and warmest zones (all zones sampled)
4. Fan status/failure: contact from RTU.
5. Filter status: contact from RTU
6. Discharge air temperature: analog output from RTU.
7. OA commanded damper position.
8. Coil low temperature thermostat
9. Supply-fan-discharge static-pressure indication and setpoint.
10. ERU status/failure

1.6 AIR HANDLING UNIT SYSTEMS

A. AHUs shall have all temperature controls furnished and installed by the Temperature Controls Contractor.

B. Coordination of Air-Handling Unit Sequences: Ensure that all coil controls have common inputs and do not overlap in function. Provide a deadband between heating and cooling stages.

C. Provided an optimal start sequence: This sequence shall use the BAS to determine the length of time required to bring each zone from night setback temperature to the occupied setpoint temperature. The system shall wait as long as possible before starting, so that the temperature in each zone reaches occupied setpoint just in time for occupancy. This optimal starting time shall be determined using the difference between actual zone temperature and occupied setpoint. The BAS shall compare the difference with the historical performance of how quickly the zone has been able to warm up or cool down.

D. Provide an optimal stop sequence: At the end of the occupied period, the system is shut off and the temperature is allowed to drift away from occupied setpoint. Optimal stop shall use the BAS to determine how early heating and cooling can be shut off for each zone, so that the indoor temperature drifts 1F from occupied setpoint for the last hour of the day.

E. Occupied mode:

1. Occupied mode shall be determined by:

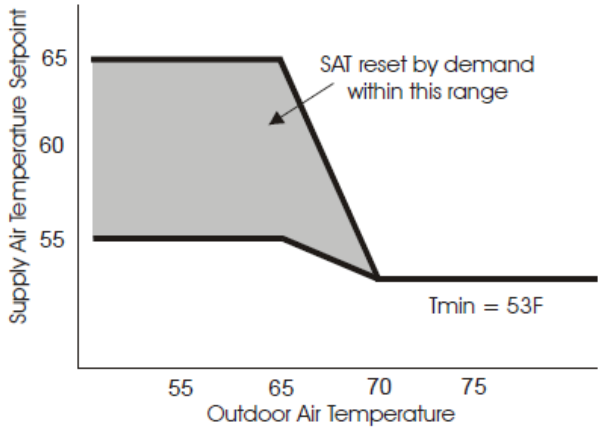
   a. User defined occupancy schedule.
   b. Local space temperature sensor with override button that will index the unit to the occupied mode for up to 2 hours.
   c. The air handling unit shall be scheduled to run 24/7.

2. With the H-O-A starter in the automatic position, system starts supply fan and associated exhaust fan to run continuously.
3. Morning warm up shall be based on “optimal start” control based on building temperature and lag time to reach each zone’s setpoint. During warm up the OA and EA dampers are 100% closed,

RA damper is 100% open, and heating coil control valve is 100% open (Units with VAV terminals shall have reheat coil control valves at 100% open). After each zone has reached setpoint, air system OA, RA and EA dampers go to set minimum positions, heating coil control valve modulates to maintain DA or Space setpoint (units with VAV terminals shall have control valves modulate as required to maintain space setpoints).

4. Heating mode: Air handler 2-way control valve modulates to maintain DA setpoint (reset ability based on OA) or space setpoint as required for each specific system.
5. Cooling Mode:

   a. System resets supply-air temperature set point from higher, subject to warmest space temperature sensor reading. Reset by zone cooling demand during cool weather (<55ºF to 60ºF), then ramp down to design SAT in warm weather (>60ºF to 70ºF)
   b. During occupied periods, when fan is running, system shall use a PID algorithm to control cooling to maintain discharge-air temperature.
   c. Supply air temperature reset control: During occupied mode, the setpoint is reset from T-min (53°F) when the outdoor air temperature is 70°F and above, proportionally up to T-max when the outdoor air temperature is 65°F and below. T-max shall be reset using trim and respond logic within the range 55°F to 65°F. When fan is off, lock T-max at the maximum value (65ºF). While fan is proven on, every 2 minutes, increase the setpoint by 0.2ºF if there are no zone cooling requests. If there are more than two (adjustable) cooling requests, decrease the setpoint by 0.3ºF. A cooling request is generated when the cooling loop of any zone served by the system is >99%. All values adjustable from fan graphic.



   d. DX Cooling Coil: System stages the DX system to maintain supply-air temperature.
      1) A suction line temperature sensor on the evaporator near the TXV bulb location shall be used to determine if the coil is getting close to a freezing condition. Mechanical cooling capacity shall be shed as necessary to prevent icing. The supply fans shall not shut off and will de-ice the coil.
      2) Timers shall prevent the compressors from rapid cycling.
      3) When the outside air temperature is 50°F or cooler, the mechanical cooling shall be disabled.
6. Variable Air Volume Control
   a. Supply air static pressure control shall be provided by a proportional integral derivative (PID) algorithm that modulates the VFD to maintain a duct static pressure set point.
   b. Fan-pressure optimization: Static pressure setpoint shall be reset using trim and respond logic within the range 0.2 inches to 1.5 inches for VAV AHUs. When fan is off, lock setpoint at the minimum value (0.2 inches). While fan is proven on, every 2 minutes, decrease the setpoint by 0.04 inches if there are no pressure requests. If there are more than two (adjustable) pressure requests, increase the setpoint by 0.04. Where VAV zone damper position is known, a pressure request is generated when any VAV damper served by the system is wide open. Where VAV zone damper position is unknown, a pressure request is

made when the ratio of the zone's actual supply airflow to supply airflow setpoint is less than 90%. All values adjustable from fan graphic. The control logic shall be slow-acting to avoid hunting.

c. If the controller does not receive a valid duct static-pressure value, it shall generates a diagnostic and shut down the unit.
d. Static-pressure controller located in fan discharge stops fan and signals alarm when static pressure rises above excessive-static-pressure set point.
e. Set variable-speed drive to minimum speed when fan is stopped.
f. The algorithm shall provide soft start of the fan by ensuring the VFDs are at minimum speed before energizing the fan.

7. Minimum Outside Air Control for VAV Systems (select strategy):

a. Air flow measuring: When in the occupied mode, the controller shall measure the outside airflow and modulate the outside air dampers to maintain the proper minimum outside air ventilation, overriding normal damper control. On dropping outside airflow, the controller shall modulate the outside air dampers open to maintain the outside airflow setpoint (adj.).

b. Exhaust Fan Control for VAV Systems

1) During minimum ventilation cycles and when the outdoor air damper is closed, the exhaust fan shall be turned off and the exhaust damper closed.
2) The exhaust fan VFD speed shall not drop below 20% (adj.).
3) The mixed air controller opens the outdoor air and exhaust dampers and closes the return damper, causing the exhaust fan to eliminate excessive pressure.
4) Static pressure: Exhaust fan loading shall be controlled from space static pressure. Each AHU system shall monitor the differential pressure between the space served and the adjacent Service bays and shall modulate fan speed to maintain positive pressure at the area served (.08” wc, adj.)

8. Economizer cooling:

a. Air economizer system shall be capable of modulating OA and RA to provide up to 100% of the design SA quantity as OA for cooling.
b. To save energy, economizer dampers shall be capable of being sequenced with the mechanical cooling equipment. To ensure proper sequencing, mixed air (MA) temperature shall not control the economizer. Instead, the dampers must be controlled by the same controller used to control the mechanical cooling (SA temperature)
c. High Limit Shutoff: Economizers shall be capable of automatically reducing OA intake to the minimum OA quantity when OA intake will no longer reduce cooling energy usage. Provide the following High Limit Control Settings and Type:
1) Differential Enthalpy: Setting: OA enthalpy exceeds RA enthalpy; two enthalpy sensors shall be provided to compare total heat content of the indoor air and outdoor air to determine the most efficient air source when economizing. Differential enthalpy-based economizer change-over cycles require at least one enthalpy switch or sensor in the OA stream for the building or system and another switch or sensor in each air handling system’s return air. The control strategy is arranged to change over from economizer mode to non-economizer mode if the actual measured enthalpy of its RA is less than the current OA enthalpy.

F. Unoccupied mode:

1. OA, and EA dampers 100% closed, RA damper 100% open.
2. Associated relief fan shall be OFF.
3. Associated exhaust fans do not operate.

4. Supply fan cycles and each zone terminal unit will modulate heating output to maintain night set back temperature at 62°F (adj). AHUs without terminal units or duct coils cycle supply fan to maintain space setpoint. (AHUs with ERUs shall not cycle supply fan because most served zones have fintube and cabinet unit heaters.)
5. Systems shall have 2 hour (adj) unoccupied override ability. Associated exhaust fans shall also operate in override mode.

G. Safeties:

1. The supply fan and all BAS Hardware control loops shall be subject to Proofs and Safeties. Safeties shall be direct-hardwire interlocked to the fan starter circuit. BAS Hardware shall monitor all proofs and safeties and failure of any proof or activation of any safety shall result in all control loops being disabled and the AHU fan being commanded off until reset.
2. Shall stop the supply fan; cause the system valves and dampers to return to their normal positions.
3. BAS Hardware reset of all proofs and safeties shall be via a local binary push-button input to the BAS Hardware.
4. A capillary freezestat shall initiate a low temperature alarm if the temperature drops below the freezestat's setpoint. Return to the normal mode of operation shall require manual reset at the freezestat. The BAS shall monitor the freezestat through auxiliary contacts and shall generate an alarm condition when the freezestat trips.
5. Duct smoke detectors shall be installed in supply **[return]** airstream and as indicated on the plans. Installation in ductwork and connection to control system shall be under Division 23. Detector furnished and wired to the fire alarm system by Division 26. Activated when products of combustion are detected in air stream. Smoke detector signals alarm, stops supply fan when products of combustion are detected in airstream. Restarting the supply fan shall require manual reset at the smoke detector.
6. DA high temperature limit is 105°F (adj) and low temperature limit is 50°F (adj).

H. A status signal is wired to the supply and return fan VFDs. The BAS system uses the status to confirm the fans are in the desired state (i.e. on or off) and generates an alarm if status deviates from BAS start/stop control.

I. Display of input points thru BAS:

1. System graphic
2. System occupied/unoccupied mode.
3. Coldest and warmest zones (all zones sampled)
4. Fan status/failure (typical all fans) (Generate an Alarm)
5. Fan rpm and Hz. thru VFD (typical all fans)
6. OA-RA-EA commanded damper positions.
7. Minimum outside airflow indication & setpoint.
8. OA, DA, RA temperature indications and setpoints
9. Coil low temperature thermostat (Generate Alarms).
10. High and Low DA limit (Generate an Alarm).
11. Filter air-pressure-drop indication (Generate and alarm at setpoint).
12. Supply-fan-discharge static-pressure indication and setpoint.
13. Supply-fan rpm and Hz. thru VFD.
14. Building static-pressure indication and setpoint for each respective air system.
15. Space static-pressure indication and setpoint for each respective air system
16. Relative humidity indication & setpoint
17. Relative humidity commanded position, % output
18. Heating-coil air-temperature indication and setpoint.
19. Heating-coil pump operation indication.
20. Commanded heating-coil control-valve position.
21. Mixed-air-temperature indication & setpoint.

22. Filter air-pressure-drop indication and high pressure alarm setpoint.
23. Commanded cooling-coil control-valve position.

1.7 ENERGY RECOVERY UNITS

A. Energy Recovery Unit with heating duct coils.

1. Occupied Mode:

   a. User defined occupancy schedule.
   b. Duct heating coil operation: 2-way heating coil control valve shall modulate to maintain space (zone) setpoint 72°F (adj.).

2. Unoccupied Mode:

   a. User defined schedule.
   b. RTU shall be cycled (100% recirculation per manufacturer's controls) to maintain reduced space setpoint 60°F (adj.). Duct heating control valves shall be at 100% flow thru the coils. Dedicated heating coil pump shall operate continuously below 40°F (adj.).

3. Safety:
   a. Freezestat (by unit Manufacturer and by control contractor).
   b. Low and High DA temperature (by unit Manufacturer).

4. BAS: Display the following data:

   a. Monitoring DA temperature.
   b. Heating coil pump status.
   c. Freezestat (Generate an alarm).
   d. Monitor supply fan and exhaust fan status.
   e. Monitor system operating mode: heating, cooling, or economizing.

1.8 MAKEUP AIR UNITS WITH ASSOCIATED EXHAUST FANS

A. Sign Shop
1. MAU-1 shall operate continuously in occupied mode.
2. OA Damper 100% open.
3. In heating mode, the MAU controls modulate the gas valve to maintain discharge air temperature at setpoint.
4. EF-2 is interlocked to operate continuously with MAU-1.
5. In unoccupied mode, the MAU shall be off, along with associated exhaust fan. OA damper 100% closed.

B. Fabrication/Machine Shop
1. MAU-2 operates continuously in occupied mode.
2. In heating mode, the MAU controls modulate the gas valve to maintain discharge air temperature at setpoint.
3. OA/RA dampers open to maintain minimum scheduled outside air at 2,500 cfm.
4. EF-3 and EF-18 are interlocked with MAU-2 such that the exhaust fans operate when the MAU is energized.
5. EF-16 is manually energized via wall switch and does not impact MAU-2 system operation. Provide CT to monitor EF-16 status.

6. Existing relocated welding exhaust fan shall be manually energized via wall switch. Operation shall be interlocked with the BAS via CT sensor at the fan. Once the fan is manually energized, the OA and RA dampers at MAU-2 shall modulate to maintain negative pressure between the fabrication shop and the adjacent office suite.
7. In unoccupied mode, MAU-2 and all associated exhaust fans shall be off, OA damper 100% closed, RA damper 100% open.

C. Heavy/Light Service Bay Ventilation
1. MAU-3 operates continuously in occupied mode. OA damper 100% open.
2. In heating mode, the MAU controls modulate the gas valve to maintain discharge air temperature at setpoint.
3. EF-12 and EF-13 (general exhaust fans) shall operate continuously with MAU-3, when vehicle exhaust fans are off.
4. Vehicle exhaust fans operate via manual wall switch. Operation shall be monitored at the BAS via CT sensors.
5. Upon actuation of vehicle exhaust fan EF-4, general exhaust fan EF-13 shall be de-energized.
6. Upon actuation of vehicle exhaust fan EF-5, general exhaust fan EF-12 shall be de-energized.
7. In unoccupied mode, MAU-3 and all associated exhaust fans shall be off, OA damper 100% closed.

D. Wash Bay
1. MAU-4 operates continuously in occupied mode. OA damper 1005 open.
2. In heating mode, the MAU controls modulate the gas valve to maintain discharge air temperature at setpoint.
3. EF-8 is interlocked with MAU-4 to operate continuously in unoccupied mode.
4. In unoccupied mode, MAU-4 and all associated exhaust fans shall be off, OA damper 100% closed.

E. BAS: Display the following data:

a. Monitoring DA temperature.
b. Monitor supply fan and exhaust fan status.
c. Monitor OA/RA damper status
d. Monitor system operating mode.

1.9 TERMINAL UNITS

A. Hydronic Unit Heaters

1. Hot Water Unit Heaters : On call for heat space thermostat starts fan and opens 2-way control valve on call for heat after pipe mounted aquastat setpoint (135 F) is satisfied. When space reaches setpoint the reverse happens.

a. Occupied Mode: The unit shall maintain a heating setpoint of 70°F (adj.).
b. Unoccupied Mode (night setback): The unit shall maintain a heating setpoint of 65°F

2. Gas Fired Unit Heaters : On call for heat the space thermostat enables the unit heater to operate thru its own safety controls. When the space reaches setpoint the reverse happens.

a. Occupied Mode: The unit shall maintain a heating setpoint of 70°F (adj.).
b. Unoccupied Mode (night setback): The unit shall maintain a heating setpoint of 65°F

1.10 AIR TERMINAL UNITS

A. Each VAV box shall include maximum and minimum (cooling and heating) flow settings (CFM), Space Override, and Room Temperature Control. Each VAV unit shall have 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 to set minimum position.
2. When the central air handling unit is off, the BAS shall command the hot water valve closed.

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. Cooling:

   a. The BAS shall modulate the VAV supply air damper to maintain room temperature of 74 Deg F. (adjustable) through the VAV room sensor as well as the BAS.
   b. The supply damper shall be modulated towards the maximum position as the room temperature rises above setpoint and shall be modulated towards the minimum position as the room temperature drops below the setpoint.
   c. The VAV shall operate independent of the supply air pressure.

3. Heating:

   a. When the room temperature drops below the heating setpoint, the VAV Box shall be considered to be in the heating mode.
   b. The BAS shall modulate VAV supply air damper to maintain the heating minimum flow (CFM).
   c. When the room temperature drops below the heating setpoint, the BAS shall modulate the hot water reheat valve to maintain the heating setpoint of 70 Deg F. (adjustable) through the VAV room sensor as well as the BAS. The BAS shall start to open the hot water reheat valve when the room temperature drops below 71 Deg F.. The BAS shall modulate the hot water reheat valve to the full open position when the room temperature drops below the heating setpoint by 1 Deg F. (adjustable).

4. The BAS shall limit the maximum cooling setpoint to 78 Deg F. (adjustable) and the minimum cooling setpoint to 68 Deg F. (adjustable).
5. The BAS shall limit the maximum heating setpoint to 76 Deg F. (adjustable) and the minimum heating setpoint to 65 Deg F. (adjustable).
6. Space Override

   a. When a VAV is in the Unoccupied Mode and a button on the room sensor is pushed, the BAS shall place the VAV in the Occupied Mode until the next scheduled Occupied Mode (adjustable). The BAS shall command the appropriate central air handling unit and central plant equipment to on to provide the overridden VAV with the necessary comfort.

7. BAS shall 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 pressure
f. VAV supply box CFM
g. VAV box damper % open
h. Heating coil control-valve position as percent open.

1.11 RADIANT FLOOR HEATING

A. Radiant floor heating pumps serving the radiant manifold, shall operate continuously in occupied mode when OA temperature is below 65° F. Floor slab temperature sensor shall monitor slab temperature. Space sensor shall modulate 3- way control valves for the manifold to maintain space setpoint of 60° F (adj.).

B. Control sequence shall set an upper limit of 135 degrees F. for the supply water temperature to the slab, and shall limit the three way valve to control at the upper limit.

C. Display the following thru BAS:

1. Pump status/failure (Print out Alarm).
2. Slab temperature.
3. Space temperature.
4. HWS temperature to manifold and HWR temperature from manifold.

1.12 VENTILATION SEQUENCES

A. Exhaust fans that are interlocked with associated AHUs/RTU's occupied mode: Fans shall run continuously after MOD end switch proves opened 100% (some exhaust fans have BDD's in lieu of MOD's. (See Fan Schedule).
1. EF-2 shall be interlocked to operate continuously with RTU-1, in occupied mode.
2. EF-7 and EF-17 shall operate continuously with AHU-1, in occupied mode.
3. EF-14 shall be interlocked with AHU-2 for relief/economizer function.
4. EF-15 shall be interlocked with AHU-1 for economizer/relief function.
5. EF-11 shall operate continuously when either RTU-2 or AHU-2 is in occupied mode.
6. Refer to Specialty Sequences for all other exhaust fan operation.

B. EF-4 and EF-5 (Vehicle Capture Exhaust Fans) shall be enabled via manual wall switch. Exhaust hose shall energize fan whenever pulled down from its stored position via on/off micro switch at hose reel housing.
1. BAS shall monitor fan status via CT sensor.

2. Display the following thru BAS:
a. Each fan status/failure (Print out Alarm)

C. Manual switched fans:
1. Fan wall switch shall have GREEN indicator light when ON.
2. Wall Switch enables fan when switch ON.

a. EF-2 (MOD opens and fan starts).
b. EF-7 (Fan MOD opens and room return duct MOD closes then fan starts).
c. EF-16 (MOD opens and fan starts).
d. Existing Large Parts Washer EF.

1.13 SPECIALTY SEQUENCES

A. Elevator Machine Room Heat Relief

1. Sequence applies to the following fans:

a. EF-9

2. The fan shall be enabled after the damper status has proven.
3. The unit shall be continuously enabled to maintain a zone temperature cooling setpoint of 80°F (adj).
4. Alarms

a. High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
b. Damper Failure: Commanded open, but the status is closed.

B. Ductless Split Air Conditioning Units

1. AC operates by manufacturer-supplied controls and wall thermostat to maintain setpoint during occupied and unoccupied modes.
2. Alarm high condensate level at BAS.
3. Display the following thru BAS for the above:

a. Unit status ON/OFF.
b. Condensate level (Print out Alarm).

C. Domestic Hot Water Recirculation Pump:

1. Domestic Hot Water Recirculation Pump: Operate the pump only when the DHW temperature in the return line near the DHW heater falls below 110°F. Pump cycling shall be controlled by a return line aquastat set at 110°F with a 5°F deadband.
2. BAS shall monitor pump status.

D. Ejector Pump (EP-1)

1. Ejector Pump High Level Alarm: BAS shall receive alarm status from pump control panel and generate an alarm at high level.

E. Elevator Pump (SP-1)

1. High Level Alarm: BAS shall receive alarm status from pump control panel and generate an alarm at high level.
2. Oil minder Alarm: BAS shall receive alarm status from pump control panel and generate an alarm when oil is detected in sump.

F. Kitchen Exhaust Fan (EF-10)

1. Local hood switch starts exhaust fan and closes room return air MOD 90%.
2. When the hood fire suppression trips:
   a. Exhaust fan shall remain on.

G. Coatings Mechanical Rm 196 Heating and Ventilating:

1. Space heating shall be sequenced as follows:
   a. Space Heating: 25 HP air compressor heat generation shall be first heat stage, 100 HP air compressor heat generation shall be second stage, and hydronic unit heater shall be third stage heating during occupied hours and only source of heating during unoccupied hours.
   b. 100 HP air compressor (when operating) shall open OA MOD 100% and modulate exhaust MOD open to space to maintain space heating setpoint. If space temperature rises above setpoint do not set 25 HP air compressor in cooling mode until 100 HP air compressor modulates exhaust air MOD to 100% exhaust.

2. Space Cooling Ventilation shall be sequenced as follows.
   a. Space Cooling Ventilation: 25HP air compressor associated hi/lo combination wall louvers shall open high louver MOD 100% when space temperature reaches 85 F (adj), upon continued rise in space temperature the low MOD shall modulate open. 100 HP air compressor shall open exhaust MOD 100% to exhaust louver and open outside air MOD 100% to bypass space.

H. Emergency Ventilation Sequence & Reduced Ventilation Sequence

1. Emergency Ventilation Sequence: Exhaust Fan (EF-6) and Supply Fan (SF-1): General bay CO and NOx sensors, provided and installed under this section, shall automatically energize EF and SF fans upon detection of 3 ppm NOxand/or 25 ppm CO. The sensors shall further activate an audible alarm upon rise of NOx to 5 ppm and/or CO to 35 ppm. All associated control wiring and interlock shall be by this division. Coordinate with Division 26 for installation of combination starters to manually energize the exhaust fan and associated supply air fan. Provide time delay relays for each EF set at 15 minutes (adj) to prevent short cycling of operation by CO/NOx sensors. EFs/SFs shall be interlocked for simultaneous operation as dictated by sensors and switches serving specific area monitored. Building shall incorporate (2) separate zones for ventilation. All SF MODs shall modulate open for 10 seconds (adj) before SF shall be engergized to minimize supply air impact force on duct sock; EF MODs shall modulate open and energize EF immediately.

   a. Provide adequate quantity of sensors to detect gases for specific floor areas per approved manufacturer's recommendations.
   b. CO and NOx sensors shall be commissioned by running vehichles inside the garage. A gasoline engine vehicle shall run for a length of time requred to alarm CO ppm. A diesel engine vehicle shall run for a length of time required to alarm NO2 ppm.

2. Reduced Vetilation Sequence: A manually operated timed wall switch (1 hour adj.) located at the fabrication bay exterior wall shall energize EF-6 and SF-1 after MODs prove open. After 1 hour is timed out, EF-6 and SF-1 shall be de energized and MODs close.

3. Display the following thru BAS for the above:

   a. Fan status ON/OFF.
   b. Emergency Ventilation Mode Status.
   c. Reduced Ventilation Mode Status.
   d. MOD position.
   e. Fan VFD Hz.

I. Paint Booth Exhaust Fan Building B:

1. Manual switch located adjacent to booth man door shall enable and disable the booth manufacturer provided exhaust fan. Fan shall be interlocked with man door switch to prove man door is closed 100% before fan starts. The MUA unit shall also be interlocked with this manual EF switch to allow MUA unit operation thru its manual switch.

2. Display the following thru BAS for the above:

a. Fan status ON/OFF.

J. LP Gas Fired Paint Booth MAU-1 Building B:

1. Manual switch at paint booth (adjacent to paint booth EF switch) shall have OFF-Summer On-Winter On operation. When switch is turned to summer or winter position and the paint booth EF switch is turned on with man door closed, the MUA unit shall be enabled to operate thru its own factory provided controls and safeties; including MOD open and close. Summer mode the unit heating is locked out above (70 F adj.) and operates as an un tempered air MUA. Winter mode the unit gas heating burner modulates to maintain a discharge air temperature (80 F adj.).

2. Building pressure/space controller (provided by MUA Mfg.) shall modulate the MUA supply fan via the VFD to match pressure setpoint established after air balancing the paint booth's exhaust fan.

3. Display the following thru BAS for the above:

a. Fan status ON/OFF.
b. DA temperature.
c. Duct Smoke Detector Status.
d. Burner flame failure alarm monitoring point.

1.14 MICELLANEOUS CONTROLLED POINTS (All points shall be displayed thru the BAS.)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.

2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 230993

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SECTION 23 11 23 – FACILITY FUEL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 2 Sections.
2. Division 7 Section for materials and methods for sealing pipe penetrations through fire and smoke barriers.
3. Division 23 Section "Common Work Results for HVAC"
4. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.

1.2 SUMMARY

A. This Section includes fuel gas piping, specialties, and accessories within the building.

1.3 PROJECT CONDITIONS

A. Gas System Pressure: Coordinate with gas supplier.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Corrugated, stainless-steel tubing systems. Include associated components.
2. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Include pressure rating, capacity, and settings of selected models.
4. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

C. Maintenance Data: For natural gas specialties and accessories to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

A. All work shall be performed by technicians holding a Maine Propane and Natural Gas Technician License: “Large Equipment Connection and Service Technician”

B. Installations of propane and natural gas must also comply with all other applicable statutes or rules of the State and all applicable ordinances, orders, rules, and regulations of local municipalities.

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

D. All work shall be per the following codes. Year edition of code shall be as recognized by the authority with jurisdiction

1. NFPA 54 "National Fuel Gas Code".
2. NFPA 30, Flammable and Combustible Liquids Code
3. NFPA 211, Chimneys, Fireplaces, Vents, and Solid Fuel Appliances

E. FM Standard: Provide components listed in FM's "Fire Protection Approval Guide" if specified to be FM approved.

F. IAS Standard: Provide components listed in IAS's "Directory of A. G. A. and C. G. A Certified Appliances and Accessories" if specified to be IAS listed.

G. UL Standard: Provide components listed in UL's "Gas and Oil Equipment Directory" if specified to be UL listed.

H. American Society of Mechanical Engineers (ASME) Code CSD-1 Controls and Safety Devices for Automatically Fired Boilers, 2002 edition

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and legally dispose of liquids from drips in existing gas piping. Handle cautiously to avoid spillage and ignition. Notify fuel gas supplier. Handle flammable liquids used by Installer with proper precautions and do not leave on premises from end of one day to beginning of next day.

1.7 COORDINATION

A. Make arrangements with local utility for gas service to the Owner’s distribution system. Provide service to the building as required by the Utility Company. Coordinate all activities between the Owner and Utility Company. The installation of the gas service shall comply with the published Utility Company standards. Pay all utility company charges; include charges in the base bid.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Corrugated, Stainless-Steel Tubing Systems:

a. Omega Flex, Inc.
b. Titeflex Corp.
c. Tru-Flex Metal Hose Corp.
d. Ward Manufacturing, Inc.

2. Valves:

a. American Valve.
b. B&K Industries, Inc.
c. Brass Craft Manufacturing Co.
d. Conbraco Industries, Inc.; Apollo Div.
e. Crane Valves.
f. Grinnell Corp.
g. Honeywell, Inc.
h. Key Gas Components, Inc.
i. McDonald: A. Y. McDonald Mfg. Co.
j. Milwaukee Valve Co., Inc.
k. Nibco, Inc.
l. Mueller Co.; Mueller Gas Products Div.
m. Watts Industries, Inc.

3. Electrically Operated Gas Valves:

a. ASCO General Controls.
b. Atkomatic Valve Co., Inc.
c. Automatic Switch Co.
d. Eclipse Combustion Inc.
e. Magnatrol Valve Corp.
f. Parker Hannifin Corp.; Climate & Industrial Controls Group; Skinner Valve Div.

4. Meters:

a. American Meter Co.
b. Badger Meter, Inc.; Utility Products Div.
c. Equimeter, Inc.
d. National Meter.
e. Schlumberger Industries; Gas Div.

5. Pressure Regulators:

a. American Meter Co.
b. Equimeter, Inc.
c. Fisher Controls International, Inc.
d. Maxitrol Co.
e. National Meter.

f. Richards Industries, Inc.; Jordan Valve Div.
g. Schlumberger Industries; Gas Div.

2.2 PIPING MATERIALS

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

2.3 PIPES, TUBES, FITTINGS, AND JOINING MATERIALS

A. Steel Pipe: ASTM A 106, ANSI/ASME B36.10, ASTM A 53; Grade B; Schedule 40; black.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
3. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
4. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
5. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
6. Joint Compound and Tape: Suitable for natural gas.
7. Steel Flanges and Flanged Fittings: ASME B16.5.
8. Gasket Material: Thickness, material, and type suitable for natural gas.

B. Corrugated Stainless Steel Tubing Systems: Gastite or approved equal; a corrugated stainless steel tubing complying with ANSI LC 1b "Fuel Gas Piping Systems Using CSST" and listed with CSA®, ICBO and IAPMO. Manufacturing materials shall be: ASTM A240 type 300 corrugated stainless steel tubing with a minimum wall thickness of .010", jacketing of UV resistant polyethylene meeting the requirements of ASTM E84 for flame spread and smoke density. All mechanical tube fittings shall be SAE CA360 brass incorporating double wall flare sealing and Jacket Lock® jacket capturing for steel tubing protection.

1. Striker Plates: Steel, designed to protect tubing from penetrations.
2. Manifolds: Malleable iron or steel with protective coating. Include threaded connections according to ASME B1.20.1 for pipe inlet and corrugated tubing outlets.

C. Transition Fittings: Type, material, and end connections to match piping being joined.

D. Common Joining Materials: Refer to Division 23 Section "Common Work Results for HVAC" for joining materials not in this Section.

E. Furnish pipe and fittings with factory-applied, corrosion-resistant polyethylene coating for use in corrosive atmosphere.

2.4 PIPING SPECIALTIES

A. Flexible Connectors: ANSI Z21.24, copper alloy.

B. Quick-Disconnect Devices: ANSI Z21.41, convenience outlets and matching plug connector.

C. Pressure gages shall conform to ASME B40.100, Type I, Class 1. Pressure-gage size shall be 3-1/2-inch nominal diameter. Case shall be corrosion-resistant steel conforming to any of the AISI 300 series of

ASTM A 666, with a No. 4 standard commercial polish or better. All gages shall be equipped with adjustable red marking pointer and damper screw adjustment in inlet connection.

2.5 SPECIALTY VALVES

A. Valves, NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.

B. Valves, NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

C. Appliance Connector Valves: ANSI Z21.15 and IAS listed.

D. Gas Stops: Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.

E. Gas Valves, NPS 2 and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating. Tamperproof Feature: Include design for locking.

F. Plug Valves, NPS 2-1/2 and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating. Tamperproof Feature: Include design for locking.

G. General-Duty Valves, NPS 2-1/2 and Larger: ASME B16.38, cast-iron body, suitable for fuel gas service, with "WOG" indicated on valve body, and 125-psig pressure rating.

1. Gate Valves: MSS SP-70, OS&Y type with solid wedge.
2. Butterfly Valves: MSS SP-67, lug type with lever handle.

H. Automatic Gas Valves: ANSI Z21.21, with electrical operator for actuation by appliance automatic shutoff device.

I. Electrically Operated Gas Valves: UL 429, bronze, aluminum, or cast-iron body solenoid valve; 120-V ac, 60 Hz, Class B, continuous-duty molded coil. Include NEMA ISC 6, Type 4, coil enclosure and electrically opened and closed dual coils. Valve position shall normally be closed.

2.6 PRESSURE REGULATORS

A. Regulators may include vent limiting device, instead of vent connection to outside, if approved by authorities having jurisdiction. Provide venting as required by code.

B. Line Pressure Regulators: ANSI Z21.80 with 10-psig inlet pressure rating, unless otherwise indicated.

C. Appliance Pressure Regulators: ANSI Z21.18.

D. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

PART 3 - EXECUTION

3.1 PREPARATION

A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.

B. Comply with ANSI Z223.1, "Prevention of Accidental Ignition" Paragraph.

3.2 SERVICE ENTRANCE PIPING

A. Extend fuel gas piping and connect to fuel gas distribution for service entrance to building.

1. Exterior fuel gas distribution system piping, service pressure regulator, and service meter will be provided by gas utility.

B. Install dielectric fitting downstream from and adjacent to each service meter unless meter is supported from service-meter bar with integral dielectric fitting. Install shutoff valve downstream from and adjacent to dielectric fitting. Refer to Division 23 Section "Common Work Results for HVAC" for dielectric fittings.

3.3 PIPING APPLICATIONS

A. Flanges, unions, transition, and special fittings with pressure ratings same as or higher than system pressure rating may be used in applications below, unless otherwise indicated.

B. Fuel Gas Piping: Use the following:

1. NPS 1 and Smaller: steel pipe, malleable-iron threaded fittings, and threaded joints. Option: Corrugated, stainless-steel tubing may be used for runouts at individual appliances.
2. NPS 1-1/4 to NPS 2: Steel pipe, malleable-iron threaded fittings, and threaded joints.
3. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.

C. Gas Service Piping at Meters and Regulators: Steel pipe, steel welding fittings, and welded joints.

3.4 VALVE APPLICATIONS

A. Appliance Shutoff Valves for Pressure 0.5 psig or Less: Appliance connector valve or gas stop.

B. Appliance Shutoff Valves for Pressure 0.5 to 2 psig: Gas stop or gas valve.

C. Appliance Shutoff Valves for Pressure 2 to 5 psig: Gas valve.

D. Piping Line Valves, NPS 2 and Smaller: Gas valve.

E. Piping Line Valves, NPS 2-1/2 and Larger: Plug valve or general-duty valve.

F. Valves at Service Meter, NPS 2 and Smaller: Gas valve.

G. Valves at Service Meter, NPS 2-1/2 and Larger: Plug valve.

3.5 PIPING INSTALLATION

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

1. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
2. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.
3. Install fuel gas piping at uniform grade of ¼" per 15 feet.
4. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
5. Connect branch piping from top or side of horizontal piping.
6. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
7. Install flanges on valves, specialties, and equipment having NPS 2-1/2 and larger connections.
8. Install corrugated, stainless-steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.
9. Install strainer on inlet of each line pressure regulator and automatic and electrically operated valve.
10. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.
11. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping joint construction.

B. Concealed Locations: Except as specified below, install concealed gas piping in airtight conduit constructed of Schedule 40, seamless, black steel pipe with welded joints. Vent conduit to outside and terminate with screened vent cap.

1. Above-Ceiling Locations: Gas piping may be installed in accessible spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves above ceilings.
2. In Partitions: Do not install concealed piping in solid partitions. Protect tubing from physical damage when installed inside partitions or hollow walls. Exception: Tubing passing through partitions or walls.
3. In Walls: Gas piping with welded joints and protective wrapping specified in "Protective Coating" Article in Part 2 may be installed in masonry walls, subject to approval of authorities having jurisdiction.
4. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts. Exception: Accessible above-ceiling space specified above.

3.6 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."

B. Support gas piping in accordance with NFPA 54. Steel pipe spacing of supports: ½" pipe = 6 feet; ¾" or 1" = 8 feet; 1-1/4" and larger = 10 feet.

C. Refer to Division 23 Section "Seismic Restraints for Mechanical" for seismic-restraint devices.

D. Support horizontal corrugated, stainless-steel tubing from structure according to manufacturer's written instructions.

3.7 CONNECTIONS

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

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

C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.8 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each service meter, pressure regulator, and specialty valve.

1. Text: In addition to name of identified unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
2. Refer to Division 23 Section "Identification for HVAC" for nameplates and signs.

3.9 PAINTING

A. Use materials and procedures in Division 9 Section "Painting," "Exterior Paint Schedule" Article, "Ferrous Metal" Paragraph, "Full-Gloss, Alkyd-Enamel Finish" Subparagraph.

B. Paint exterior piping, service meters, pressure regulators, and specialty valves. Color: Safety Yellow.

C. Paint all exterior metal support brackets for piping. Color: Black.

3.10 FIELD QUALITY CONTROL

A. Inspect, test, and purge piping according to ANSI Z223.1, Part 4 "Inspection, Testing, and Purging," and requirements of authorities having jurisdiction.

B. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

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

D. Verify capacities and pressure ratings of service meters, pressure regulators, valves, and specialties.

E. Verify correct pressure settings for pressure regulators.

F. Verify that specified piping tests are complete.

G. Verify that the gas piping has been grounded by Division 16 in accordance with NFPA requirements.

3.11 ADJUSTING

A. Adjust controls and safety devices. Replace damaged and malfunctioning controls and safety devices.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 11 23

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SECTION 23 21 13 – HYDRONIC HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 7 Section for materials and methods for sealing pipe penetrations through fire and smoke barriers.
2. Division 23 Section "Common Work Results for Mechanical"
3. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements.
4. Division 23 Section "Thermometers and Pressure Gages"
5. Division 23 Section "Mechanical Identification" for labeling and identifying hydronic piping.
6. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
7. Division 23 controls section for temperature-control valves and sensors.

1.2 SUMMARY

A. This Section includes piping, special-duty valves, and specialties for hydronic HVAC piping.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer’s standard submittal cut sheets. For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.

B. Welding Certificates: Copies of certificates for welding procedures and personnel.

C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

D. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

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

B. Qualify soldering processes, procedures, and solderers for copper and copper alloy pipe and tube in accordance with ASTM B 828.

C. Qualify brazing processes for copper and copper alloy pipe and tube according to ANSI/AWS C3.4.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.5 COORDINATION

A. 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.

B. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

C. Coordinate pipe sleeve installations for foundation wall penetrations.

D. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

E. Coordinate pipe fitting pressure classes with products specified in related Sections.

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Refer to Division 23 Section “Common Work Results for Mechanical”.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Balancing Valves:

a. Griswold Controls.
b. ITT Bell & Gossett; ITT Fluid Technology Corp.
c. Taco, Inc.
d. Tour & Anderson
e. Flow Design, Inc.
f. Griswold Controls
g. Watts Industries Inc.;Watts Regulator

2. Hydronic Pressure-Reducing Valves:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Conbraco Industries, Inc.
   d. ITT Bell & Gossett; ITT Fluid Technology Corp.
   e. Spence Engineering Company, Inc.
   f. Watts Industries, Inc.; Watts Regulators.

3. Safety Valves:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Conbraco Industries, Inc.
   d. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
   e. Kunkle Valve Division.
   f. Spence Engineering Company, Inc.
   g. Watts Industries Inc.;Watts Regulator

4. Expansion Tanks, Air Separators, and Hydronic Specialties:

   a. Amtrol, Inc.
   b. Woods
   c. ITT Bell & Gossett; ITT Fluid Technology Corp.
   d. Taco, Inc.
   e. Aurora
   f. Watts Industries Inc.;Watts Regulator

5. Air Vents and Vacuum Breakers:

   a. Armstrong International, Inc.
   b. Barnes & Jones, Inc.
   c. ITT Hoffman; ITT Fluid Technology Corp.
   d. Johnson Corp. (The).
   e. Spirax Sarco, Inc.

2.2 PIPING MATERIALS

A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Wrought-Copper Fittings: ASME B16.22.

E. Wrought-Copper Unions: ASME B16.22.

F. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.

G. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 STEEL PIPE AND FITTINGS

A. Steel Pipe, NPS 2 and Smaller: ASTM A-53, Type S (seamless) or Type F (furnace-butt welded), Grade B, Schedule 40 and 80, black steel, plain ends.

B. Steel Pipe, NPS 2-1/2 and larger: ASTM A-53, Type E (electric-resistance welded), Grade B, Schedule 40 and 80, black steel, plain ends.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A-234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt-welding.
3. Facings: Raised face.

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

I. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and thredolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ANSI B16.11 may be used for drain, vent and gage connections.

J. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

K. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 PEX PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. PEX-a manufacturer system warranty shall cover tubing for a duration of 30 years from the date of installation.

1. Uponor Wirsbo hePEX (Basis of Design)
2. Rehau
3. Mr. PEX

B. PEX-a (Engle-method Crosslinked Polyethylene) Piping: ASTM 876 with oxygen-diffusion barrier that meets DIN 4726. Performance Requirements: 200°F at 80 psi, 180°F at 100 psi.

C. PEX-a Fittings, Elbows and Tees (½ inch through 2 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:

1. UNS No. C69300 Lead-free (LF) Brass
2. 20% glass-filled polysulfone as specified in ASTM D6394
3. Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D6394
4. Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D6394
5. Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D6394
6. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked “F1960”.

D. PEX-a Fittings (2½ inch through 4 inch nominal pipe size): SDR9 compression type fitting consisting of a double O-ring insert with a compression sleeve tightened around the pipe and insert.

E. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Provide fittings from the same manufacturer of the piping.

2. 2” and below: Threaded Brass to PEX-a Transition: one-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring. Brass Sweat to PEX-a Transition: one-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
3. 2-1/2” to 4”: Dezincification-resistant (DZR) Brass to PEX-a Transition: male NPT thread and PEX compression fitting.

F. Plastic-to-Metal Transition Unions:

1. Manufacturers: Provide fittings from the same manufacturer of the piping.

2. Threaded Brass to PEX-a Union: one-piece brass fitting with male or female threaded adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.

G. Brass Sweat to PEX-a Union: one-piece brass fitting with sweat adapter and F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.

2.6 HYDRONIC VALVES

A. Gate Valves

1. Threaded Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising-stem, solid wedge: Hammond IB617, Nibco T-124/134, Stockham B105, Milwaukee 1152 or equal.
2. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge: Hammond IR1140, Nibco F617-0, Stockham G623, Milwaukee F2885 or equal.
3. Solder Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising-stem, solid wedge: Hammond IB648, Nibco S134, Stockham B115, Milwaukee 1169 or equal.
4. Comply with the following standards: Cast Iron Valves: MSS SP – 70; Bronze Valves: MSS SP – 80.

B. Ball Valves

1. Threaded Ends 4" and Smaller: 150 psi WP and 600psi non-shock CWP, forged brass full-port 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: Watts FBV-3C series/B6080 series, Hammond 8501, Nibco T-585-70, Milwaukee BA100, Apollo 70-Series, or approved equal.
2. Soldered Ends 3" and Smaller: 150 psi WP and 600psi non-shock CWP, full-port cast bronze or forged brass 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: Watts FBVS-3C series/B6081 series, Hammond 8511, Nibco S-585-70, Milwaukee BA150, Apollo 70-Series, approved or equal.
3. Comply with MSS SP-110.

C. Swing check valves:

1. Construct pressure containing parts of Valves as follows: Bronze Valves: 125 or 150 psi: ANSI/ASTM B 62; Iron Body Valves: ANSI/ASTM A-126, Grade B
2. Comply with the following standards for design, workmanship, material and testing: Bronze Valves: MSS SP – 80; Cast Iron Valves: MSS SP – 71.
3. Construct valves of pressure casting free of any impregnating materials. Construct disc and hanger as one piece. Support hanger pins by removable side plug.
4. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB904, Nibco T-413Y, Stockham B320T, Milwaukee 509 or approved equal.
5. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB912, Nibco S-413-Y, Stockham B310T, Milwaukee 511 or approved equal.
6. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Hammond IR1124, Nibco F918-B, Stockham G931, Milwaukee F2974 or approved equal.

D. Calibrated Balancing Valves, Watts CSM-61/81 series, Taco Accu-Flo, or approved equal.

1. Accuracy 4-5 times greater than variable orifice balancing valves.
2. Flow measurement independent of stem and ball position.
3. Calibrated nameplate: Easy to read. Memory stop is tamper resistant and has a fast and accurate resetting if shut-off feature is used. Calibrated to aid in pre-balancing flow loop.
4. Tamper resistant memory- stop for accurate resetting; positive shut-off; ability to read low flows.
5. Schrader style pressure ports
6. Bronze Body rated to: 300 PSI, 250°F;
7. Cast Iron Body: Class 125
8. Modified venturi design; blowout-proof stem held secure by valve body; ball valve construction with Teflon seats; built-in drain port; all brass interior parts.
9. Provide a closed cell polyethylene foam insulation kit with each valve.

E. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.

F. ASME Safety Relief Valves: Bell & Gossett A-434D, or equal; diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV. The fluid shall not discharge into the spring chamber. The valve shall have a low blow-down differential. The valve seat and all moving parts exposed to the fluid shall be of non-ferrous material.

G. Automatic Flow-Control Valves: Watts Automatic Control/ACV, Griswold, Flow Design, Inc., or approved equal. Automatic flow control valve cartridges shall automatically control flow rates with ±5% accuracy over an operating pressure differential range of at least 14 times the minimum required for control. Four operating pressure ranges shall be available with the minimum range requiring less than 3 PSID to actuate the mechanism.

1. Valve internal control mechanism shall consist of a stainless steel one-piece cartridge with segmented port design and full travel linear coil spring.
2. All flow control valve cartridges shall be warranted by the manufacturer for five years from date of sale.
3. Griswold Isolator-Y series valves, sizes 1/2" through 1-1/2", shall have an ASTM brass alloy body, rated at no less than 400PSI/250°F. Isolator series valves, sizes 1-1/2" Large through 3", shall have a CAST brass alloy body, rated at no less than 275PSI/250°F. These sizes shall be constructed in a one-piece body to include a handle ball valve, a flow control cartridge assembly, dual pressure or pressure/temperature test valves for verifying accuracy of flow performance for all sizes combined with a manual air vent, and a union end which will accept various end pieces. The IY shall include a removable 20 mesh stainless steel strainer. Available flow rates shall be from 0.25 GPM to 160.0 GPM.
4. The body design shall allow inspection or removal of cartridge or strainer without disturbing piping connections.
5. The body design shall allow inspection or repair of handle operated stem without disturbing piping connections. The repairable stem shall include two Teflon seals and one EPDM o-ring for protection against chemicals and modulating temperature.
6. The valve shall come fully assembled and be permanently marked to show direction of flow; shall have a body tag to indicate flow rate and model number

2.7 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

B. Automatic Air Vent: designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection. Seton, Brady, or approved equal.

C. Expansion Tanks: Taco Model CA, or approved equal. Construction: Welded steel, designed, tested and stamped in accordance with ASME (BPV code sec VIII, div 1); supplied with National Board Form U-1, rated for working pressure of 150 psi, with flexible heavy duty butyl rubber bladder. Bladder shall be able to accept the full volume of the expansion tank and shall be removable and replaceable. Bladder shall be NSF 61 rated for potable water service and shall be manufactured with FDA approved materials.

1. Expansion tank isolation valves: Provide valve lockouts: shall meet OSHA requirements to ensure ball valves are locked securely and effectively; for use on 1/4-turn valves to prevent tampering; polypropylene material resists chemicals, solvents, cracking & rust; provide padlock locking mechanism. Seton, Brady, or approved equal.
2. Accessories: Pressure gage (field installed by others) and air-charging fitting.
3. Automatic Cold Water Fill Assembly (field installed by others): Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

D. Air and Dirt Separator

1. Furnish and install air and dirt removal device(s) of the size and type as shown on the plans. Air and dirt separation devices shall be Taco 4900 Series or approved equal by Spirovent or Bell & Gossett.
2. Air and dirt removal device shall be constructed of steel designed and fabricated per Section VIII Division 1 of the A.S.M.E. Boiler and Pressure Vessel Code with a maximum working pressure rating of (125 / 150) psi at 270°F. Units up to 3 inch in size shall be provided with (threaded / flanged) system connections. Units 4 inch and larger shall be provided with flanged system connections as standard.
3. Each air & dirt separator shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly. Air vent shall be furnished with a closeable port to prevent vent clogging during system fill. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and the removal of floating impurities from the air / system fluid interface within the separator. A blowdown valve shall be provided by the unit manufacturer on the bottom of each air and dirt separator to allow cleaning as required. (2" and 2.5" units are provided with a 1" factory-supplied blow down valve. / 3" and larger units are supplied with a 2" blowdown valve.)
4. The air & dirt separator shall employ the use of high surface area, stainless steel pall rings to achieve optimal separation of (air / air & dirt) from the system fluid. Screens made of 304-stainless steel are provided on the inlet and outlet of each separator to isolate the internals from the system. Units installed in open systems shall be provided with a removable top head for removal and cleaning of the internal coalescence media.
5. The supplier of the air & dirt separator shall furnish to the design engineer the results of independent air & dirt testing of a representative unit from the suppliers' standard product offering. Suppliers not providing these independent performance test results will not be accepted.

E. Flexible Connectors: Refer to Section 23 05 00 "Common Work Results for HVAC".

F. Y-Pattern Strainers: Strainers shall be Y-type with removable basket. Body shall have cast-in arrows to indicate direction of flow. Strainer screens shall have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material shall be AISI Type 304 corrosion-resistant steel. Provide fine-mesh start-up strainers.

1. Strainers in sizes 3-inch and smaller shall have screwed ends; Hammond 3010, or approved equal. Body material shall be cast bronze conforming to ASTM B584-C84400. Strainer bodies fitted with screwed screen retainers shall have straight threads and shall be gasketed with nonferrous metal. Strainer screens shall have perforations not to exceed 1/32".
2. In sizes 4 and larger, strainers shall have flanged ends; Hammond 3030, or approved equal. Body material shall be cast iron conforming to ASTM A126 Class B. Strainer bodies fitted with bolted-on screen retainers shall have offset blowdown holes. Strainer screens shall have perforations not to exceed 1/16" (4" size); 1/8" (5" size and larger).

PART 3 - EXECUTION

3.1 HYDRONIC PIPING APPLICATIONS – ABOVE GROUND

A. Hot Water, NPS 2 and Smaller: Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints.

B. Hot Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded or welded and flanged joints.

C. Concealed run outs to terminal units, 1" or smaller: optional PEX; 8 ft maximum length.

D. Makeup water piping, downstream of backflow preventer: Type K or L, drawn-temper copper tubing.

E. Drain Lines: ¾" minimum diameter; Type L drawn-temper copper tubing with soldered joints or Schedule 40, PVC pipe with solvent-welded joints

3.2 HYDRONIC PIPING APPLICATIONS – BELOW GROUND

A. Hydronic piping within slabs, use PEX or Type K annealed-temper copper tubing with soldered joints. Use the fewest possible joints belowground and within floor slabs.

3.3 VALVE INSTALLATION

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

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

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

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

E. Install chain-wheel operators on valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 74 inches above finished floor elevation.

F. Install check valves for proper direction of flow.

3.4 VALVE APPLICATIONS

A. Hydronic Valve Applications: Unless otherwise indicated, use the following valve types:

1. Shutoff Duty: Ball and butterfly valves.
2. Throttling Duty: Globe, ball, and butterfly valves.

B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

C. Install calibrated balancing valves in the return water line of each terminal unit and elsewhere as required to facilitate system balancing.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.5 HYDRONIC PIPING INSTALLATIONS

A. Refer to Division 23 Section "Common Work Results for Mechanical" for basic piping installation requirements.

B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

C. Refer to Division 23 Section "Common Work Results for Mechanical" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC and CPVC piping.

D. Hydronic piping systems shall be provided to permit the system to be drained. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and hose-end fitting with cap, at low points in piping system mains and elsewhere as required for system drainage.

E. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

F. Pipe size at connections to equipment shall be distribution main size, not connection size.

G. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

H. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

I. Install unions in piping**,** NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

J. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

K. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, and elsewhere as indicated or recommended by component manufacturer to have strainer protection.

1. Provide valved drain and hose connection on strainer blow down connection.
2. Install with provisions for service clearance.
3. Remove and clean strainer after 24 hours of operation and after 30 days of operation.

3.6 SAFETY VALVE INSTALLATIONS

A. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

B. Check the settings and operation of each safety valve, including valves furnished by heater manufacturer. Record settings.

3.7 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."

3.8 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

B. Air separator and expansion tank to be installed on the suction side of the system pumps. Expansion tank to be tied into system piping in close proximity to air separator and system fill line. Install piping to compression tank with a 2 percent upward slope toward tank.

C. Install expansion tanks on concrete pad. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements. Do not install drain valve.

3.9 CONTROL VALVE INSTALLATION

A. Perform the following as directed by the BAS contractor:

1. Install modulating control valves with minimum of 10 pipe diameters straight pipe at inlet and 5 pipe diameters straight pipe at outlet.
2. Installation of immersion wells and pressure tappings, along with associated shut-off cocks.
3. Installation of flow switches.
4. Setting of automatic control valves or other control devices.

B. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.

C. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.

D. Valves shall be installed in accordance with the manufacturer's recommendations.

E. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be services and removed without interference from structure or other pipes and/or equipment.

F. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at all connections to screw-type control valves.

3.10 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be same as for equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Arrange piping with offsets to allow for expansion, as well as terminal unit removal.

3.11 CLEANING AND FLUSHING

A. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 6 feet/second if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply

and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean.

B. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

C. Close and fill system as soon as possible after final flushing to minimize corrosion.

D. Chemical Treatment

1. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling.
2. Fill system and perform initial chemical treatment.
3. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
4. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

3.12 FIELD QUALITY CONTROL

A. Prepare piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, un-insulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
3. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure but not less than 100 psi. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix-A of ASME B31.9, "Building Services Piping."
4. After hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
5. Prepare written report of testing.

C. Check expansion tanks to determine that they are not air bound and that system is full of water.

3.13 ADJUSTING

A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

B. Perform these adjustments before operating the system:

1. Open valves to fully open position.
2. Check pump for proper direction of rotation.
3. Set automatic fill valves for required system pressure.
4. Check air vents at high points of system and determine if all are installed and operating and bleed air completely.
5. Set temperature controls so all coils are calling for full flow.
6. Check operation of automatic bypass valves.
7. Lubricate motors and bearings.

3.14 CLEANING

A. Flush piping systems with clean water.

B. Remove and clean or replace strainer screens.

C. After cleaning and flushing hydronic-piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers, and replace with the permanent stainless steel screens.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 21 13

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for HVAC"

1.2 SUMMARY

A. This Section includes hydronic pumps and accessories.

1.3 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities; shipping, installed, and operating weights; furnished specialties; final impeller dimensions; and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Installation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

A. Concrete Bases: Refer to Section 23 05 00.

B. Coordinate electrical power with Division 26.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Hydronic Pumps

1. Taco
2. Armstrong
3. Bell & Gossett ITT
4. PACO
5. Grundfos
6. Patterson
7. Wilo

C. Automatic Condensate Pump Units:

1. Beckett Corp.
2. Hartell Div.; Milton Roy Co.
3. Little Giant Pump Co.
4. Marsh Manufacturing, Inc.

2.2 GENERAL PUMP REQUIREMENTS

A. Pump Units: Factory assembled and tested.

B. Motors: Include built-in, thermal-overload protection and grease-lubricated ball bearings. Select each motor to be non-overloading over full range of pump performance curve.

C. Motors Indicated to be premium efficiency: Refer to Section 23 05 00 for minimum efficiencies.

D. Motors shall be inverter duty.

2.3 WET ROTOR CIRCULATORS (Radiant Floor and Domestic water recirc)

A. Circulators shall be Taco 00-Series circulator or approved equal.

1. The circulator shall be water lubricated, direct drive, requiring no seals, couplers or bearing assembly. Ceramic shaft and carbon bearing construction.
2. The circulator shall be repairable in-line without removal of the circulator from the piping using a stainless steel replaceable cartridge. Cartridge shall be provided with a 3 year warranty.
3. Provide "-IFC" integral flow check.
4. For chilled water pumps provide an Anti-Condensate Baffle (ACB) to Protect Motor Windings.
5. Circulator can be either direct acting or reverse acting. Circulator shall be rated for 125 psi working pressure. Circulator shall bear UL label.

2.4 BOILER INJECTOR PUMPS

A. Furnish and install inline centrifugal single stage pumps with the capacities and characteristics as shown on the plans. Pump shall be Grundfos UPS Series or approved equal.

1. All pump casings shall be centerline discharge of bronze designed for line mounting. All pumps are to be provided with companion flanges. Units shall have a maximum operating pressure of 175 psig at a maximum operating temperature of 300º F.
2. Pumps shall have a cast bronze impeller and shall be dynamically balanced. Suction and discharge flanges shall be provided with drilled and tapped gauge ports.
3. The pump shaft shall be hardened alloy steel with removable cupro-nickel shaft sleeve. If no shaft sleeve is furnished, the shaft shall be stainless steel. Vent and drain openings and a water slinger integral to the shaft sleeve shall be provided between the mechanical seal and bearing area.
4. Pumps shall have a two piece mechanical seal assembly replaceable without the use of special tools.
5. Pump shall be furnished with EPT Ceramic seals / EPT Ni-Resist seals rated to 250° F.
6. Pump shall be furnished with sleeve bearings and a disc type lubrication system with the bearing assembly removable in one piece. One bearing assembly shall be suitable for all size units. Sump oil temperature shall not exceed 180° F when pumping 250° F fluid at 90° F ambient temperature. A dip stick for inspection and a drain plug for draining the oil shall be provided.
7. A flexible non-metallic coupler shall connect the pump to the motor. Motors shall be oil lubricated resilient mounted NEMA Standard open drip proof (ODP). All single phase motors shall have thermal overload protection.

2.5 IN-LINE CIRCULATOR PUMPS (Building Heating)

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

B. Hydronic Pumps

1. Taco (Basis of Design)
2. Armstrong
3. Bell & Gossett ITT
4. PACO

5. Grundfos
6. Patterson

C. General Pump Requirements

1. Pump Units: Factory assembled and tested.

2. Motors: Include built-in, thermal-overload protection and grease-lubricated ball bearings. Select each motor to be non-overloading over full range of pump performance curve.

3. Motors Indicated to be premium efficiency: Refer to Section 230500 for minimum efficiencies.

4. Motors shall be inverter duty.

D. General Smart Pump Controller Requirements

1. The self-sensing product shall consist of a factory prepackaged and preprogrammed pump, drive, motor, and integral controls package.

2. The drive shall be mounted and integral to the motor. It shall be mounted with rubber vibration mounts. The mounting and packing of the drive shall be done in a manner that transmitted acceleration levels will be three times below the allowable limits published by the drive manufacturer. These limits will apply to a frequency range of 0-10,000 HZ.

3. The performance speed of this package shall 1750 RPM nominal as standard. Exceptions for 3600 RPM will be noted in the schedules. 3600 RPM shall NOT be an allowable substitution for a specified 1750 PRM package. 3600 RPM products might be considered as a substitution for 1750 RPM only if that manufacturer provides a spare motor, drive, and seal for each pumping unit.

4. Pump logic controller, variable frequency drives, sensor/transmitters and related equipment shall be installed by the mechanical contractor as shown on the plans.

E. Components

1. Pump Logic Controller.

   a. The controller operation shall operate the system using a tested and proven program that safeguards against undesirable or damaging conditions including:
      1) Motor overload
      2) Pump flow surges
      3) Hydraulic cycling (hunting).
      4) End of curve unstable operation: The pump logic controller, through a factory pre-programmed algorithm, shall be capable of protecting the pumps from hydraulic damage due to operation beyond their published end-of-curve. This feature requires a flow meter for activation. The operator interface shall include an owner adjustable flow set point to set the parameters for this routine.

2. The pump logic controller shall be capable of starting, unloading, and stopping pumps based on a system performance program that will minimize energy consumption , provide reliable performance and bumpless transitions.
3. The integrated logic controller shall be capable of running four different hydronic optimization sub-routines

a. Setup one: This subroutine shall allow the pump package to track a quadratic system curve and will optimize a secondary distribution loop. It shall use a technology that allows the pump, drive, and motor package to translate the hydronic data from both a pump and system curve and translate it to electrical data. This allows the drive to know exactly where it is in the hydronic world.
b. Setup two: This subroutine shall allow two pumps to run as backup for each other and shall alternate the pumps based on a real time clock.
c. Setup three: This subroutine shall allow the package to run in a customer defined flow rate. The package will always seek to run at the user defined flow even with fouling causing system changes. It shall use a technology that allows the pump, drive, and motor package to translate the hydronic data from both a pump and system curve and translate it to electrical data. This allows the drive to know exactly where it is in the hydronic world.
d. Setup four: This subroutine shall incorporate a traditional external sensing and control platform. It shall allow the option of controlling the pumps with three zones of differential pressure or central plant differential temperature. This optional setup shall allow the owner the option of external sensing without adding an external controller. This feature shall be equal to Taco System Logic (TSL) or equal.

4. The control platform shall include a subroutine equal to the Taco Self-Sensing Series with ProBalance™. This subroutine shall allow for the automatic balancing of secondary system distribution pumps. The package shall automatically run system distribution pumps to a user defined duty point and will recognize that duty point and hold the pumps at a speed that matches the actual installed system quadratic system curve. The package will then use this data to set up a new duty point as the max point for the quadratic control curve. Use of external balancing devices or contractors will not be needed.
5. The package shall serve as a flow metering device and will display pump flow at the user interface.

F. Vertical Pumps

1. Furnish and install centrifugal in-line single stage pumps with capacities and characteristics as shown on the plans. The design must permit easy replacement of the mechanical shaft seal without removal of the motor.
2. Vertical Close Coupled Pumps.

a. Pumps shall be Taco Model KV or approved equal. The pumps shall be single stage end suction rear pull out design. The seal shall be serviceable without disturbing the piping connections. The capacities and characteristics shall be as called for in the plans/schedules.

b. Pump casing shall be constructed of ASTM A48 class 30 cast iron. The pump casing/volute shall be rated for 250 psi working pressure for all jobs. The pump flanges shall be matched to suit the working pressure of the piping components on the job, with either ANSI Class 125 flanges or ANSI class 250 flanges. The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing. The casing shall have an additional tapping on the discharge connection to allow for the installation of a seal flush line. The pump cover shall be drilled and tapped to accommodate a seal flush line which can be connected to the corresponding tapping on the discharge connection, or to an external source to facilitate cooling and flushing of the seal faces.

c. All casings shall be flanged. Threaded casings not allowed unless extra unions and fittings are provided with that pump to allow servicing.

d. The pump shall have a factory installed vent/flush line to insure removal of trapped air from the casing and mechanical seal cooling. The vent/flush line shall run from the seal chamber to the pump discharge.

e. The impeller shall be ASTM B584-836/875 bronze and hydraulically balanced. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted to the shaft with a key. The impeller shall be cast by the hydraulically efficient lost foam technique to ensure repeatability of high quality.

f. The pump shall incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft. The pump shaft shall be AISI 1045 carbon steel with field replaceable bronze SAE 660 shaft sleeve. In order to improve serviceability and reduce the cost of ownership the shaft sleeve must be slip on (press on not allowable) and must be easily replaced in the field.

g. The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250ºF. This seal must be capable of being flushed externally via a tapping in the pump cover adjacent to the seal cavity. The entire pump line shall use no more than three different sizes of seals.

h. The pump shall be close coupled to a NEMA standard JM frame motor

2.6 PUMP SPECIALTY FITTINGS

A. Pumps shall be fitted with a discharge multi-purpose balancing valve or other means of providing system balance, isolation, and check feature for reverse flow. The valve shall be straight or angle pattern and shall be field convertible between the two. The valve shall be ductile iron and rated for 250 psi working pressure. The valve flanges shall be matched to suit the working pressure of the piping components on the job; with either ANSI class125 psi flanges or ANSI class 250 flanges. The valve shall include the following components; non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation. Valve shall be serviceable under full system pressure. The valve shall be a Taco model MPV Plus Two multi-purpose valve or equivalent.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations for compliance with requirements for installation. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Install pumps and equipment according to manufacturer's written instructions.

B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

C. Pipe connections to pumps shall be made in such a manner so as not to exert any stress on pump housings. If necessary to meet this requirement, provide additional pipe supports and flex connectors.

D. Pumps shall **NOT** be run dry to check rotation.

3.3 INLINE PUMPS

A. Suspend in-line pumps per manufacturer's written instructions.

3.4 CONNECTIONS

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

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

C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles. Install fittings and specialties as detailed on the plans.

E. Install electrical connections for power, controls, and devices. Electrical power and control wiring and connections are specified in Electrical Specification Sections. Ground equipment. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 COMMISSIONING

A. Verify that pumps are installed and connected according to the Contract Documents.

B. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.

C. Perform the following preventive maintenance operations and checks before starting:

1. Lubricate bearings.
2. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
3. Verify that pumps are free to rotate by hand. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
4. Check suction piping connections for tightness to avoid drawing air into pumps.
5. Clean strainers.
6. Verify that pump controls are correct for required application.

D. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:

1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
2. Open sealing liquid-supply valves if pumps are so fitted.
3. Start motors with suction valves open and discharge valve closed. Open discharge valves slowly.
4. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
5. Check general mechanical operation of pumps and motors.
6. Follow manufacturers recommended procedures.

E. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
2. Review data in maintenance manuals.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 21 23

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 7 for roof curbs, piping supports, and roof penetration boots.
2. Division 7 for materials and methods for sealing pipe penetrations through fire and smoke barriers.
3. Division 7 for materials and methods for sealing pipe penetrations through exterior walls.
4. Division 23 Section "Common Work Results For Mechanical"
5. Division 23 Section "Hangers and Supports" for pipe supports and installation requirements.
6. Division 23 Section "Mechanical Identification" for labeling and identifying refrigerant piping.
7. Division 23 Section "Meters and Gages" for thermometers and pressure gages.
8. Division 23 Section "HVAC Instrumentation and Controls" for thermostats, controllers, automatic-control valves, and sensors.

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for thermostatic expansion valves, solenoid valves, and pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and equipment.

1. Refrigerant piping indicated is schematic only. Size piping and design the actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and compliance with warranties of connected equipment.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

D. Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. ASHRAE Standard: Comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."

C. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Non-electrical"; or UL 429, "Electrically Operated Valves."

1.5 COORDINATION

A. 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.

B. Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

C. Coordinate pipe sleeve installations for foundation wall penetrations.

D. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7.

E. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 for materials and methods for sealing pipe penetrations through fire and smoke barriers.

F. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

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

1. Refrigerants:

a. Allied Signal, Inc./Fluorine Products; Genetron Refrigerants.
b. DuPont Company; Fluorochemicals Div.
c. Elf Atochem North America, Inc.; Fluorocarbon Div.
d. ICI Americas Inc./ICI KLEA; Fluorochemicals Bus.

2. Refrigerant Valves and Specialties:

a. Climate & Industrial Controls Group; Parker-Hannifin Corp.; Refrigeration & Air Conditioning Division.
b. Danfoss Electronics, Inc.
c. Emerson Electric Company; Alco Controls Div.
d. Henry Valve Company.

e. Sporlan Valve Company.

2.2 COPPER TUBE AND FITTINGS

A. Seamless Copper Tube: ASTM B 280-Type ACR; ASTM B 88-Type L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Bronze Filler Metals: AWS A5.8, Classification.

2.3 VALVES

A. Diaphragm Packless Valves: 500-psig working pressure and 275 deg F working temperature; globe design with straight-through or angle pattern; forged-brass or bronze body and bonnet, phosphor bronze and stainless-steel diaphragms, rising stem and handwheel, stainless-steel spring, nylon seat disc, and with solder-end connections.

B. Packed-Angle Valves: 500-psig working pressure and 275 deg F working temperature; forged-brass or bronze body, forged-brass seal caps with copper gasket, back seating, rising stem and seat, molded stem packing, and with solder-end connections.

C. Check Valves Smaller Than NPS 1: 400-psig operating pressure and 285 deg F operating temperature; cast-brass body, with removable piston, polytetrafluoroethylene seat, and stainless-steel spring; globe design. Valve shall be straight-through pattern, with solder-end connections.

D. Service Valves: 500-psig pressure rating; forged-brass body with copper stubs, brass caps, removable valve core, integral ball check valve, and with solder-end connections.

E. Solenoid Valves: Comply with ARI 760; 250 deg F temperature rating and 400-psig working pressure; forged brass, with polytetrafluoroethylene valve seat, 2-way, straight-through pattern, and solder-end connections; manual operator; fitted with suitable NEMA 250 enclosure of type required by location, with 1/2-inch conduit adapter and 24-V, normally closed holding coil.

F. Pressure Relief Valves: Straight-through or angle pattern, brass body and disc, neoprene seat, and factory sealed and ASME labeled for standard pressure setting.

G. Thermostatic Expansion Valves: Comply with ARI 750; brass body with stainless-steel parts; thermostatic-adjustable, modulating type; size and operating characteristics as recommended by manufacturer of evaporator, and factory set for superheat requirements; solder-end connections; with sensing bulb, distributor having side connection for hot-gas bypass line, and external equalizer line.

2.4 REFRIGERANT PIPING SPECIALITIES

A. Straight- or Angle-Type Strainers: 500-psig working pressure; forged-brass or steel body with stainless-steel wire or brass-reinforced Monel screen of 80 to 100 mesh in liquid lines up to 1-1/8 inches, 60 mesh in larger liquid lines, and 40 mesh in suction lines; with screwed cleanout plug and solder-end connections.

B. Moisture/Liquid Indicators: 500-psig maximum working pressure and 200 deg F operating temperature; all-brass body with replaceable, polished, optical viewing window with color-coded moisture indicator; with solder-end connections.

C. Replaceable-Core Filter-Dryers: 500-psig maximum working pressure; heavy gage protected with corrosion-resistant-painted steel shell, flanged ring and spring, ductile-iron cover plate with steel cap screws; wrought-copper fittings for solder-end connections; with replaceable-core kit, including gaskets and the following:

1. Filter Cartridge: Pleated media with integral end rings, stainless-steel support, ARI 730 rated for capacity.
2. Filter-Dryer Cartridge: Pleated media with solid-core sieve with activated alumina, ARI 730 rated for capacity.
3. Wax Removal Cartridge: Molded, bonded core of activated charcoal and desiccant with integral gaskets.

D. Permanent Filter-Dryer: 350-psig maximum operating pressure and 225 deg F maximum operating temperature; steel shell and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.

E. Mufflers: 500-psig operating pressure, welded-steel construction with fusible plug; sized for refrigeration capacity.

2.5 REFRIGERANTS

A. ASHRAE 34, R-410a

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Aboveground, within Building: Type ACR drawn-copper tubing or Type L drawn-copper tubing.

3.2 VALVE APPLICATIONS

A. Install check valves in compressor discharge lines and in condenser liquid lines on multiple condenser systems.

B. Install packed-angle valve in liquid line between receiver shutoff valve and thermostatic expansion valve for system charging.

C. Install diaphragm packless or packed-angle valves on each side of strainers and dryers, in liquid and suction lines at evaporators, and elsewhere as indicated.

D. Install a full-sized, three-valve bypass around each dryer.

E. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve.

1. Install solenoid valves in horizontal lines with coil at top.

2. Electrical wiring for solenoid valves is specified in Division 26 Sections. Coordinate electrical requirements and connections.

F. Install thermostatic expansion valves as close as possible to evaporator.

1. If refrigerant distributors are used, install them directly on expansion-valve outlet.
2. Install valve so diaphragm case is warmer than bulb.
3. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
4. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

G. Install pressure regulating and pressure relief valves as required by ASHRAE 15. Pipe pressure relief valve discharge to outside.

3.3 SPECIALTY APPLICATIONS

A. Install liquid indicators in liquid line leaving condenser, in liquid line leaving receiver, and on leaving side of liquid solenoid valves.

B. Install strainers immediately upstream from each automatic valve, including expansion valves, solenoid valves, hot-gas bypass valves, and compressor suction valves.

C. Install strainers in main liquid line where multiple expansion valves with integral strainers are used.

D. Install moisture-liquid indicators in liquid lines between filter-dryers and thermostatic expansion valves and in liquid line to receiver.

E. Install replaceable-core filter-dryers in vertical liquid line adjacent to receivers and before each solenoid valve.

F. Install permanent filter-dryers in low-temperature systems, in systems using hermetic compressors, and before each solenoid valve.

G. Install solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.

H. Install receivers, sized to accommodate pump-down charge, on systems 5 tons and larger and on systems with long piping runs.

I. Install flexible connectors at or near compressors where piping configuration does not absorb vibration.

3.4 PIPING INSTALLATION

A. Install refrigerant piping according to ASHRAE 15.

B. Basic piping installation requirements are specified in Division 23 Section "Common Work Results For Mechanical."

C. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

D. Arrange piping to allow inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.

E. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

F. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

G. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

H. Install unions to allow removal of solenoid valves, pressure-regulating valves, and expansion valves and at connections to compressors and evaporators.

I. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports."

B. Refer to Division 23 Section "Mechanical Vibration Controls and Seismic Restraints" for seismic-restraint devices.

3.6 PIPE JOINT CONSTRUCTION

A. Braze joints according to Division 23 Section "Basic Mechanical Materials and Methods."

B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent scale formation.

3.7 FIELD QUALITY CONTROL

A. Test and inspect refrigerant piping according to ASME B31.5, Chapter VI.

1. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure.
2. Test high- and low-pressure side piping of each system at not less than the lower of the design pressure or the setting of pressure relief device protecting high and low side of system.

a. System shall maintain test pressure at the manifold gage throughout duration of test.
b. Test joints and fittings by brushing a small amount of soap and glycerine solution over joint.

c. Fill system with nitrogen to raise a test pressure of 150 psig or higher as required by authorities having jurisdiction.
d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Check compressor oil level above center of sight glass.
2. Open compressor suction and discharge valves.
3. Open refrigerant valves, except bypass valves that are used for other purposes.
4. Check compressor-motor alignment, and lubricate motors and bearings.

3.9 CLEANING

A. Before installing copper tubing other than Type ACR, clean tubing and fittings with trichloroethylene.

B. Replace core of filter-dryer after system has been adjusted and design flow rates and pressures are established.

3.10 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter-dryer after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to a vacuum of 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line. Provide full-operating charge.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.

2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 23 00

SECTION 23 31 13 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 8 for Access Doors
2. Division 23 Section "Common Work Results for Mechanical"
3. Division 23 Section "Mechanical Insulation"
4. Division 23 Section "Air Terminals"
5. Division 23 Section "Diffusers, Registers, and Grilles."
6. Division 23 Control Section
7. 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. Terminal unit, coil, and related installations.
9. Hangers and supports, including methods for building attachment

B. Coordination Drawings; provide to avoid field conflicts; show the following

1. Ceiling suspension assembly members.
2. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounted access doors and panels required providing access to dampers and other operating devices.
4. Coordination with ceiling-mounted items, including lighting fixtures, diffusers, grilles, speakers, sprinkler heads, access panels, and special moldings.
5. Areas of building where coordination drawings are required:
   a. Heavy Service Bays
   b. Light Service Bay
   c. Fabrication/Machine Shop
   d. Coatings Building

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

1. Sealant
2. Duct-mounted access doors and panels.
3. Flexible ducts.
4. Backdraft dampers.
5. Manual-volume dampers: Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval.
6. Louvers: Include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals. For units with factory-applied color finishes, provide color chart. Provide product test reports: Based on evaluation of comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. 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.

B. National Fire Protection Association (NFPA):

1. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
2. 96-2008: Ventilation Control and Fire Protection of Commercial Cooking Operations

C. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

1. 3rd Edition: 2005 HVAC Duct Construction Standards, Metal and Flexible
2. 1st Edition: 1985 HVAC Air Duct Leakage Test Manual

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 or G90 as indicated.

C. Galvanized ductwork to be painted shall have a Galvaneal finish.

D. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form with standard, one-side bright finish for ducts exposed to view and with mill finish for concealed ducts.

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

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 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 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.
3. Fig. 2-5 Rectangular Divided Flow Branches: Type 1, Type 2, Type 4A, or 4B.
4. Fig. 2-6 Branch Connections: 45-degree entry, 45-degree lead-in, bell-mouth or spin-in (single diffuser supply only).
5. 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 as follows:

1. Exposed Round Ducts: Shall be Spiral Seam (RL-1 seam) at 2-inch wg construction.
2. Concealed Round Ducts: Shall be longitudinal Grooved Seam Flat lock (RL-5 seam) at 2-inch wg construction.
3. 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. 21” and larger: Install using a three-piece, gasketed flanged-joint consisting of two internal flanges, with integral mastic sealant, and one external closure band, which compress the gasket between the internal flanges. Ductmate Spiralmate or equivalent system.

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 WELDING EXHAUST SYSTEM

A. It shall be the intent that the welding evacuation arms, fan, VFD, and specialties be relocated from the existing MDOT Fleet Services facility and re-commissioned for use at the project site. New ductwork shall be installed at the project site under the scope of this project as shown on the contract drawings.

B. The new duct system shall be Donaldson Torit Easy Duct system, or approved equal, to match the existing system.

C. Ducting system shall consist of two (2) trunk lines that will service a total of fourteen (14) fume extraction arms and a direct connection to the plasma cutting table, as shown on the contract drawings. The ducting system shall be designed to allow all source collection positions to operate simultaneously and maintain 3,000 – 3,500 FPM throughout the entire system.

D. All interior duct-work shall be of a clamp-together design using a die-formed, rolled edge in which is then joined together by a single lever clamp of similar material. All clamp together ducting shall be of continuous laser welded construction along the longitudinal seam of the rolled form duct with the exception of the 3" which is lock formed. All connections shall have Nitrile seal in clamp.

E. All exterior ducting between the building and fan shall be of 16 gauge welded construction, be weather tight and feature angle iron flanged, bolt together connections.

F. Straight duct and other connecting components to be constructed of galvanized sheets produced by the continuous galvanizing process in which conforms to ASTM-A-527, and commercial quality ASTM A-527. Galvanized sheeting shall be produced with a minimum spangle.

G. Relocate the existing Donaldson Torit Weld Fume Extraction Arms, Model Ex-Arm AD3649112, from the existing facility, complete with mounting swivel, top joint assembly, lightweight ducting (black), mid-joint assembly, end joint assembly, hood with impacter plate, and damper assembly.

H. Provide high static relief damper (max -12" adjustment) Equal to Greenheck HB series for system duct pressure relief when most fume drops are closed.

2.6 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. Concrete Inserts: Steel or malleable iron, galvanized; continuously slotted or individual inserts conforming with MSS SP-58, Types 18 & 19, Class A-B.
3. C Clamps: Fee & Mason Co.'s 255L with locking nut, and 255S with retaining strap.
4. Metal Deck Ceiling Bolts: B-Line Systems, Inc.'s Fig. B3019.
5. Welding Studs: Erico Fastening Systems, capacitor discharge, low carbon steel, copper flashed.
6. Structural (carbon) Steel Shapes and Steel Plates: ASTM A36, shop primed.
7. Stainless Steel Shapes and Plates: ASTM A276 and ASTM A666.
8. 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. Riser Supports: SMACNA Fig 4-7 and Fig 4-9.
3. Wall Supports: SMACNA Figs. 4-8.
4. HVAC Unit Suspension: SMACNA Fig. 4-10.
5. Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
6. 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.

E. Supports For Roof Mounted Items:

1. Equipment rails shall be galvanized steel, minimum 18-gauge, with integral baseplate, continuous welded corner seams, factory installed 2x4 treated wood nailer, 18-gauge galvanized steel counter flashing cap with screws, built-in cant strip; minimum height 11 inches. Provide raised cant strip to start at the upper surface of the insulation.
2. Pipe/duct pedestals: Provide a galvanized unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.

2.7 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.

D. Low-point drains: Ductmate moisture drain with funnel collection design; ¾" connection with drain fitting and cap.

2.8 FABRIC DUCTWORK

A. Manufacturer:

1. FlowCon, Fabric Air Diffusers (Basis of Design), HVAC Products Inc., S. Portland, Maine
2. DuctSox, Dura Tex

B. Fabric Air Dispersion System: Air diffusers shall be constructed of a coated woven fabric, equal to FlowCon Fabric Air Diffuser complying with the following physical characteristics:

1. Fabric Construction: 300 denier coated polyester with EPA approved antimicrobial agent.
2. Weight: 7 oz./sq yard, per ASTM D3776
3. Flame Retardancy: NFPA 701, ASTM-84 Class A.
4. Color: Coordinate with the owner for color selection.
5. Air Permeability: 0 cfm/ft2 at 125 Pa, per ASTM D737, Frazier
6. Temperature Range: 0 degrees F to 180 degrees F
7. Melt Temperature: 350 degrees F.

D. Design Parameters:

1. Fabric air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F.
2. Design CFM, static pressure and diffuser length shall be designed or approved by the manufacturer. Velocity shall be approximately 222 fpm at 10 feet.
3. Tube Sizes: (refer to drawings for lengths)

    a. 18" diameter shall have 2.5" holes on 14.5" centers at 10 and 2 o'clock positions. 4 rows total staggered, 2 rows each side.

C. Suspension Hardware, One Row Cable: System shall include std. cable system located 3" above top-dead-center of fabric duct system. Hardware to include cable, eye bolts, cable clamps and turnbuckle(s) as required. System attachment shall be made using nylon snap clips spaced 24 inches.

2.9 GRAVITY BACKDRAFT DAMPERS

A. Description: Ruskin BD2/A2.

1. Frame: 0.090-inch- thick extruded aluminum, with mounting flange.
2. Blades: 0.025-inch- thick, roll-formed aluminum, with extruded-vinyl seals, Zytel bearings.
3. Tie Bars and Brackets: Aluminum.
4. Return Spring: Adjustable tension.

2.10 LOUVERS

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

1. Ruskin Company
2. American Warming and Ventilating, Inc.
3. Arrow United Industries.
4. Cesco Products.
5. Construction Specialties, Inc.
6. Greenheck.

B. Louvers shall be AMCA Licensed. Louvers shall comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

C. Extruded Aluminum Drainable Combination Louvers

1. Provide louver dimensions shown on plans.
2. Construction: 6063-T5 extruded aluminum alloy construction, drainable blades, factory-assembled, all-welded, drain gutters in head frame and each blade; downspouts in jambs to drain water from louver for minimum water cascade from blade to blade; hidden vertical supports to allow continuous line appearance up to 120 inches; steeply angled integral sill eliminating areas of standing or trapped moisture where mold or mildew may thrive and effect indoor air quality.
3. Based on Ruskin ELC637DAX or approved equal; 6 inch depth, 0.081” frame and blade wall thickness, 37.5 degree angles blades, 5-29/32” blade centers.
4. Bird Screen: aluminum, ½” mesh, removable frame, re-wireable.
5. Louver Finish

    a. Prime Coat: Louvers shall receive prime coating following thorough cleaning and pretreatment of metal. Field topcoat with epoxy, vinyl, urethane or other heavy-duty coating within six months of application. Prime coat shall be a minimum of .3 ± .1 mils thick.
    b. Premium Kynar Paint Finish: Before paint application, louvers shall be thoroughly cleaned and pretreated. Cleaning includes complete submersion in alkali cleaner, detergent deoxidization, amorphous chrome phosphate conversion ® ® coating and acidulated final rinse. Kynar 500 or Hylar 5000 finish shall be applied to provide 1.2 mils factory applied, baked-on film build in accordance with AAMA 2605-98* “Voluntary Specification Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Architectural Extrusions and Panels”. Color shall be RUSKIN (specify color name and number).

6. Accessories

    a. Blank-Off Panels: 0.040 inch aluminum sheet; factory installed with removable screws and neoprene gaskets.
    b. Aluminum Insect Screen

2.11 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.

2.12 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

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

   a. Double wall, rectangular; rated for up to 4.5” static pressure.
   b. Door panel filled with 1" fiberglass insulation; ¾ lb. density.
   c. Hinges and Latches: 1-by-1-inch continuous piano hinge and cam latches.
   d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs.
3. Provide 1/8” thick neoprene gaskets.
4. Number of Hinges and Locks:

   a. Access Doors Less Than 12 Inches Square: No hinges and two cam locks.
   b. Access Doors up to 24 Inches Square: One hinge and cam locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.

2.13 FLEXIBLE CONNECTORS

A. Provide for all air moving equipment. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 0 or 1. Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized, sheet steel or 0.032-inch aluminum sheets. Select metal compatible with connected ducts. Duro-Dyne, Hardcast, or approved equal.

B. Indoor Flexible Connector Fabric: Glass fabric double coated with polychloroprene or neoprene. Minimum Weight: 26 oz. /sq. yd. Tensile Strength: 480 lbf/inch in the warp, and 360 lbf/inch in the filling.

2.14 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 0 0r 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: ¾".

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. Thickness: 1", R4.2, Basis of Design: Atco #80
2. Reinforcement: Steel-wire helix encapsulated in inner liner.
3. Outer Jacket: Polyethylene film.
4. Inner Liner: Polyethylene film.

E. Flexible Ducts, Un-insulated: A triple lamination of metallized polyester, aluminum foil, and polyester shall encapsulate a steel wire helix. Basis of Design: Atco #50

F. 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.

G. Hangers shall be band type, 1" wide minimum.

2.15 FIRE DAMPERS

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

1. Air Balance Inc.
2. Cesco Products
3. Greenheck Fan Corporation.
4. METALAIRE, Inc.
5. Nailor Industries Inc.
6. Prefco
7. Ruskin Company.

B. Type: Static; rated and labeled according to UL 555S by an NRTL.

C. Fire Rating: 1-1/2 hours.

D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

J. Provide the grille option for curtain style fire dampers provides mounting flanges on the sleeve to ease installation of grilles in the field (Grilles specified in Section 233713). The flanges shall be made out of 20 gauge galvanized steel (3/4 inch x 2 in. long) with .149 in. diameter hole for fastening of grille. The flanges are concealed when the grille is installed.

PART 3 - EXECUTION

3.1 MATERIALS

A. Hangers, accessories, and dampers shall be same material as parent duct.

B. Refer to Specification Section 23 07 00 for sheet metal covering of rigid insulation for protection from maintenance personnel crossing insulated ductwork in mechanical spaces.

C. All ducts shall be G60 galvanized steel except as follows:

1. Un-insulated exterior ductwork: G90 galvanized steel.
2. Exterior ductwork: Hangers and attachments shall be electro-galvanized, all-thread rod or galvanized rods with threads painted after installation. Refer to SMACNA Fig. 5-3. All ductwork shall be pitched or sloped to prevent “ponding” of water.
3. Exposed Ductwork: Galvaneal (ready for paint)
4. Plenums at outside louvers: G90 galvanized steel, water-tight, pitched to drain. Provide low-point drain fittings at low points.
5. Wash Bay area exhaust ductwork: Aluminum

3.2 DUCT CLASSIFICATIONS AND SEALING

A. Static-Pressure Classifications: Unless otherwise indicated, construct ducts to the following:

1. Supply duct upstream of VAV terminal units: 3 in. w.g.
2. Supply Ducts downstream of VAV terminal units: 2-inch wg.
3. Supply Ducts: 3 in. w.g.
4. Return Ducts: 2-inch wg, negative pressure.
5. Exhaust Ducts: 2-inch wg, negative pressure.
6. Vehicle Capture Exhaust Ducts: 6-inch 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. Exceptions:

    a. Continuously welded and locking-type longitudinal joints and seams on ducts operating at less than 2 in. wg pressure classification.
    b. Exposed exhaust or return ducts operating at less than 2 in. wg pressure classification.
    c. Exposed supply ducts in the space that the duct serves.

3. 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.

J. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

3.4 DUCT PENETRATIONS

A. Fire or Smoke Rated Penetrations not requiring a fire and/or smoke damper: Where ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and fire dampers are not required, 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 firestopping material as specified in Section 23 05 00.

B. Non-Fire-Rated Exposed Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.

C. Non-Fire-Rated Concealed Penetrations: Provide insulation infill and acoustical sealant around gaps. Tightly seal to prevent sound transmission. Neatly finish.

D. Mechanical room floor penetrations: Provide 4-inch high concrete curbs or other sealing method to prevent leakage from mechanical room into floor penetration.

E. 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 steel decks which are not to receive concrete fill.
7. Do not attach hangers to pre-cast concrete planks less than 2-3/4 inches thick.
8. Avoid damage to reinforcing members in concrete construction.
9. Metallic fasteners installed with electrically operated or powder driven tools may be used as upper hanger attachments, in accordance with the SMACNA Manual, with the following exceptions:

    a. Do not use powder driven drive pins or expansion nails.
    b. Do not attach powder driven or welded studs to structural steel less than 3/16 inch thick.
    c. Do not support a load, in excess of 250 lbs from any single welded or powder driven stud.
    d. Do not use powder driven fasteners in pre-cast concrete.

10. 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 hall 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 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.8 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. Perform the following as directed by the controls contractor:

1. Installation of:

    a. Automatic control dampers.
    b. Smoke detectors.
    c. Necessary blank off plates.

2. Access doors where indicated and as required.

F. 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.

G. Control Damper Installation

1. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
2. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure ¼ in. larger than damper dimensions and shall be square, straight, and level.
3. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 1/8 in. of each other.
4. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
5. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
6. Provide a visible and accessible indication of damper position on the drive shaft end.
7. Support ductwork in area of damper when required to prevent sagging due to damper weight.
8. After installation of low-leakage dampers with seals, caulk between frame and duct opening to prevent leakage around perimeter of damper.

3.9 LOUVER INSTALLATION

A. Louvers to be furnished by Division 23; mounted and installed by Division 10. Ductwork shall be connected to the louvers by Division 23.

B. Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings. For new construction, or where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

C. Installation

1. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
2. Pitch horizontal ducts and plenums connected to louvers downward toward louvers not less than 1 inch in 10 feet. Connect to louver to allow drainage to exterior. Seal duct water-tight.
3. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.
4. Form closely fitted joints with exposed connections accurately located and secured.
5. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
6. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
7. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weather tight louver joints are required.

D. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

E. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

3.10 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. Cover supply openings with filter media prior to system start-up to catch any loose material that may remain inside the ductwork. Turn the HVAC system on and allow it to run until steady state operation is reached. Remove the temporary filter media from supply openings and, along with it, any loose material blown downstream and caught by the filter media.

D. All ductwork shall be provided with temporary enclosures to keep the HVAC system free of dust and construction debris. The HVAC system includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire duct from the points where the air enters the system to the points where the air is discharged from the system.

1. 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.
2. 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.
3. 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.

E. Check all filters in accordance with their manufacturer's instructions. Use specified grade of filters at all times that system is operating.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.

2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

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SECTION 23 34 23 - POWER AND GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for Mechanical"

1.2 SUMMARY

A. This Section includes fans and ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base air ratings on actual site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material gages and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
7. Vibration Isolation

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Belts: One set(s) for each belt-driven unit.

1.7 QUALITY ASSURANCE

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

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal for sound and air performance.

1. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standards: Power ventilators shall comply with UL 705.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.9 COORDINATION

A. Refer to Division 23 Section "Common Work Results for Mechanical"

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

C. Coordinate size and location of structural-steel support members.

D. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Loren Cook (Basis of Design)
2. New York Blower Company
3. Penn Ventilation Companies, Inc.
4. Greenheck Fan Corp.

2.2 CEILING-MOUNTING VENTILATORS

A. Description: Centrifugal fans; Cook GC Series for installing in ceiling; Cook GN Series for concealed in-line applications.

B. Housing: Steel, lined with acoustical insulation. To accommodate different ceiling thickness, an adjustable pre-punched mounting bracket shall be provided.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings.

E. Grille: A powder painted white steel grille shall be provided.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in. Motor shall be open drip proof type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug.

G. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Isolation: Rubber-in-shear hanging vibration isolators.
4. Aluminum wall cap, with ½” bird screen, and transition fittings.

2.3 KITCHEN EXHAUST WALL VENTILATORS

A. Description: Cook Model VCR, Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, base, and accessories.

B. Fan shall be listed by Underwriters Laboratories (UL 762); designed to eject contaminated or grease laden air. The fan shall be UL listed to operate continuously at elevated temperatures, and continue operation during grease flare-up.

C. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16-gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one-piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The wind band shall have a rolled bead for added strength. A two-piece top cap shall have quick release latches to provide access into the motor compartment. An external wiring compartment with integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14-gauge steel power assembly. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. A one-inch thick, three-pound density foil backed heat shield shall be utilized to protect the motor and drive components from excessive heat.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Construction shall be heavy-duty regreasable ball type in a cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

F. Provide a factory disconnect Switch: NEMA-3R non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

G. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent.
2. Automatic belt tensioner to maintain constant tension on the belt-drive.
3. Extended lube lines to allow bearing lubrication while the fan is running.
4. Cook Grease Terminator-2 grease capture and containment system.

2.4 UTILITY SET FANS

A. Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper shall be minimum 14-gauge steel and the scroll side panels shall be a minimum 12-gauge steel. The entire fan housing shall have continuously welded seams for leak proof operation. A performance cut-off shall be furnished to prevent the recirculation of air in the fan housing. The fan housing shall be field rotatable to any one of eight discharge positions and shall have a minimum 1-1/2 inch outlet discharge flange. Bearing support shall be minimum 10-gauge welded steel. Side access inspection ports shall be provided with quick release latches for access to the motor compartment without removing the weather cover. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit-tested packaging.

C. Provide seismic spring vibration isolators.

D. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.

1. Blade Materials: Steel.
2. Blade Type: Airfoil
3. Spark-Resistant Construction: AMCA 99.

E. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

F. Shaft Bearings: Pre-lubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L_{50} of 200,000 hours.

G. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor: 1.5.
2. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
3. Belts: Oil resistant, non-sparking, and non-static; matched sets for multiple belt drives.
4. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

H. Accessories:

1. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades and felt edges in steel frame installed on fan discharge.
2. Access Doors: Gasketed doors with latch-type handles.
3. Automatic belt tensioner to maintain constant tension on the belt-drive.
4. Inlet Screens: Removable wire mesh.
5. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
6. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
7. Seismically-housed spring isolators.

I. Coatings:

1. All steel fan components shall be finished with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.
2. Hot-dip galvanized.

2.5 CENTRIFUGAL ROOF VENTILATORS

A. Description: centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Upblast Units Belt-driven (Cook Model ACRUB) or direct-driven (Cook Model ACRUD) as scheduled. Housing: provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

E. Provide a factory disconnect Switch: NEMA-3R non-fusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

F. Accessories:
1. Automatic belt tensioner to maintain constant tension on the belt-drive.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
4. Extended lube lines to allow bearing lubrication while the fan is running.
5. Provide roof curb as specified hereinafter.

2.6 MOTORS

A. Refer to Division 23 Section “Common Work Results for Mechanical” for general requirements for factory-installed motors.

B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.

C. Enclosure Type: Open drip-proof.

2.7 GRAVITY ROOF VENTILATORS

A. Ventilators shall be equal to Cook Manufacturer:

1. Model GR (Relief) with maximum pressure drop of 0.10 inches w.g.
2. Model GI (Intake) with maximum pressure drop of 0.10 inches w.g.

B. Unit shall be a hooded aluminum, roof mounted gravity *relief* ventilator or gravity *intake* ventilator as required for each specific application. Ventilators shall be manufactured at an ISO 9001 certified facility. Dimensions shown on drawings are clear area throat dimensions.

C. The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The aluminum hood shall be constructed of minimum 14 gauge marine alloy aluminum, bolted to a minimum 8 gauge aluminum support structure. The aluminum base shall have continuously welded curb cap corners and rain gutters for maximum leak protection. Bird screen constructed of 1/2" mesh shall be mounted across the relief opening. Unit shall bear an engraved aluminum nameplate.

D. Accessories:

1. Provide roof curb as specified hereinafter.

a. Relief ventilators: 18” minimum curb height.
b. Intake ventilators; 30” minimum curb height.

2.8 ROOF CURBS

A. Ducts from fans shall be connected to fan with a flex connector; below roofline.

B. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and less wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: per roofing manufacturer's requirements. Coordinate with roofing contractor.
2. Provide a neoprene seal between the fan and the curb cap to help prevent insects and moisture from entering and vibration transmission in the ductwork.
3. Pitch Mounting: Manufacture curb for roof slope.
4. Metal Liner: Galvanized steel.
5. Provide hinged sub-base. Hinged base shall be a factory welded sub-base, hinge and locking hasp that provides a secure and stable means of access to the inlet and interior ductwork for cleaning and inspection. Galvanized aircraft cable shall be installed on the hinged base to support the fan in an open position.
6. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Provide vibration isolation as specified.

C. Support suspended units from structure using threaded steel rods and spring hangers.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in the Division 23 HVAC Identification Section.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Ductwork."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Equipment Startup Checks and Adjustments:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices. Verify that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Inspect and tighten fasteners and setscrews, particularly fan mounting and bearing fasteners.
5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.

6. Verify lubrication for bearings and other moving parts.
7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
8. Adjust damper linkages for proper damper operation.
9. Adjust belt tension.
10. Lubricate bearings.
11. Disable automatic temperature-control operators.

B. Starting Procedures:

1. Energize motor and adjust fan to indicated rpm.
2. Measure and record motor voltage and amperage.

C. Inspection of the fan shall be conducted at the first 30 minute, 8 hour and 24 hour intervals of satisfactory operation. During the inspections, stop the fan and inspect as instructed.

1. 30 Minute Interval: Inspect bolts, setscrews, and motor mounting bolts. Adjust and tighten as necessary.
2. 8 Hour Interval: Inspect belt alignment and tension. Adjust and tighten as necessary.
3. 24 Hour Interval: Inspect belt tension. Adjust and tighten as necessary.

D. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Shut unit down and reconnect automatic temperature-control operators.

G. Refer to Division 23 Section "Testing, Adjusting, and balancing" for testing, adjusting, and balancing procedures.

H. Replace fan and motor pulleys as required to achieve design airflow.

I. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.4 CLEANING

A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

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

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain power ventilators.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals. Refer to Division 1 Section "Closeout Procedures."
3. Schedule training with Owner with at least seven days' advance notice.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

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    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 34 23

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SECTION 23 34 24 – CARBON MONOXIDE EXHAUST SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.1 SUMMARY

A. Section Includes:

1. Duct fittings for vehicle exhaust source capture.
2. Inlet fittings.
3. Hose reel assembly.
4. Accessories.

B. Related Documents: The Contract Documents, as defined in Section 01 10 00 - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents.

C. Related Sections:

1. Section 26 27 26 "Wiring Devices" - Electrical characteristics and wiring connections.

1.2 REFERENCES

A. ACGIH - Industrial Ventilation, A Manual of Recommended Practice.

B. AMCA 99 - Standards Handbook.

C. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.

D. AMCA 300 - Test Code for Sound Rating Air Moving Devices.

E. AMCA 301 - Method of Calculating Fan Sound Ratings from Laboratory Test Data.

F. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Sheet Articles.

G. ASTM A 653 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanealed) by the Hot-Dip Process.

H. ASTM C 443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

I. AWS 9.1 - Welding of Sheet Metal.

J. NBS PS 15 - Voluntary Product Standard for Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment.

K. NFPA 70 - National Electrical Code.

L. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

M. SMACNA - Rectangular Industrial Duct Construction

N. SMACNA - Round Industrial Duct Construction Standard.

O. UL 214 - Tests for Flame-Propagation of Fabrics and Films.

1.3 SUBMITTALS

A. Section 01330 - Submittal Procedures: Procedures for submittals.

1. Product Data: Provide manufacturers literature and data sheets indicating rated capacities, dimensions, weights and point loadings, accessories, electrical characteristics and connection requirements, wiring diagrams, and location and sizes of field connections.

a. Submit sound power levels for both fan inlet and outlet at rated capacity.

2. Shop Drawings: Indicate dimensions, sizes, weights and point loadings, and locations and sizes of field connections.

a. Provide fan curves with specified operating point clearly plotted.

3. Manufacturer's Installation Instructions: Indicate assembly and installation instructions.
4. Assurance/Control Submittals:

a. Certificates: Manufacturer's certificate that Products meet or exceed specified requirements.
b. Qualification Documentation: Submit documentation of experience indicating compliance with specified qualification requirements.

B. Section 01780 - Closeout Submittals: Procedures for closeout submittals.

1. Operation and Maintenance Data: Include instructions for fan lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
2. Special Warranty: Submit written special warranty with forms completed in United States Postal Service name and registered with manufacturer as specified in this Section.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing Products specified with minimum 5 years documented experience.
2. Installer: Company specializing in performing the Work of this Section with minimum 5 years documented experience.

B. Fans

1. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
2. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
3. Fabrication: Conform to AMCA 99.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Section 01600 - Product Requirements: Transport, handle, store, and protect Products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with project requirements, manufacturers offering Products which may be incorporated in the Work include the following:

1. Ventaire, Inc., or equal. (**Sales at HVAC Products, Inc. Tel. 207- 874-6100**).

B. Section 01600 - Product Requirements: Product options and substitutions. Substitutions: Permitted providing equal quality and performance.

2.2 DUCT ACCESSORIES

A. Materials:

1. Galvanized Steel Ducts: ASTM A 653 galvanized steel sheet, lock-forming quality, having G 90 zinc coating in conformance with ASTM A 90.

B. Ductwork

1. Fabricate and support in accordance with SMACNA Round Industrial Duct Construction Standard and Rectangular Industrial Duct Construction Standard and ACGIH Industrial Ventilation Manual except as indicated.
2. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.

3. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
4. Joints: Minimum 4 inch (100 mm) cemented slip type, brazed or electric welded to AWS 9.1. Prime coat welded joints.
5. Provide standard 45 degree lateral wye branch fittings unless otherwise indicated.
6. Use double nuts and lock washers on threaded rod supports.

C. Blast Gates: Full collar of steel, with galvanized steel slide.

2.3 EXHAUST HOSE REEL STATION

A. Equal to Ventaire Spring Powered Hose Reel Model HRA. Unit shall have pull ring kit and be capable of storing 30 feet of flexible tubing and Micro switch to enable exhaust fan.

2.4 EXHAUST SYSTEM ACCESSORIES

A. Tail Pipe Adapters: Provide diesel stack adapter for each hose reel station. Provide dual tail pipe adaptor (“2 Wye Adaptor” connection) for the auto and pickup work. Adapters shall be stainless steel, except for dual pipe adapter which shall be EPDM polymer, spiral pattern, with 60” long legs.

B. Flexible Exhaust Hose: Equal to Ventaire HSGS flexible tubing. Temperature range to 625 F. Fiberglass coated with 2 plies of silicone with a mechanically bonded external helix. All heavy service truck bays shall have 8” diameter hose. Light service vehicle bays shall have 6” diameter hose.

1. All hose lengths shall be 30 feet.

C. Furnish and install a duct mounted pressure relief damper be the vehicle exhaust system manufacturer to open on excess pressure in the ductwork.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer’s instructions.

B. Do not operate fans for any purpose until ductwork is clean, bearings lubricated, and fan has been test run under observation.

C. Coordinate location and mounting heights of hose reel stations with mechanic work bench areas.

D. Provide pitot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage.

E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
3. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
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B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

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END OF SECTION 23 34 24

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SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, 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 the following:

1. Single-duct air terminals.

1.3 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated.

B. Include a schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished.

C. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.

D. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

E. Maintenance Data: List of parts for each type of air terminal and troubleshooting maintenance guide.

1.4 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.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

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. Carrier Corp.
3. Environmental Technologies.
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 VCWF – With Hot Water Coil

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

C. The interior surface of the unit casing shall be acoustically and thermally lined with 3/8-inch, 4.4 lb/ft3 closed-cell insulation. The insulation shall be UL listed and meets NFPA-90A and UL 181 standards. The insulation shall have an R-Value of 1.4. There shall be 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. Accessories

1. 2 Row and 4 Row Water Coisl: 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.
2. A 50 VA transformer shall be factory mounted in an enclosure with 7/8" knockouts to provide 24 VAC for controls.

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. Allow adequate clearance to meet NEC on control box side of unit to meet NEC.

C. Support in accordance with SMACNA and manufacturer recommendations.

D. 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 befitted to a size 8 terminal.

E. 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, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Electrical: Comply with applicable requirements in Division 26 Sections. Ground equipment. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 CLEANING

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

3.5 COMMISSIONING

A. Verify that installation of each air terminal is according to the Contract Documents.

B. Check that inlet duct connections are as recommended by air terminal manufacturer to achieve proper performance.

C. Check that controls and control enclosure are accessible.

D. Verify that control connections are complete.

E. Check that nameplate and identification tag are visible.

F. Verify that controls respond to inputs as specified.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance. Review data in the maintenance manuals. Refer to Division 1.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

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END OF SECTION 23 36 00

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SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, 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 ceiling- and wall-mounted diffusers, registers, and grilles.

1.3 DEFINITIONS

A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.

B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

C. Register: A combination grille and damper.

1.4 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.

1.5 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."

B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of Air-Conditioning and Ventilating Systems."

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 23 31 13 “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 (Basis Of Design)
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) or aluminum (Price 630 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.

2.3 SUPPLY

A. Double-deflection Supply Register

1. Material: steel (Price 520D Series) or aluminum (Price 620D Series)
2. Grilles of the sizes indicated on the plans.
3. Registers shall be double deflection type with two sets of fully adjustable deflection blades spaced ¾" on center. The front set of blades shall run parallel to the short dimension of the register.
4. The integral volume control damper shall be of the opposed blade type. Material shall match the register material. The damper shall be operable from the register face.

B. Directional Louvered-face Diffusers

1. Furnish and install PRICE model (SMD steel, AMD aluminum) directional louvered face diffusers of the sizes and mounting types shown on the plans and air distribution schedule. Diffusers shall consist of an outer frame assembly which facilitates mounting in the application shown. A collar that allows connection to the square (or rectangular) duct size indicated shall be an integral part of the frame assembly. An inner core assembly consisting of fixed louvers capable of producing the airflow discharge pattern indicated on the plans shall be fully removable from the installed diffuser frame for access to any dampers or other ductwork components located in or near the diffuser neck. The inner core assemblies shall be identically constructed so that directional core assemblies providing different airflow discharge patterns may be interchanged between frames, provided the frame duct connections are of the same size.

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.

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.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
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END OF SECTION 23 37 13

SECTION 23 38 13 - COMMERCIAL KITCHEN HOODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.2 SUMMARY

A. This Section includes commercial kitchen hoods.

1.3 DEFINITIONS

A. Listed Hood: A hood, factory fabricated and tested for compliance with UL 710 by a testing agency acceptable to authorities having jurisdiction.

B. Type I Hood: A hood designed for grease exhaust applications.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Standard hoods.
2. Filters/baffles.
3. Fire-suppression systems.
4. Lighting fixtures.
5. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
6. Show fire-protection cylinders, piping, actuation devices, and manual control devices.
7. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
8. Wiring Diagrams: Power, signal, and control wiring.
9. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.

B. Welding certificates.

C. Manufacturer Seismic Qualification Certification: Submit certification that commercial kitchen hoods, accessories, and components will withstand seismic forces defined in Division 23 Section "Mechanical Vibration and Seismic Controls."

D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D 1.1M, "Structural Welding Code - Steel," for hangers and supports; and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for joint and seam welding.

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

1.6 COORDINATION

A. Coordinate equipment layout and installation with adjacent Work, including lighting fixtures, HVAC equipment, plumbing, and fire-suppression system components.

PART 2 - PRODUCTS

2.1 NFPA 101KITCHEN RANGE HOOD

A. Hood shall be D1000 Series by DENLAR Fire Protection, 36” width, be wall mounted so that the bottom of the mounting bracket sits 18” to 26” above the cooktop.

B. Unit shall be of stainless steel construction (#18 & #20 GA, polished 304) w/ no sharp edges and brushed finish

C. Unit shall have fire suppression system factory installed. Activation of the mechanical fire suppression system shall be by 280 degree fusible link.

D. Wet chemical extinguishing agent: Low PH Amerex 660 (pressurized potassium citrate / potassium acetate mix)

E. Unit shall be rear discharge for service by wall mounted exterior fan as scheduled.

F. Unit shall be ETL listed, tested to UL300A standards

G. Motor shall be permanantly lubricated and meet UL507

H. Unit shall include a fuel shut-off device for gas & electric appliances, activated at suppression system discharge

I. Unit shall also automatically disconnect range element once a certain pre-set temperature in reached

J. Unit shall have multiple alarm contacts pre-installed (local, remote & trouble alarms) and an audible buzzer

K. Lighting shall be by 60w shatter-proof bulb

L. Include the following options:

1. Manual Pull Station Kit
2. NSF - Upgrade to Natl. Sanitation Foundation Compliance
3. ADA - Handicapped Accessible Control Box
4. CLBX - THE CLOCKBOX (Key-lock, Range Element Timer) NFPA101 - Upgrade to NFPA Life Safety Code Compliance
5. Custom Powdercoat Finish-color to be selected by the architect.
6. Electric range element disconnect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

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

3.2 INSTALLATION

A. Complete field assembly of hoods where required.

1. Make closed butt and contact joints that do not require filler.
2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in Part 2 "General Hood Fabrication Requirements" Article.

B. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.

C. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.

D. Install hoods to operate free from vibration.

E. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

F. Install lamps, with maximum recommended wattage, in equipment with integral lighting.

G. Set initial temperatures, and calibrate sensors.

H. Set field-adjustable switches.

3.3 CONNECTIONS

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

B. Connect ducts according to requirements in Division 23 Section "Duct Accessories."

C. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Test piping and components for leaks. Repair or replace leaking components.
4. Perform hood performance tests required by authorities having jurisdiction.
5. Perform fire-suppression system performance tests required by authorities having jurisdiction.

D. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial kitchen hoods. Refer to Division 1 Section "Demonstration and Training."

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

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SECTION 23 52 00 – HOT WATER HEATING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for HVAC"
2. Division 23 temperature control section.

1.2 SUMMARY

A. This Section includes boilers, trim, and accessories.

1.3 EFFICIENCY MAINE

A. This project intends to pursue Efficiency Maine prescriptive and/or custom incentives. The contractor shall participate in the activities associated with Efficiency Maine incentive approval process including but not limited to; preparation and submission of required incentive applications and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.

G9	Natural gas-fired condensing hot water boiler >500 MBtu/h and ≤1,000 MBtu/h	Thermal Efficiency ≥ 90%	$2,500.00

1.4 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Source quality-control test reports.

C. Startup service reports.

D. Operation and Maintenance Data: For cast-iron boilers to include in emergency, operation, and maintenance manuals.

E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of cast-iron boilers and are based on the specific system indicated.

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

C. ASME Compliance: Fabricate and label cast-iron boilers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code: Section IV.

D. Boilers shall exceed ASHRAE/IESNA 90.1 (latest edition) requirements.

E. I=B=R Compliance: Cast-iron boilers shall be tested and rated according to HI's "Testing and Rating Standard for Heating Boilers," with I=B=R emblem on a nameplate affixed to boiler.

F. UL Compliance: Test cast-iron boilers to comply with UL 726, "Oil-Fired Boiler Assemblies."

G. UL Compliance: Test cast-iron boilers to comply with UL 795, "Commercial-Industrial Gas Heating Equipment."

H. American Society of Mechanical Engineers (ASME) Code CSD-1 Controls and Safety Devices for Automatically Fired Boilers, 2002 edition

1.6 COORDINATION

A. Refer to Section 15050 “Basic Mechanical Materials and Methods”.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace controls and heat exchangers of cast-iron boilers that fail in materials or workmanship within specified warranty period.

B. Warranty Period for Controls: One year from date of Substantial Completion.

C. Warranty Period for Heat Exchangers: **10** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONDENSING BOILERS

A. Manufacturers

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

   a. Viessmann Manufacturing Co. (US) Inc. (BASIS OF DESIGN)
   b. Cleaver Brooks
   c. Buderus.
   d. Lochinvar

B. Manufactured Units

1. Each unit shall be a Inox-Radial type heat exchanger made of SA240 316Ti complete with boiler fittings and automatic controls. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 60 PSIG. The boiler shall be CSA (formerly AGA/CGA) approved as an indirect or direct vent boiler and comply with ASME CSD-1 Code requirements.
2. The capacity of each unit shall be indicated on the drawing schedule.
3. Exit flue gas temperature of the boiler shall not exceed 160 °F gross at maximum rated input and a hot water supply temperature of 160°F and return temperature of 120°F. The boiler net input shall not exceed 352MBTU/Hr and the output not less than 333M BTU/Hr with an overall fuel-to-water efficiency of 88 % at high fire and 93% at low fire at above operating temperatures.
4. A wiring diagram corresponding to the boiler shall be affixed to the boiler near the electrical panel.

C. Boiler

1. Boiler shall be Inox-Radial design Heat Exchanger. The boiler pressure vessel shall be completely insulated with a minimum of ½”of insulation and shall be encased in an 18 gauge metal cabinet with primer and finish coat of paint. Casing and controls shall ship loose for field installation by manufacturer’s representative.
2. The radial heat exchanger shall be 240 316Ti Stainless Steel
3. The Vessel shall be mounted on a structural steel stand and fitted with drilled feet to facilitate bolt-down to the floor. Exhaust gasses and flue gas condensation shall be collected in a polymer drain collection box complete with drain fitting for draining condensation from the products of combustion.
4. A condensate neutralizing assembly designed by the boiler manufacturer for this boiler shall be included and shipped loose for field installation by contractor. Condensate neutralization assembly shall be shipped complete with sacrificial limestone pellets.
5. The heat exchanger shall be fully accessible by pulling the burner assembly.
6. The vessel shall be fully insulated with a minimum of 1/2” of insulation, guaranteeing external convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated input.
7. The condensing capability shall allow the boiler to be operated without the use of a 3-way valve for the boiler supply water temperature reset. No minimum boiler return water temperature. Minimum flow rate shall be required which would necessitate the use of a secondary circulation pump. Boiler pump shall be Grundfos UPS26-150F, as scheduled, or equivalent.

8. Boiler shall be built to seismic zone 4 requirements and manufacturer shall provide seismic calculations showing tie-down requirements for bolt diameters. Bolts and tie-down shall be by contractor. Vibration isolation components shall not be required.

D. Burner

The burner shall use Lambda Pro technology that self adjusts to all gas types (NG/LPG/LNG) and altitudes with a simple electronic adjustment. The control shall adjust gas and air independently based on flame quality (ionization current). Combustion shall be “self calibrating”.

1. Burner shall be constructed of high grade stainless steel for universal use of propane or natural gas

E. Boiler Trim

1. Safety valve shall be ASME Section IV approved side outlet type mounted on the boiler water outlet. Size shall be in accordance with code requirements and set to open at 60 psig.
2. Temperature and pressure gauge shall be mounted on top of the boiler.
3. Low water cut-off probe with manual reset.
4. Auxiliary low water cut-off, manual reset, shipped loose for field installation by contractor
5. Temperature controls including operating controller, modulating controller, and high limit controller.
6. Low pressure Gas pressure regulator shall be furnished factory installed. A single 60# body gas regulator for installation in common gas line prior to boilers shall be provided by boiler supplier for installation by contractor.

F. Accessory

1. Sidewall Vent Kit: #KIT 7424121 vent kit.
2. Neutralizer Kit: #KIT p/n 7441823, 1 ¼” flexible drain to CPVC standpipe, indirect to floor drain.
3. Low-Loss Header 200/120 (80 gallon flow).
4. Viessmann 3-way mixing valve, 2 1/2" size.
5. Conbraco Motorized isolation valve.

G. Venting and Air Intake

1. Coaxial Piping per manufacturer's recommendations and written instructions.
2. The boiler shall be equipped with a flue gas vent opening at the top of the boiler. Venting shall be through the roof, (direct vent) chimney system. The boiler shall operate under Category IV positive vent pressure conditions for room air dependant operation. Venting material for room air dependant operation shall be stainless steel UL approved venting system for positive pressure or polypropylene ULC S636 listed material (equal to M&G / Duravent or Centrotherm InnoFlue) for sustained flue gas temperature up to 230°F.

3. Provide support clamps, concentric termination, condensate drains, roof supports, appliance adapters, elbows, and other fittings as recommended by the vent manufacturer and boiler manufacturer.

H. Boiler Controls

1. The Boiler package shall include an integrated, microprocessor-based controller. Boiler Control shall perform the following functions:

    a. Electronic ignition.
    b. Burner sequencing and flame supervision with safe start check, pre-purge, electronic direct spark ignition, and post purge. Flame rod to prove combustion.
    c. Modulating combustion fan and burner modulation over a 3:1 turndown ratio.
    d. Safety shutdown with display of error.
    e. Low gas pressure, air proving, high limit, and frost protection.
    f. The supply temperature and set point temperature shall be displayed at all times by an LED readout. Output shall be a continuous PID via 4-20 mA current. (The control shall have the ability to reset the boiler water temperature based on outside air temperature or an input signal from a building management system).

2. Controller shall have an option for communication device to computer interface for commissioning and advanced diagnostics.
3. All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to CSA requirements. Electrical power supply shall be 120 volts, 60 cycle, single phase, for the boiler fan; 110 volts, 60 cycle, single phase for the control circuit requirements.

I. Boiler Management Control System

1. Supply a fully integrated boiler control system to coordinate the operation of Three (3) fully modulating hot water boilers and boiler primary water circulating pumps in order to maintain the Hot Water Supply (HWS) temperature at setpoint. The control system shall be microprocessor-based and suitable for wall mounting.
2. The control system shall incorporate a HWS header temperature PID control scheme. Boilers shall be modulated in “Unison” (all at the same firing rate) to optimize the efficiency of the boilers. Modulation signals shall be 4-20mAdc and shall be electrically isolated channel-channel and channel-ground.
3. When the HWS Temperature control loop is in the “automatic” mode, the control system shall establish the HWS temperature setpoint based on the time of day, day of the week and the outside air temperature. When in “manual” mode the operator may set the HWS temperature via a front panel display. All temperatures and time/date data must be field adjustable through “fill-in-the-blanks” style displays. The control system shall accept a 4-20 mAdc outdoor air temperature reset setpoint signal from an external Building Automation System (BAS).
4. The control system shall utilize both HWS temperature and boiler firing rate percent to start and stop the boilers and shall minimize the total number of boilers in operation. The controller shall start and stop boilers when the HWS temperature is outside the adjustable temperature limit for longer than the adjustable time delay. In order to minimize header temperature deviations the control system shall start and stop the next boiler when the “lead” boiler is at an adjustable firing rate limit for longer than the adjustable time delay. The control system shall monitor both boiler lockout and limit circuits to automatically skip over those boilers that are powered down for maintenance, tripped or otherwise will not start. The lead boiler shall either automatically rotate every 1 to 168 hours or shall be manually selected by the operator. The boiler shall be run at low fire for warm-up for a preset low fire hold time. The base load ramp rate shall be field adjustable. The control system shall reduce the firing rate to a minimum before stopping a boiler to prevent accumulation of fuel in the furnace.
5. Provide main header primary water pump control to improve fired equipment availability. Start the quantity of header pumps as required for the number of boilers in operation. The control system shall monitor pump outlet flow switch status to automatically start a standby pump when a command to start the pump fails to produce flow. System must keep at least one pump running to ensure water is always moving past the header temperature sensor even after the last boiler has been stopped.

6. Provide boiler water flow valve control to prevent water from flowing through off-line boilers (and lowering the HWS temperature); continue water flow for an adjustable cool down period after the boiler has stopped; and ensure water is always moving past the header temperature sensor even after the last boiler has been stopped. The valve shall be immediately closed if any trips occur during pre-purge, pilot, or main flame trial for ignition.
7. The control system shall include a 16 line x 40 character (or greater) LCD display for boiler sequence control and status, alarm and event summaries, and setup menus for easy operation, tuning and troubleshooting. Alarms, events and operator actions shall be logged with Time/Date stamp and English language description. The control system shall include a minimum of 200 point memory. The Control System shall include a minimum 100x150 pixel historical trending display or a paperless chart recorder or other video-graphic hardware to permit the logging of at least 32 data points for at least 45 days. Provide a minimum of 4 “pens” per chart with 8 minute thru 24 hour chart “width” selections available.
8. Include hard wired backup stations to permit manual operation of the plant should the control system require service. Manual operation must be possible when the microprocessor is not functioning. Hard wired “Hand-Off-Auto” control switches must be wired directly into every boiler, pump, Start/Stop circuit. Each 4-20 mAdc modulating control output must include a hard wired manual backup station with Auto/Manual switch, output control knob and output level indicator (bargraph, analog meter or digital display).
9. The Control System shall include simultaneous communication to a Data Acquisition System (DAS), Building Automation System (BAS) or Building Management System (BMS) via RS485 Modbus protocol and to a Personal Computer and an alphanumeric pager via standard telephone lines. The individual boiler limits, lockout, start/stop, warm standby, and firing rate status shall be readable. Header setpoint, plant firing rate, boiler quantity called to start, boiler selected as lead, and all setup parameters shall be readable and writable.
10. The control system shall be manufactured and labeled in accordance with UL508 requirements. Inspection and labeling shall be supervised by UL or other OSHA approved Nationally Recognized Test Lab (NRTL).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

B. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

C. Examine mechanical spaces for suitable conditions where boilers will be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Boiler installation shall be accomplished within acceptable A.S.M.E. piping practices and requirements and in strict accordance with the boiler manufacturer's recommendations and instructions.

B. Install boilers level on concrete base. Refer to Section 15050, Basic Mechanical.

C. Install gas-fired boilers according to NFPA 54.

D. Install oil-fired boilers according to NFPA 31.

E. Install boilers in accordance with the Maine Oil and Solid Fuel Board requirements.

F. Assemble and install boiler trim.

G. Install electrical devices furnished with boiler but not specified to be factory mounted.

H. All boiler discharges shall be piped to floor drains as shown on the contract drawings and as indicated by the consulting engineer. Blowdown valves shall be brass, ball type and not less than one-inch IPS and they shall discharge to a floor drain or away from the boiler as directed by the Consulting Engineer. Pipe ends shall be cut at a 45-degree angle to prevent a cap or plug from being installed. Hangars or standoffs to prevent the valve body from undue stress or strain shall support all such discharge piping.

3.3 BOILER PLANT WIRING

A. Gas-fired boilers shall be wired in accordance with NFPA 58 requirements.
   1. All **new** wiring shall be brought into compliance with the requirements of the Maine rules. The wiring update includes the following:

      a. Properly rated fuse or breaker.
      b. Properly rated wiring.
      c. The emergency shut off switches shall be placed at the outside entrances of the boiler room. The emergency switches and the thermal cut-off switches shall be wired in series through individual unit relays so that, if the emergency switch is opened, all heating equipment in the room and the transfer pump set will be rendered inoperable.
      d. A thermal cut-off switch shall be wired into the burner circuits to shut off the burners in the event of a fire at the unit. The switches shall be placed at the highest point directly above the unit to be fired with the thermal element pointed downwards. The switch shall be placed on the bottom the joist at the front of the unit, but in no case shall it be lower than the point where the flue connector enters the chimney and shall be wired to shut-off the burner, circulating fan, forced or induced draft fan and remote oil pump not an integral part of the burner. Install the switch into a 3 1⁄4 “or 4" round junction box and wire into the burner control circuit. In the event ambient temperature rises above 165° F the fusible element melts to open the contact and stop the burner firing. The fusible element safety switch shall be a Preferred Utilities Mfg. Fusomatic Electric Cut-Off Switch.
      e. Properly installed and located service switch. A service disconnect switch shall be placed at the unit, within arm’s reach of the technician, for control of the burner while observing the flame.
      f. The emergency and thermal electrical switches shall be wired in series through individual unit relays so that, if one switch is opened, all equipment will be rendered inoperable whenever the "EMERGENCY" switch is opened.

3.4 CONNECTIONS

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

B. Stop valves of the outside stem and yoke type shall be provided in the supply and return pipe connections to the boiler. Provisions shall be made for the expansion and contraction of the heating mains connected to the boiler by providing substantial anchorage at suitable points and assisted by the use of swing joints to allow the piping to expand and contract without imposing excessive forces on the boiler castings.

C. Connect gas piping full size to boiler gas-train inlet with union.

D. Connect oil piping full size to burner inlet with shutoff valve and union.

E. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

F. Install piping from safety relief valves to nearest floor drain.

G. Connect breeching full size to boiler outlet.[Refer to Division 15 Section "Breechings, Chimneys, and Stacks" for venting materials.]

H. Install piping adjacent to boiler to allow service and maintenance.

3.5 BOILER PLANT MASTER CONTROL SYSTEM INSTALLATION

A. General: Provide a fully automatic combustion control and instrumentation system, complete with all controls, instruments, panel boards, and miscellaneous items required to include the following system functions:

1. Maintain constant water temperature.
2. Maintain primary and secondary loop water set points by pumps operating thru Variable Frequency Drives and modulating of control loop and domestic hot water control valves.
3. Monitor and control boiler operation.
4. Coordinate with Temperature Controls Contractor to provide Interface with Building Management System.

B. Wiring: Provide all electrical (Power and Control) wiring, conduits and appurtenances from junction box provided under Division 16 to the operator’s station, control panels, boilers, remote controls and sensors. Wiring shall comply with all Division 16 requirements.

3.6 MANUFACTURER’S FIELD SERVICES

A. General: The boiler supplier shall be responsible for performance of inspections, start up and testing of the packaged boiler and accessory equipment and materials furnished under this Section. A detailed written record of the start up performance, including burner setting data over the entire load range shall be furnished to the engineer before acceptance. All labor, equipment and test apparatus shall be furnished by the supplier. All equipment defects discovered by the tests shall be rectified. The minimum time for two (2) boilers is two (2) days.

B. Equipment inspection: Boiler representative to provide 4 hours of jobsite assistance to inspect boilers and other equipment verifying completeness of equipment supplied. Casing, insulation and boiler mounted controls shall ship loose for field assembly by Manufactures Representative after boiler has been set and mounted on legs by installing contractor. Installing contractor shall provide laborer for assistance. Responsibility of making freight claims shall be with the contractor or owner personnel.

C. Pre start-up walk through: Boiler representative shall provide 2 hours at jobsite reviewing installation with mechanical contractor. This walk-through to be conducted approximately 1 week prior to startup.

D. A hydrostatic pressure test of one-and-one-half times the working pressure of the boiler shall be conducted on this boiler for a period of not less than five hours. Such tests shall be of such duration as

necessary and as directed by the engineer to ensure the boiler has been assembled and installed correctly with no leaks or improper operating conditions.

E. The installing contractor shall contact and notify the Boiler Inspections Divisions of the State when the installation of the boiler, burner and controls is substantially complete. Installing contractor shall request an Inspection of the boiler to be conducted by the State Boiler Inspector and to have a Certificate of Inspection issued upon satisfactory inspection.

F. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the boiler supplier, and shall include the following:

1. Demonstrate that boiler, burner, controls and accessories comply with requirements of this Section as proposed by the boiler and accessories supplier. Pre-test all items prior to scheduling the final testing that will be witnessed by the test engineer.
2. Readings at different firing rates (20, 50, 75 and 100%) of load for the modulating burner shall be taken with a written report of the tests submitted to the engineer. The reports shall include readings for each firing rate tested and shall include stack temperatures, O2, CO, NOx, and overall boiler efficiency.
3. Auxiliary Equipment and Accessories: Observe and check all valves, draft fans and electric motors, as well as other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctions, defects, and non-compliance with referenced standards or overloading as applicable.
4. Commissioning Requirements:

    a. Fireside inspection
    b. Set up fuel train and combustion air system
    c. Set up operating set points
    d. Check all safeties, including: Flame safeguard, LWCO, ALWCO, Air flow, Fuel pressures, High limits.
    e. Set up and verify efficiencies at 20%, 50%, 75%, and 100%
    f. Set up and verify burner turndown.

G. Training to include all safety procedures, maintenance procedures, control operations, and diagnostic procedures. Training to be provided in a single 2 hour continuous session to accommodate operator’s availability on site.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cast-iron boilers. Refer to Division 1.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.

2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 52 00

SECTION 23 55 33 - FUEL-FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Division 23 Section "Common Work Results for Mechanical"

1.2 SUMMARY

A. This Section includes gas-fired unit heaters.

1.3 EFFICIENCY MAINE

A. This project intends to pursue Efficient Maine prescriptive and/or custom incentives. The contractor shall participate in the activities associated with Efficiency Maine incentive approval process including but not limited to; preparation and submission of required incentive applications and the tracking and submission of measure specific invoices to Efficiency Maine within 60 days of the completion of the work.

G16	Natural gas-fired, warm-air unit heater	Thermal Efficiency ≥ 90%	$600.00

1.4 SUBMITTALS

A. Product Data: For each type of fuel-fired unit heater indicated. Include rated capacities, operating characteristics, and accessories.

B. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Operation and Maintenance Data: For fuel-fired unit heaters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTUERSS

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

1. Reznor/Thomas & Betts Corporation.
2. Trane
3. Sterling HVAC Products; Div. of Mestek Technology Inc.

2.2 ULTRA HIGH EFFICIENCY, PROP FAN, GAS FIRED UNIT HEATER

A. Provide (90 %+) high-efficiency, separated-combustion, power vented, condensing, gas-fired unit heaters; Reznor UEAS. The unit shall be designed for use in a building with negative pressures up to 0.15 "w.c. and for use in building where a non-explosive atmosphere exists that is dust laden and/or contains mildly corrosive fumes.

B. The unit heater shall be equipped for use with natural gas with propane conversion kit shipped with each unit. Gas connection shall be external to the cabinet.

C. The heater shall be equipped with a multi-cell, 4 pass serpentine style steel primary heat exchanger. Primary heat exchanger tubes shall be press fabricated of 409 stainless steel. The heater shall also be equipped with an extruded aluminum secondary heat exchanger. Secondary heat exchanger shall have a PVC condensate drain connection. All heat exchangers shall be fabricated with no welding or brazing, only tool pressed mechanical joints. All heat exchanger cells shall be designed with an aerodynamic cross section to provide maximum airflow.

D. The units shall incorporate a single, one piece burner assembly with a single orifice. The burner shall have a continuous wound close pressed stainless steel ribbon separating the flame from the burner interior. All units shall have a single venturi tube and orifice supplying fuel to a one-piece burner housing. Each heat exchanger cell shall use balanced draft induction to maintain optimum flame control.

E. Controls shall include a single-stage gas valve; direct spark multi-try ignition with electronic flame supervision with 100% lockout integrally controlled via a printed circuit control board. The control board shall also incorporate diagnostic lights, DIP switches for fan overrun settings, and a relay for fan only operation. All units shall be equipped with a safety limit switch. All controls shall be enclosed in the sealed control compartment to protect them from accidental damage, dust, and atmospheric corrosion.

F. The unit shall have a factory-installed power venter device to draw combustion air from outside of the building. The outside air shall enter the unit through a factory-installed round inlet air terminal on the rear of the heater.

G. The control compartment shall be sealed and the access door shall be gasketed to prevent dirt, lint, dust, or other contaminants present in the heated space from entering the unit. The control compartment door shall be equipped with a safety interlock switch to prevent operation when the door is open.

H. The combustion air supply pipe and flue exhaust pipe shall be run in parallel from the heater to a factory supplied concentric adapter assembly, which allows for a single wall or roof penetration, to the (horizontal) (vertical) air inlet and vent terminal. A 4" PVC clean out cap drilled and tapped for attaching a vent condensate drain is included with the vent/combustion air kit. The combustion air/venting system shall include a vibration isolated power venter motor and wheel assembly and a combustion air pressure switch.
   1. Horizontal kits: equal to Reznor #CC6
   2. Vertical kits: equal to Reznor # CC2
   3. Provide Breidert style vent cap for high wind environment.

I. Operation shall be controlled by an integrated circuit board that includes LED diagnostic indicator lights. Supply voltage connections shall be made in a sealed junction box. 24-volt control connections shall be made on an externally mounted terminal strip with connections (W1, W2, R, and G). All internal wiring, both line and control voltages, shall be terminated by insulated terminal connectors to minimize shock hazard during service.

J. Each unit shall be equipped for use with 115/1 volt power supply.

K. All units will be equipped with a built-in disconnect switch.

L. The cabinet shall be low profile with a pre-coat or powder-coat white paint finish. Finish shall be a minimum 80 gloss on G30 galvanized steel. The cabinet shall be constructed so that screws are not visible from the bottom, front, or sides, except for service panel and accessories. Unit construction shall incorporate a beveled front corner on control side for additional cabinet rigidity. All units shall be manufactured with a tooled drawn supply air orifice on the rear panel to reduce fan inlet noise.

M. The unit shall be designed for ceiling suspension featuring 3/8”-16 female threads (hanger kits for 1” pipe) at 4-point locations with no additional adapter kits.

N. The cabinet shall be equipped with burgundy painted, roll-formed horizontal louvers. Louvers shall be spring held and adjustable for directing airflow.

O. The cabinet shall be equipped with a full safety fan guard. The open drip proof motor and fan assembly shall be resiliently mounted to the cabinet to reduce vibration and noise.

P. The unit shall be designed with a full opening service access panel complete with screw closure attachment and lifting handle for removal. Service panel shall be fully gasketed and equipped with a safety interlock switch. All components in the gas train, all standard electrical controls, and the power venter shall be within the sealed service compartment.

Q. Minimum top clearance from combustibles shall be 4”. Minimum bottom clearance from combustibles shall be 1”. Minimum clearance from combustibles on non-service side shall be 2”.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and connect gas-fired unit heaters and associated fuel and vent features and systems according to NFPA 54, applicable local codes and regulations, and manufacturer's written installation instructions.

B. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

C. Restrain the unit to resist code-required horizontal acceleration.

3.2 CONNECTIONS

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

B. Install piping adjacent to fuel-fired unit heater to allow service and maintenance.

C. Gas Piping: Comply with Division 15 Section "Fuel Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.

D. Vent Connections: Comply with Division 15 Section "Breechings, Chimneys, and Stacks."

E. Electrical Connections: Comply with applicable requirements in Division 16 Sections. Install electrical devices furnished with heaters but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Verify bearing lubrication.
3. Verify proper motor rotation.
4. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

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

3.4 ADJUSTING

A. Adjust initial temperature set points.

B. Adjust burner and other unit components for optimum heating performance and efficiency.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fuel-fired unit heaters.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 55 33

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SECTION 23 62 00 – AIR COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Section 15050 “Common Work Results For Mechanical”
2. Division 15 Section "Refrigerant Piping" for valves and accessories for piping connections to units.

1.2 SUMMARY

A. This Section includes Air-cooled condensing units.

1.3 SUBMITTALS

A. Product Data: Include rated capacities; shipping, installed, and operating weights; dimensions; required clearances; methods for assembling components; furnished specialties; accessories; and installation and startup instructions for each model indicated.

B. Refrigerant piping schematic; Size piping and design the actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes, to ensure proper operation and compliance with warranties of connected equipment.

C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: For each condensing unit to include in the maintenance manuals specified in Division 1. Include a parts list for each condensing unit, control, and accessory; troubleshooting maintenance guide; and servicing and preventive maintenance procedures and schedule.

F. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide electrically operated equipment specified in this Section that is listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Code for Mechanical Refrigeration."

C. Comply with NFPA 70.

D. Comply with UL 303, "Refrigeration and Air-Conditioning Condensing and Compressor Units."

1.5 COORDINATION

A. Coordinate size and location of concrete housekeeping bases. Cast anchor-bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7.

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Compressor Warranty: A written warranty, executed by Contractor and signed by manufacturer, agreeing to replace components that fail in materials and workmanship within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed. Warranty Period: not less than 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Condensing Units, Air Cooled, 1 to 5 Tons:

a. Trane Co. (The); North American Commercial Group. (Basis of Design).
b. Carrier Corp.; Carrier Air Conditioning Div.
c. York, Johnson Controls Corp, Contact Daniel Meyers: tel 603-222-2409.

2.2 CONDENSING UNITS, AIR COOLED, 1 TO 5 TONS

A. Description: Factory assembled and tested, air- cooled; consisting of compressors, condenser coils, fans, motors, refrigerant reservoirs, and operating controls.

B. Compressor: The compressor shall have internal over temperature and pressure protection, and total dipped hermetic motor windings. Provide roto-lock suction and discharge refrigerant connections, and centrifugal oil pump.

C. Condenser: Copper-tube, aluminum-fin coil, with liquid sub-cooler.

D. Refrigeration circuit: Refrigeration system controls include condenser fan and compressor contactor. High and low pressure protection shall be inherent to the compressor. A factory installed liquid line drier and low-pressure switch shall be provided. Field braze connections shall be externally accessible, with multi-use liquid and gas line valves with service pressure gauge ports.

E. Provide operating charge of R410a.

F. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated fan motor with thermal-overload protection.

G. Accessories include the following:

1. Pre-charged and insulated suction and liquid tubing.
2. Low ambient kit to permit operation down to 45 deg F.
3. Crankcase heater.
4. Automatic reset timer to prevent compressor rapid cycle.
5. Polyethylene mounting base to provide a permanent foundation.

H. Casing: Steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

2.3 CONDENSING UNITS, AIR COOLED, 6 TO 120 TONS

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

1. Trane Co. (The); North American Commercial Group. (Basis of Design).
2. Carrier Corp.; Carrier Air Conditioning Div.
3. York, Johnson Controls Corp, Contact Daniel Meyers: tel 603-222-2409.

B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

C. Compressor: Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.

1. Capacity Control: On-off compressor cycling.

D. Compressor: Hermetic or semihermetic rotary screw compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.

1. Capacity Control: On-off compressor cycling.

E. Refrigerant: R-410A

F. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

G. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:

1. Permanently lubricated, ball-bearing totally enclosed motors.
2. Separate motor for each fan.
3. Dynamically and statically balanced fan assemblies.

H. Operating and safety controls include the following:

1. Manual-reset, high-pressure cutout switches.
2. Automatic-reset, low-pressure cutout switches.
3. Low-oil-pressure cutout switch.
4. Compressor-winding thermostat cutout switch.
5. Three-leg, compressor-overload protection.
6. Control transformer.
7. Magnetic contactors for compressor and condenser fan motors.
8. Timer to prevent excessive compressor cycling.

I. Accessories:
1. Gage Panel: Package with refrigerant circuit suction and discharge gages.
2. Part-winding-start timing relay, circuit breakers, and contactors.
3. Reversing valve.

J. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:

1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
3. Gasketed control panel door.
4. Nonfused disconnect switch, factory mounted and wired, for single external electrical power connection.
5. Condenser coil hail guard grille.

K. Capacities and Characteristics: As scheduled on the drawings.

2.4 SOURCE QUALITY CONTROL

A. All condensing units shall be U.L. Listed.

B. Verification of Performance: Rate condensing units according to ARI.

C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install condensing units according to manufacturer's written instructions.

B. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

C. Install ground-mounted units on 4-inch- thick, reinforced concrete base, 4 inches larger than condensing unit on each side. Concrete, reinforcement, and formwork requirements are specified in Division 3. Coordinate installation of anchoring devices.

D. Install units on spring isolators.

3.2 CONNECTIONS

A. Connect pre-charged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

B. Connect refrigerant piping to air-cooled condensing units; maintain required access to unit. Install furnished field-mounted accessories.

C. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Repair leaks and replace lost refrigerant and oil.

B. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units with new units and retest.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Clean units to remove dirt and construction debris and repair damaged finishes.

3.5 COMMISSIONING

A. Verify that units are installed and connected according to the Contract Documents.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for physical damage to unit casing.
2. Verify that access doors move freely and are weather-tight.
3. Clean units and inspect for construction debris.
4. Check that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

C. Lubricate bearings on fans.

D. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

E. Adjust fan belts to proper alignment and tension.

F. Start unit according to manufacturer's written instructions.

1. Complete manufacturer's starting checklist.

G. Measure and record airflow over coils.

H. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

I. After startup and performance test, lubricate bearings and adjust belt tension.

3.6 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals.
3. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.

2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

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END OF SECTION 23 62 00

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SECTION 23 72 00 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.2 SUMMARY

A. Section Includes: Packaged Energy Recovery Units – Fixed Plate Enthalpic

1.3 SUBMITTALS

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

B. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Wiring Diagrams: For power, signal, and control wiring.

D. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.

1.4 QUALITY ASSURANCE

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

B. ARI Compliance: Capacity ratings for air-to-air energy recovery equipment shall comply with ARI 1060, "Rating Air-to-Air Energy Recovery Equipment."

C. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. UL Compliance: UL 1812.

1.5 COORDINATION

A. Coordinate layout and installation of air-to-air energy recovery equipment and suspension system with other construction that penetrates ceilings or is supported by them.

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

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 PACKAGED ENERGY RECOVERY UNITS – FIXED PLATE ENTHALPIC

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

1. RenewAire LLC.
2. Mitsubishi Electric Sales Canada Inc.

B. Quality Assurance

1. The energy recovery cores used in these products shall be third party Certified by AHRI under its Standard 1060 for Energy Recovery Ventilators. AHRI published certifications shall confirm manufacture's published performance for airflow, static pressure, temperature and total effectiveness, purge air (OACF) and exhaust air leakage (EATR). Products that are not currently AHRI Certified will not be accepted.
2. Manufacturer shall be able to provide evidence of independent testing of the core by Underwriters Laboratory (UL), verifying a maximum flame spread index (FSI) of 25 and a maximum smoke developed index (SDI) of 50 thereby meeting NFPA 90A and NFPA 90B requirements for materials in a compartment handling air intended for circulation through a duct system. The method of test shall be UL Standard 723.
3. Unit shall be Listed under UL 1812 Standard for Ducted Air to Air Heat Exchangers. Some exceptions to UL Listing may apply. Units intended for "Outdoor Use" shall be listed using the specific UL requirements for rain penetration, corrosion protection and seal durability and shall be so labeled.
4. The ERV core shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of ten years from the date of purchase. The balance-of-unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of two years from the date of purchase.

C. Performance

1. Energy Transfer: The ERV shall be capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one air stream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air.
2. Passive Frost Control: The ERV core shall perform without condensing or frosting under normal operating conditions (defined as outside temperatures above -10°F and inside relative humidity

below 40%). Occasional more extreme conditions shall not affect the usual function, performance or durability of the core. No condensate drains will be allowed.

3. Continuous Ventilation: Unit shall have the capacity to operate continuously without the need for bypass, recirculation, pre-heaters, or defrost cycles under normal operating conditions.
4. Positive Airstream Separation: Water vapor transfer shall be through molecular transport by hydroscopic resin and shall not be accomplished by "porous plate" mechanisms. Exhaust and fresh airstreams shall travel at all times in separate passages, and airstreams shall not mix.
5. Laminar Flow: Airflow through the ERV core shall be laminar over the products entire operating airflow range, avoiding deposition of particulates on the interior of the energy exchange plate material.

D. Construction

1. The energy recovery component shall be of fixed-plate cross-flow construction, with no moving parts.
2. No condensate drain pans or drains shall be allowed and unit shall be capable of operating in both winter and summer conditions without generating condensate.
3. The unit case shall be constructed of G90 galvanized, 20-gauge steel, with lapped corners and zinc plated screw fasteners. The unit roof shall be one piece or have watertight standing seam joints and shall overlap wall panels and doors in order to positively shed water.
4. Access doors shall provide easy access to blowers, ERV cores, and filters. Doors shall have an airtight compression seal using closed cell foam gaskets rated for outdoor exposure. Pressure taps, with captive plugs, shall be provided allowing cross-core pressure measurement allowing for accurate airflow measurement.
5. Weather hoods shall be screened to exclude birds and animals. Inlet weather hoods shall be sized to maintain inlet velocities below 500 fpm, and equipped with rain excluder baffles.
6. Case walls and doors shall be insulated with 1 inch, 4 pound density, foil/scrim faced, high-density fiberglass board insulation, providing a cleanable surface and eliminating the possibility of exposing the fresh air to glass fibers, and with minimum R-value of 4.3 (hr·ft2·°F/BTU).
7. The ERV cores shall be protected by a MERV-8 rated, 2" nominal, pleated, disposable filter in both airstreams.
8. Unit shall have single-point power connection and a single-point 24 VAC contactor control connection
9. Blower motors shall be Premium Efficiency, EISA compliant for energy efficiency. The blower motors shall be totally enclosed (TEFC) and shall be supplied with factory installed motor starters (HE6X and HE8X 208-230/460V models are open drip proof). Direct drive models (EV450 and HE1X models) shall be EISA compliant for energy efficiency with open drip proof design and integral thermal protection.
10. Blowers shall be quiet running, forward curve type and be either direct drive (EV450 and HE1X only) or belt drive. HE6X and HE8X units use backward incline, belt drive blower packages. Belt drive motors shall be provided with adjustable pulleys and motor mounts allowing for blower speed adjustment, proper motor shaft orientation and proper belt tensioning.
11. The unit electrical box shall include a factory installed, non-fused disconnect switch and a 24 VAC, Class II transformer/relay package.
12. The ERV shall be provided "inverter-ready" allowing for applications of inverters supplied and installed by others

E. Options (Select options based on application requirements)

1. Provide unit and duct connection orientation per project schedule.
2. Provide double wall construction with 24-gauge galvanized steel liner.
3. Provide factory installed disconnect fuses.
4. Provide factory installed filter monitors for each airstream.
5. Provide MERV-13 filters for final installation after construction phase.

6. Provide 14 inch high, non-pitched roof curbs as available from the factory. Pitched curbs, vibration curbs, seismic curbs and other custom curbs are available directly from curb manufacturer. Roof curbs shall be constructed according to recommendations of NRCA.
7. RTC (Roof Top Connect) units shall have return air and fresh air ducts configured to permit direct tie-in to rooftop air handlers using factory offered transition piece. (See separate specification for factory transition availability.)
8. Provide high wind tie-down kit.
9. Provide factory installed Variable Frequency Drives (available for all models HE2XIN and larger) allowing either preset or variable speed operation with appropriate 0-10 volt DC or DDC control signal.
10. Provide ECM controlled motors (available for EV450IN and HE1XIN models) allowing for to preset speeds or variable speed operation with a 0-10 volt DC control signal.
11. Provide factory installed isolation dampers for either or both air streams (available for all models except EV450IN). The insulated dampers shall be of a low leakage design and shall not restrict the airstream, reducing airflow, in any way. The dampers shall be opened with a motor actuator powered by the standard unit transformer package and have a spring return for low off- position power consumption.

F. Coordinate configuration of ERU-1 with the RTU manufacturer such that ERU-1 operates in direct integration with RTU-3 for economizer and demand controlled ventilation. This unit shall share a curb with RTU-3 for operation as a package system. Refer to Section 230993-Sequence of Operation for HVAC Controls and Section 237413 – Rooftop Air Conditioners for additional requirements. Provide interface of the unit mounted controller with the facility BAS.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

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

E. Locate and orient unit to provide the shortest and most straight duct connections. Provide service clearances as indicated on the plans. Locate units distant from sound critical occupancies.

3.2 INSTALLATION

A. Install units with clearances for service and maintenance.

B. Equipment Mounting: Install floor-mounted air-to-air energy recovery equipment on concrete bases. Comply with requirements for concrete bases specified in Section 230500 “Common Work Results for HVAC”.

C. Roof Mounted Units

1. Install air-to-air energy recovery equipment on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 7. Secure air-to-air energy recovery equipment to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.
2. Install a structurally sound, weathertight, level and properly insulated roof curb with nailers, curb gasket and tie-downs to meet local wind load requirements.
3. Insure roof decking penetrations inside curb are properly positioned and sized for ducts. Seal all penetrations and gaps between ducts and decking with appropriate fire, weather and acoustic sealant system.
4. Install fiberglass batt insulation over the decking inside the curb. Insulation thickness to be determined by local thermal requirements.
5. Use proper rigging, including spreader bars, for safe lifting and placement.
6. Ductwork shall be installed to the curb duct adaptors before unit is set in place.
7. Both the return and the supply ducts shall be thermally insulated at levels appropriate to the local climate from the unit through the curb and continuous until at least the first elbow or tee. A continuous vapor barrier shall also be provided on warm surface of the insulation.

D. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in Division 23 Section vibration/seismic specification section.

E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

F. Sound Control: To control sound associated with the two blower outlets:

1. Provide straight, gradual transition ductwork for a minimum of 2-1/2 duct diameters downstream from the blower outlet.
2. Provide continuous acoustic insulation treatment of the duct until after the first elbow or tee.

3.3 CONNECTIONS

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

B. Comply with requirements for ductwork specified in Division 23 Section "Ductwork."

C. Install piping adjacent to machine to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Test and Balancing: Test and Balancing may not begin until 100% of the installation is complete and fully functional.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

E. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.

c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

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SECTION 23 73 13 - INDOOR AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 23 Section "Common Work Results for Mechanical"
2. Division 23 Section "Humidifiers" for humidifiers not an integral part of air-handling units specified in this Section.

1.2 SUMMARY

A. This Section includes air-handling units with coils for indoor installations.

1.3 SUBMITTALS

A. Product Data: For each type of indoor air-handling unit indicated. Include the following:

1. Certified fan-performance curves with system operating conditions indicated.
2. Certified fan-sound power ratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Motor ratings, electrical characteristics, and motor and fan accessories.
5. Material gages and finishes.
6. Filters with performance characteristics.
7. Dampers, including housings, linkages, and operators.

B. Field Quality-Control Test Reports: From manufacturer.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain indoor air-handling units through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of indoor air-handling units and are based on the specific system indicated.

C. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

D. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

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

F. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

G. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

H. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

I. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

J. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Units may be shipped fully assembled or disassembled to the minimum module size in accordance with shipping or jobsite requirements.

B. The units must be rigged and lifted in strict accordance with the manufacturer’s recommendations.

C. All unit openings must be sealed to prevent the entrance of construction dust.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate size and location of structural-steel support members.

1.7 EXTRA MATERIALS

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

1. Filters: Two complete set for each indoor air-handling unit.

PART 2 - PRODUCTS

2.1 MODULAR AIR HANDLERS

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

1. Trane Performance CLCH-CSSA (Basis of Design)
2. Carrier 39T
3. McQuay Vision
4. York, Johnson Controls Corp

B. The unit shall be constructed as a complete frame with removable panels. Removal of side panels shall not affect the structural integrity of the unit. The casing shall be able to withstand up to 6 in. wg positive or 4 in. wg negative static pressure. All exterior wall panels shall be made of galvanized steel. Closed-cell foam gasketing shall be provided where modules join to prevent air leakage. Double-wall insulated panels shall be fabricated to allow removal for access to internal parts and components.

1. Outside Casing: G90 Galvanized steel.
2. Inside Casing: G 90 Galvanized steel, perforated as scheduled.
3. Floor Plate: Galvanized steel.

C. Cabinet Insulation: Comply with NFPA 90A. Insulation adhesive shall be UL Listed.

1. Materials: ASTM C 1071 with coated surface exposed to airstream to prevent erosion of glass fibers.
2. Panels shall be insulated with 1-inch, 1½ -lb/ft³ or 3-lb/ft³ density insulation. Thermal resistance (R) shall be 4.17 ft²•h•°F/Btu.
3. The thermal resistance shall be at least R- 7.69.
4. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
5. Location and Application: Encased between outside and inside casing.
6. Access Panels and Doors: Same materials and finishes as cabinet; complete with hinges, latches, handles, and gaskets. Inspection and access panels and doors shall be sized and located to allow periodic maintenance and inspections. Provide access doors as scheduled.

D. Access doors shall be constructed with a double-wall, solid, galvanized-steel interior panel and a solid, galvanized-steel exterior panel. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage. Surface-mounted handles shall be provided to allow quick access to the interior of the module and to prevent through-cabinet penetrations that could cause air leakage. Access doors shall be hinged and removable for quick, easy access.

E. Condensate Drain Pans: All coil sections shall be provided with polymer drain pans. Units with cooling coils shall have drain pans under complete cooling coil section. Units with heating coils shall have a drain pan under complete heating coil segment to ensure proper drainage during cleaning. All drain pan connections shall be to the side of the unit to enable proper trapping. Provide sealed double-wall drain pans constructed of G90-U galvanized steel exterior panels and G90-U galvanized steel interior liner. Encase insulation between exterior and interior walls. Drain pans shall be sloped in 2 planes; cross break interior pans and pitch toward drain connections to ensure complete condensate drainage. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil.

F. Fan-Modules: The vibration levels of the complete fan assembly shall be checked and excessive vibration including that caused by fan imbalance) shall be eliminated in the factory. Fan shaft shall be properly sized and protectively coated with lubricating oil. Fan wheels shall be keyed to fan shaft to prevent slipping. Fan shafts shall be solid and designed so that fan shaft does not pass through its first

critical speed as the unit comes up to its rated rpm. Fan shafts shall not exceed 75 percent of their first critical speed at any cataloged rpm. Fan modules shall be provided with an access door on the drive side of the fan.

1. Two Inch Spring Isolators - Fan and motor assembly shall be internally isolated from the unit casing with 2 inch deflection spring isolators. The fan discharge shall also be isolated from unit casing by an NFPA-90A compliant flexible canvas duct. The isolation system shall be designed to resist loads produced by external forces such as earthquakes and conform to the current requirements for Seismic Zone IV.
2. Direct Drive Plenum Fan (Plug Fan) shall be single-width, single-inlet, multiblade type plug fan. The fan blades shall be backward inclined airfoil (AF). Plug fans shall be equipped with self-aligning, antifriction pillow block bearings with an L-50 life of 200,000 hours. Plug fan module shall be provided with an expanded metal door guard screen to prevent unauthorized entry to the fan.
3. Field Vibration Isolation: In addition to factory vibration isolation specified herein, provide the following:

    a. For floor-mounted units located on mezzanines, provide neoprene isolation pads below all support contact points of the AHU.
    b. All units: Provide flex connectors at duct connections.

4. Weigh fan and motor assembly at AHU manufacturer's factory for isolator selection. Statically and dynamically balance fan section assemblies. Fan section assemblies include fan wheels, shafts, bearings, drives, belts, isolation bases and isolators. Allow isolators to free float when performing fan balance. Measure vibration at each fan shaft bearing in horizontal, vertical and axial directions. Balance at design RPM as scheduled on drawings.
5. Inverter balancing. Fan systems shall be checked with a variable frequency drive for resonant frequencies. Fans, shafts, and drives will meet vibrations tolerance specs from 25% to 100% of selected RPM.

G. Motors and Drives: Refer to Division 23 Section "Common Work Results for HVAC"

1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
2. Temperature Rating: 50 deg C maximum temperature rise at 40 deg C ambient for continuous duty at full load (Class A Insulation).
3. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
4. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B mounted on adjustable base.
5. Motors shall be T-frame, squirrel cage, open drip-proof with size, type and electrical characteristics as shown as scheduled.
6. Overload Protection: Built-in, automatically resetting, thermal-overload protection.
7. Noise Rating: Quiet.
8. Efficiency: Energy-efficient motors shall have a minimum efficiency according to IEEE 112, Test Method B. Motors shall be premium efficiency.
9. Motors shall be inverter-duty.

H. Bearings: The following features are required:

1. Ball or roller bearings with inner and outer shaft seals.
2. Grease lubricated.
3. Designed to resist thrust loading where belt or other drives produce lateral or axial thrust in motor.
4. Grease lines shall be extended to the fan support bracket on the drive side.

I. Coil Sections: Common or individual, insulated, galvanized-steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils.

1. Water Coils: Self-draining coil fabricated according to ARI 410.

a. Piping Connections: Threaded.
b. Tubes: Copper.
c. Fins: Aluminum
d. Fin and Tube Joint: Mechanical bond.
e. Headers: Cast iron with drain and air vent tappings.
f. Frames: Galvanized-steel channel frame
g. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410
h. Working-Pressure Ratings: 200 psig, 325 deg F.
i. Source Quality Control: Test to 300 psig and to 200 psig underwater.

2. Refrigerant Coils: Coil designed for use with R-22 refrigerant, fabricated according to ARI 410, connected with brazed fittings. After testing, insides of coils are to be dried; all connections are to be sealed and coil shall be shipped with a charge of dry nitrogen. Suction headers shall be constructed of copper tubing. Suction connections shall penetrate unit casings to allow for sweat connections to refrigerant lines. Coils shall have equalizing vertical distributors sized according to the capacities of the coils.

a. Capacity Reduction: Circuit for interleaved control.
b. Tubes: Copper.
c. Fins: Aluminum.
d. Fin and Tube Joint: Mechanical bond.
e. Suction and Distributor: Seamless copper tube with brazed joints.
f. Frames: Galvanized-steel channel frame.
g. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.
h. Working-Pressure Rating: 300 psig.
i. Source Quality Control: Test to 450 psig and to 300 psig underwater.

J. Dampers

1. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
2. Damper Operators: specified in Division 23 Section "Instrumentation and Control for HVAC."
3. A module shall be provided that supports damper assembly for outside, return.
4. Dampers shall modulate the volume of outside air and return air above set minimum position in sequence with duct mounted relief damper. Damper shall be Ruskin CD60 type double-skin airfoil design or equivalent with metal compressible jamb seals and extruded vinyl blade edge seals on all blades. The dampers shall be rated for a maximum leakage rate of less than 1 percent of nominal airflow at 1-inch wg. Blades shall rotate on stainless steel sleeve bearings. Dampers shall be arranged in parallel or opposed blade configuration.
5. Combination Filter and Mixing Box: Parallel-blade galvanized-steel dampers mechanically fastened to steel operating rod in reinforced, galvanized-steel cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously. Cabinet support members shall hold 2-inch- thick, pleated, flat permanent or throwaway filters. Provide hinged access panels or doors to allow removal of filters from both sides of unit.

K. Miscellaneous Modules

1. Access module: A module shall be provided that allows additional access/inspection for unit components and space for field installed components as needed. An access door (as scheduled) or removable panels shall be provided for easy access.

L. Base Rail

1. Provide 8" deep base rails to allow sufficient condensate trap installation.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in of piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Provide in accordance with manufacturer's recommendations.

B. Base Rails: Refer to Division 23 Section "Common Work Results for Mechanical". Provide 8" base rails as required; of sufficient height to maintain proper trap heights for proper drainage.

C. Arrange installation of units to provide access space around indoor air-handling units for service and maintenance.

3.3 CONNECTIONS

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

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

C. Connect piping to indoor air-handling units as shown on the plans.

D. Connect condensate drain pans with full-size piping. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan per manufacturer’s recommendations, and install cleanouts at changes in direction.

E. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

F. Connect to ductwork using flexible duct connections.

G. Electrical: Comply with applicable requirements in Division 16 Sections for power wiring, switches, and motor controls.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Leak Test: After installation, fill water with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify that specified filters are installed. Check for leakage around filters.
6. Verify that cooling coil drain pans have a positive slope to drain.
7. Verify that the cooling coil condensate drain trap maintains an air seal.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Final Checks before Startup: Perform the following:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connection to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Set face-and-bypass dampers to full face flow.
7. Set outside- and return-air mixing dampers to minimum outside-air setting.
8. Comb coil fins for parallel orientation.
9. Install clean filters.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

C. Starting procedures for indoor air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for indoor air-handling system testing, adjusting, and balancing.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

3.7 CLEANING

A. Clean indoor air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing indoor air handling and air-distribution systems, clean filter housings and install new filters.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain indoor air-handling units.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

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SECTION 23 73 33 - INDIRECT-FIRED H&V UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, "Standard Specifications," Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Division 23 Section: Basic Mechanical Materials and Methods.

1.2 SUMMARY

A. This Section includes indirect-fired gas fired H&V units.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

B. The supplier shall furnish gas piping schematics, as built wiring connection and control-circuit diagrams, dimension sheets and a full description of the unit(s).

C. Service manuals, showing service and maintenance requirements.

D. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, and methods of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:

E. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

F. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of indirect-fired H&V units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

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

C. Comply with NFPA 70.

D. Unit(s) assembly shall be tested in accordance with UL Standard UL 795, and shall bear the ETL label. The duct furnace shall be certified by the American Gas Association and approved by the Canadian Gas Association.

1.5 COORDINATION

A. Coordinate size, location and installation of unit manufacturer's roof curbs and equipment supports with roof Installer.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below of indirect-fired H&V units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

1.7 EXTRA MATERIALS

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

1. Filters: One set(s) for each unit.
2. Fan Belts: One set(s) for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Trane Company (The); Unitary Products Group. (Basis of Design)
2. Captive-Air Systems, Inc.
3. Greenheck.
4. Hastings Industries; Division of Eric, Inc.
5. Jackson & Church; Div. of Donlee Technologies Inc.
6. Reznor-Thomas & Betts Corporation; Mechanical Products Division.
7. Sterling Gas; Mestek, Inc.
8. Titan Air Inc.

2.2 PACKAGED UNITS

A. Factory-assembled, pre-wired, self-contained unit consisting of cabinet, supply fan, controls, filters, and indirect-fired gas furnace to be installed outside the building.

B. Unit housing shall be constructed of 20 Gauge G-90 galvanized steel. The wall panels and roof panels shall be fabricated by forming double-standing, self-locking seams that require no additional support. The floor and wall panels shall be caulked air tight with a silicone caulk. All casing panels shall be attached with sheet-metal, screws or rivets which can be removed to field service large components. The unit base shall be suitable for curb or flat mount. Housing construction should be suitable for outdoor or indoor installation.

C. An observation port shall be located on the furnace for observation of the main flame and pilot flame. All controls, gas valves, modulating controls and electrical components shall be mounted within the, burner vestibule. The burner vestibule shall be an integral part of the unit and not extend outside the exterior casing of the unit and not exposed to the main air stream.

D. The vestibule full-size door shall provide easy access to controls and gas-train components. Blower door shall provide easy access to blower, motor and drives. Access doors shall be provided on both front and back side of unit providing full access to every part of the unit.

E. The base shall be constructed of galvanized steel for improved rigidity. Base shall be structurally reinforced to accommodate the blower assembly and burner.

F. Units shall be operated, tested and set at the factory using job-site conditions for electrical and gas input. All operating and safety controls shall be tested and set at the factory. Adjustable, or fixed sheaves shall be set for proper RPM at specified conditions. Gas-pressure regulator shall be set for specified burning rate at specified inlet pressure.

G. Blower

1. Blowers shall be forward-curved, centrifugal, Class I or II, (depending on requirements of the application) double width, double inlet, constructed G-90 galvanized steel. Unit shall have a heavy-duty, solid-steel shaft. Wheels shall be balanced in two planes and done in accordance with AMCA standard 204-96, Balance Quality and Vibration Levels for Fans. The wheel blades shall be aerodynamically designed to minimize turbulence, increase efficiency and reduce noise. The wheel blades shall be securely attached to the wheel inlet ring. The wheel shall be firmly attached to the fan shaft with set screws and keys.
2. The blower assembly shall be isolated from the fan structure with seismic springs vibration isolators.
3. Blower capacity shall be as scheduled. External Static: The sum of duct loss plus duct component static- Example: louvers, diffusers. All blowers shall be tested and set at rated speed after being installed in the factory-assembled unit.
4. Motors shall be heavy duty ball bearing type and furnished at the specified voltage, phase and enclosure. Motor mounting plate shall be constructed of heavy gauge galvanized steel and shall be designed to provide easy adjustment of belt tension. Comply with requirements in Division 15 Section Basic Mechanical Materials and Methods.
5. Shafts shall be precision ground and polished. Heavy duty, pre-lubricated bearings shall be selected for a minimum (L50) life in excess of 200,000 hours of operation at maximum cataloged operating speed. They shall be designed for, and individually tested specifically for use in air handling applications.
6. Belts shall be oil and heat resistant, non-static, grip-notch type. Drives shall be cast type, precision machined and keyed and secured attached to the fan and motor shafts. Fan operating speed shall

be factory set using adjustable pitch motor pulleys. Blower drives shall be fully adjustable. All drives shall be a minimum of 2 groove above 2 HP.

H. Burner

1. The gas burner shall be an indirect-fired, push-through type.
2. The burner, heat exchanger, and drip pan shall be of type 409 stainless-steel. The burner shall be capable of 80% combustion efficiency with a maximum turndown ratio of 2.5 to One.
3. The furnace shall include a blocked vent safety switch, high temperature limit, power vent for flue gases, and burner access from both sides of unit.
4. The gas burner shall be furnished with a pilot package arranged so that the pilot flame lights the burner with instantaneous ignition.
5. Rear access doors will provide complete access to burner and furnace.
6. All gas equipment shall conform to local-Code requirements. All gas manifold components shall be piped and wired at the factory. Components:

    a. Pilot-Gas Shut-Off Valve
    b. Main-Gas Regulator
    c. Pilot-Gas Regulator
    d. Two Solenoid Valves
    e. Pilot-Gas Valve
    f. Modulating-Gas Valve
    g. Main-Gas Shut-Off Valve
    h. Burner

7. Safety Controls

    a. Motor Starter With Adjustable Overloads
    b. Main-Gas Regulator
    c. Air-Flow Safety Switch
    d. Two Solenoid Valves
    e. Electronic Flame-Safety Relay
    f. Modulating-Gas Valve
    g. High-Temperature Limit Switch
    h. Burner
    i. Non-Fused Disconnect.
    j. High gas-pressure switches to open circuit to electronic flame-safety relay, if gas pressure is too high.
    k. Low gas-pressure switch to open circuit to electronic flame safety rely, if gas pressure is too low.
    l. Adjustable low temperature blower-safety control with bypass timer to shut down unit, if discharge temperature drops below setting.

I. Accessories

1. Inlet Dampers: Manufacturer shall provide and install on unit, a two-position, motor-operated damper with internal end switch to energize the blower-starter circuit, when damper is 80% open. Blades shall be a maximum of 6" wide 16 Gauge G-90 galvanized steel shall be made to guarantee the absence of noticeable vibration at design air velocities. Damper blades to be mounted on friction-free synthetic bearings. Damper edges shall have PVC coated polyester fabric mechanically locked into blade edge. Jamb seals to be flexible metal, compression type.

2. Filters: The filters shall be (2") thick, aluminum mesh, coated with super-filter adhesive. Aluminum-mesh filters shall have aluminum frames with media to be layers of slit and expanded

aluminum, varying in pattern to obtain maximum depth loading. Washable 2" filters shall be enclosed in two-piece, die-cut frame with diagonal supports. Frame shall be constructed of heavy-duty beverage board. Filter media is supported on the air leaving side by a metal grid. Filter Section: shall be insulated; constructed of G-90 galvanized steel with filters supported by internal slides and with removable access panels. Filters shall be provided in a v-bank arrangement.

3. Fresh-Air Inlet Hood: Shall be constructed of G-90 galvanized steel with birdscreen.
4. Curb: 20" curb shall be constructed of 18 gauge G-90 galvanized steel as a completed welded assembly.
5. Operating lights mounted in a remote-control panel to indicate: power, burner ON and blower ON.

J. TEMPERATURE CONTROL SYSTEMS

1. Maxitrol Series 21/31: For building exhaust-air replacement to maintain a constant discharge temperature of supply air. The burner flame modulates to compensate for outdoor temperatures. The manual SUMMER-OFF/WINTER selector-switch and exhaust system interlock control the heater-blower operation. Supplied with optional remote- control panel with temperature selector dial and SUMMER-OFF/WINTER selector.

2. Provide interface with the facility Building Automation System for scheduling and operation as specified. Refer to Section 230993-Sequence of Operation for HVAC Controls.

K. Wiring And Electrical

1. A single point electrical connection shall be supplied. The control circuit voltage shall be 115 volts. A control transformer shall be provided, when required. The control wiring shall be carried in wire channel or conduit. Wiring in control enclosures shall be in accordance with the National Electrical Code and the local code, as it may affect the installation. Motor starter shall be provided. Starter shall be line voltage, definite purpose type.
2. Unit(s) shall be complete with all items such as relays, starters, switches, safety controls, conduit and wire as previously mentioned, and as required for proper operation. All factory-mounted controls shall be factory prewired to the unit control panel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation of indirect-fired H&V units.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where rooftop replacement-air units will be installed.

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

3.2 INSTALLATION

A. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."

B. Install and secure indirect-fired H&V units on curbs, and coordinate roof penetrations and flashing with roof construction.

C. Install controls and equipment shipped by manufacturer for field installation with indirect-fired H&V units.

3.3 CONNECTIONS

A. Piping Connections: Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to machine to allow service and maintenance.

1. Gas Piping: Comply with requirements in Division 15 Section "Fuel Gas Piping." Connect gas piping with shutoff valve and union and with sufficient clearance for burner removal and service. Provide AGA-approved flexible connectors.

B. Duct Connections: Duct installation requirements are specified in Division 15 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply ducts to indirect-fired H&V units with flexible duct connectors. Flexible duct connectors are specified in Division 15 Section "Duct Accessories."

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

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

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for visible damage to furnace combustion chamber.
2. Inspect casing insulation for integrity, moisture content, and adhesion.
3. Verify that clearances have been provided for servicing.
4. Verify that controls are connected and operable.
5. Verify that filters are installed.
6. Purge gas line.
7. Inspect and adjust vibration isolators.
8. Verify bearing lubrication.
9. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
10. Adjust fan belts to proper alignment and tension.
11. Start unit according to manufacturer's written instructions.
12. Complete startup sheets and attach copy with Contractor's startup report.
13. Inspect and record performance of interlocks and protective devices; verify sequences.
14. Operate unit for run-in period recommended by manufacturer.
15. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:

    a. Gas Burner:

        1) Measure gas pressure at manifold.
        2) Measure combustion-air temperature at inlet to combustion chamber.

3) Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

16. Calibrate thermostats.
17. Adjust and inspect high-temperature limits.
18. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
19. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:

    a. High-limit heat.
    b. Alarms.

20. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace malfunctioning components that do not pass tests and inspections and retest as specified above.

D. Prepare written report of the results of startup services.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain indirect-fired H&V units. Refer to Division 1 Section.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.

3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 73 33

SECTION 23 74 13 - ROOFTOP AIR CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Division 23 Section "Common Work Results for HVAC"

1.2 SUMMARY

A. This Section includes the packaged rooftop air conditioners.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Operation and Maintenance Data: For rooftop air conditioners to include in emergency, operation, and maintenance manuals.

D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop air conditioners and are based on the specific system indicated.

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

C. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

D. Units shall be UL listed and labeled, classified in accordance to ANSIZ21.47 for gas fired central furnaces and UL 1995/CAN/CSA No. 236-M90 for central cooling air conditioners.

E. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1-2010, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

F. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1-2010, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

G. Comply with NFPA 54 for gas-fired furnace section.

H. Sound Power Level Ratings: Comply with ARI 270, "Sound Rating of Outdoor Unitary Equipment."

I. ARI Certification: Cooling performance shall be rated in accordance with ARI testing procedures. Units shall be ARI certified and listed.

1.5 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations with Division 7.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of rooftop air conditioners that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than [**five**] [**10**] years from date of Substantial Completion.

1.7 EXTRA MATERIALS

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

1. Fan Belts: One set for each belt-drive fan.
2. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 ROOFTOP AIR CONDITIONERS 25 TONS AND SMALLER

A. Manufacturers:

1. Trane Company (The); North American Commercial Group.
2. Carrier Corp.
3. McQuay International.
4. Mammoth Inc.
5. York, Johnson Controls Corp, Contact Daniel Meyers: tel 603-222-2409.

B. Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, indoor and outside refrigerant coils, indoor fan and outside coil fan, refrigeration and temperature controls, filters, and dampers.

C. Units shall be dedicated downflow or horizontal airflow as scheduled.

D. Casing:

1. Unit casing shall be constructed of zinc coated, heavy gauge, and galvanized steel. Exterior surfaces shall be cleaned, phosphatized and finished with a weather-resistant baked enamel finish. Unit's surface shall be tested 500 hours in a salt spray test in compliance with ASTM B117. Cabinet construction shall allow for all maintenance on one side of the unit.
2. The top cover shall be one piece or where seams exist, it shall be double hemmed and gasket sealed to prevent water leakage.
3. Service panels shall have lifting handles and be removed and reinstalled by removing three fasteners or less, while providing a water and airtight seal.
4. All exposed vertical panels and top covers in the indoor air section shall be insulated with fire-resistant, permanent, odorless glass fiber material.
5. The base of the **downflow** units shall be insulated with a foil-faced closed-cell material. The downflow unit's base pan shall have no penetrations within the perimeter of the curb other than the raised 1-1 /8 " high supply/return openings to provide an added water integrity precaution, if the condensate drain backs up.
6. The base of the unit shall have provisions for forklift and crane lifting.
7. Insulation Kit: Field installed on 3-7½ ton horizontal units to prevent high humidity condensation forming on bottom of unit when mounted on a downflow curb.

E. Indoor Fan:

1. The 3-5 ton units shall have a direct-drive, FC centrifugal fan.
2. Units over 5 tons shall have belt driven, FC centrifugal fans with adjustable motor sheaves.
3. Units over 7½ tons shall have an adjustable idler-arm assembly for quick-adjustment to fan belts and motor sheaves.
4. All motors shall be thermally protected.

F. Outdoor fans: shall be direct-drive, statically and dynamically balanced; draw through in the vertical discharge position. The fan motors shall be permanently lubricated and have built-in thermal overload protection.

G. Refrigerant Coils: Evaporator And Condenser Coils shall have internally finned 3/8" copper tubes mechanically bonded to configured aluminum plate fin shall be standard. Coils shall be leak tested at the factory to ensure pressure integrity. The evaporator coil and condenser coil shall be leak tested to 200 psig and pressure tested to 450 psig.

H. Coil Guards: Coil guards shall be field-installed for condenser coil protection.

I. Sloped condensate IAQ drain pans shall be provided.

J. Refrigeration System:

1. Each refrigerant circuit shall have independent fixed orifice expansion devices, service pressure ports and refrigerant line filter driers factory-installed as standard. An area shall be provided for replacement suction line driers.
2. Compressors shall be direct-drive hermetic, reciprocating or scroll type compressors.
3. The compressors have a centrifugal oil pump providing positive lubrication to moving parts. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10

percent of unit nameplate voltage. Crankcase heater, internal temperature and current-sensitive motor overloads shall be included for maximum protection. Compressors shall have internal spring isolation and sound muffling to minimize vibration transmission and noise.

4. External high-pressure cutout and low-pressure switches shall be provided for all units.
5. Operating range shall be between 115 F and 0 F cooling as standard from the factory for all units.

K. All units shall be factory assembled, internally wired, fully charged with R-22 and 100 percent run-tested before leaving the factory.

L. Filters: 2-inch- thick, fiberglass, pleated filters in filter rack.

M. The gas heating section shall have a drum and tube heat exchanger design using corrosion resistant steel components. A forced combustion blower shall supply premixed fuel to a single burner ignited by a pilot-less hot surface ignition system. In order to provide reliable operation, a negative pressure gas valve shall be used that requires blower operation to initiate gas flow. On an initial call for heat, the combustion blower shall purge the heat exchanger 45 seconds before ignition. After three unsuccessful ignition attempts, the entire heating system shall be locked out until manually reset at the thermostat. Units shall be suitable for use with natural gas or propane (field installed kit) and also comply with California requirements for low NOx emissions.

1. Units shall have full-modulating heating.

N. Economizer: factory or field-installed; include fully modulating 0-100 percent motor and dampers, minimum position setting, preset linkage, wiring harness with plug and fixed dry bulb control; solid-state enthalpy and differential enthalpy control.

1. Powered Exhaust: shall assist the barometric relief damper in the economizer in relieving building pressurization.

O. Power Connection: Unit shall be completely factory wired with necessary controls and contactor pressure lugs or terminal block for power wiring. Units shall provide an external location for mounting fused disconnect device. Microprocessor controls shall be provided for all 24-volt control functions. The resident control algorithms shall make all heating, cooling and/or ventilating decisions in response to electronic signals from sensors measuring indoor and outdoor temperatures. The control algorithm maintains accurate temperature control, minimizes drift from set point and provides better building comfort. A centralized Microprocessor shall provide anti-short cycle timing and time delay between compressors to provide a higher level of machine protection. Provide interface with the facility Building Automation System for scheduling and operation from the central BAS as specified Section 230993-Sequence of Operations for HVAC Controls.

P. RTU-3/ERU-1 Controls: For RTU-3, where ERU-1 shares a curb with the RTU, the package controller for RTU-3 shall directly interface with the BAS for integrated control of the ERU/RTU as one system, for economizer and demand control ventilation sequences. Refer to Section 230993-Sequence of Operations for HVAC Control for specific requirements.

Q. Wiring internal to the unit shall be colored and numbered for simplified identification.

R. A field-installed circuit board shall provide interface with electro-mechanical thermostats or automation systems.

S. Powered Convenience Outlet: FCI, 120v/15amp, 2 plug, convenience outlet, powered, with a service receptacle disconnect. The convenience outlet is powered from the line side of the circuit breaker, and therefore shall not be affected by the position of the circuit breaker.

T. Roof Curb, Downflow: The roof curb shall be designed to mate with the downflow unit and provide support and a watertight installation when installed properly. The roof curb design shall allow field-fabricated rectangular supply/return ductwork to be connected directly to the curb. Curb design shall comply with NRCA requirements. Curb shall ship knocked down for field assembly and include wood nailer strips.

U. Shared Curb: For RTU-3, the roof curb shall be custom fabricated such that the RTU and its associated ERU share a common curb with direct duct interface between the units. Curb shall be as fabricated by Thycurb and shall be in strict accordance with the requirements of both unit manufacturers.

2.2 MOTORS

A. General requirements for motors are specified in Division 23 “Common Work Results for Mechanical."

B. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

C. Controllers, electrical devices, and wiring are specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb, maintaining manufacturer's recommended clearances.

B. Curb Support: Install roof curb on roof structure, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure rooftop air conditioners on curbs and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.

C. Unit Support: Install unit level on structural curbs. Retain below for units mounted on isolation curbs.

3.2 CONNECTIONS

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

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

1. Gas Piping: Comply with applicable requirements in Division 23 Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination in roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.

3. Terminate return-air duct through roof structure and insulate space between roof and bottom of unit with 2-inch- thick, acoustic duct liner.

D. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

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

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Leak Test: After installation, fill water and steam coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify that specified filters are installed. Check for leakage around filters.
6. Verify that cooling coil drain pans have a positive slope to drain.
7. Verify that the cooling coil condensate drain trap maintains an air seal.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean outside coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Adjust vibration isolators.
13. Inspect operation of barometric dampers.
14. Lubricate bearings on fan.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.

16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.

    a. Start refrigeration system in summer only.
    b. Complete startup sheets and attach copy with Contractor's startup report.

18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency. Adjust pilot to stable flame.

    a. Measure gas pressure on manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure flue-gas temperature at furnace discharge.
    d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outside-air, dry-bulb temperature.
    d. Outside-air-coil, discharge-air, dry-bulb temperature.

25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outside-air intake volume.

27. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through outside coil or from outside coil to outside-air intake.

28. Verify operation of remote panel, including pilot-light operation and failure modes. Inspect the following:

    a. High-limit heat exchanger.
    b. Warm-up for morning cycle.
    c. Freezestat operation.
    d. Economizer to limited outside-air changeover.
    e. Alarms.

29. After startup and performance testing, change filters, vacuum heat exchanger and cooling and outside coils, lubricate bearings, adjust belt tension, and inspect operation of power vents.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop air conditioners.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.

c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 74 13

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SECTION 23 81 30 – DUCTLESS SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Division 23 Section “Common Work Results for HVAC”

1.2 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

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

C. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. A dry air holding charge shall be provided in the indoor section.

F. The outdoor unit shall be pre-charged with R-410a refrigerant for 70 feet of refrigerant tubing.

G. System efficiency shall meet or exceed 13.0 SEER.

1.5 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Refer to Section 230500.

B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Carrier Air Conditioning; Div. of Carrier Corporation.
2. Mitsubishi Electronics America, Inc.; HVAC Division.
3. Sanyo Fisher (U.S.A.) Corp..
4. Trane Company (The); Unitary Products Group.
5. Daikin

B. MITSUBISHI MODEL PKA

1. Indoor Unit

a. The indoor unit cabinet shall be wall mounted by means of a factory supplied mounting plate, The cabinet shall be formed from high strength molded plastic with front panel access for filter. Cabinet color shall be white. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor.

b. The unit in conjunction with the wired, wall mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.

c. The evaporator fan shall be high performance, double inlet, forward curve, direct drive sirocco fan. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower noise levels, and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement selected by remote control.

d. Return air shall be filtered by means of an easily removable washable filter.

e. The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.

1) Provide optional factory mini condensate pump unit.

f. The electrical power of the unit shall be 208 volts or 230 volts, 1 phase, 60 hertz as scheduled. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The power to the indoor unit shall have an option of being supplied from the outdoor unit, using Mitsubishi Electric A-Control system or separate power source for indoor and outdoor units.

g. The control system shall consist of two (2) microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. Field wiring shall run directly from the indoor unit to the wall mounted controller with no splices. For A-Control, a three (3) conductor 14 ga. AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units. Where separate power is supplied to the indoor and outdoor units, a two (2) 20 ga. AWG wire shall be run between the units to provide forbid-directional control communication..

h. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.

i. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.

j. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD). There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louver Swing button, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature changes shall be by increments of 1°F with a range of 67°F to 87°F.

k. The wired controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat.

l. Normal operation of the wired controller shall provide individual system control in which one wired controller and one indoor unit are installed in the same room. The controller shall have the capability of controlling up to a maximum of sixteen systems at a maximum developed control cable distance of 1,500 feet.

m. The control voltage from the wired controller to the indoor unit shall be 12 volts, DC. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Up to two wired controllers shall be able to be used to control one unit.

n. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.

2. Outdoor Unit

a. The outdoor unit shall be compatible with the three different types of indoor units (PKA - wall mounted, PCA - ceiling suspending, and PLA - four way ceiling cassette). The

connected indoor unit must be of the same capacity as the outdoor unit. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions.

b. The outdoor unit shall be capable of operating at 0°F ambient temperature without additional low ambient controls.

1) Provide optional wind baffle.

c. The outdoor unit shall be able to operate with a maximum height difference of 100 feet indoor unit to outdoor unit,

d. System shall have a maximum refrigerant tubing length of 100 feet for the 12,000 and 18,000 and 165 feet for the 24,000, 30,000 and 36,000 between indoor and outdoor units without the need for line size changes, traps or additional oil.

e. Unit shall be pre-charged for a maximum of 70 feet of refrigerant tubing. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.

f. The casing shall be constructed from galvanized steel plate, coated with a finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. The fan grille shall be of ABS plastic.

g. The fan motor shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent contact with moving parts.

h. The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be control by a microprocessor controlled step motor.

i. There shall be a DC rotary compressor with Variable Compressor Speed Inverter Technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain enough heat. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

j. The electrical power of the unit shall be 208volts or 230 volts, 1 phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The outdoor unit shall be controlled by the microprocessor located in the indoor unit.

k. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounting, compressor-condenser components on 4-inch- thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

D. Install ground-mounting, compressor-condenser components on polyethylene mounting base.

E. Install roof-mounting compressor-condenser components on equipment supports specified in Division 7 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

F. Install seismic restraints.

G. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

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

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

C. Electrical Connections: Comply with requirements in Electrical Specification Sections for power wiring, switches, and motor controls.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

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

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

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

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

B. Refer to Division 1 for further requirements.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
    b. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
    c. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 23 81 30

SECTION 23 82 39 - UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

B. Related Sections include the following:

1. Division 23 Section “Common Work Results for Mechanical”

1.2 SUMMARY

A. This Section includes hydronic unit heaters.

1.3 SUBMITTALS

A. Product Data: Include specialties and accessories for each unit type and configuration.

1. Plans, elevations, sections, and details.
2. Power, signal, and control wiring diagrams. Differentiate between manufacturer-installed and field-installed wiring.
3. Equipment schedules to include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
4. Cabinet Unit Heater color samples for initial selection: Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.

B. Maintenance Data: For unit heaters to include in maintenance manuals specified in Division 1. Include maintenance schedules and repair parts lists for motors, coils, integral controls, and filters.

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 unit heaters and suspension system components

B. Coordinate wall construction and conditions with recessed or semi-recessed cabinet unit heater installation requirements.

1.6 EXTRA MATERIALS

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

1. Cabinet Unit Heater Filters: Furnish one set of spare filter for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Carrier Corp.
2. Trane
3. McQuay
4. Sterling
5. Modine

2.2 CABINET UNIT HEATERS

A. Description: An assembly including filter, chassis, coil, fan, and motor in blow-through configuration with heating coil.

B. Cabinet: For one or more of the following configurations:
1. Recessed, ceiling-mounting front grilles for air inlet and outlet.

C. Chassis: Galvanized steel, with flanged edges and unit-leveling bolts.

D. Coil Section Insulation: 1-inch duct liner complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916. Fire-Hazard Classification: Duct liner and adhesive shall have a maximum flame-spread rating of 25 and smoke-developed rating of 50 when tested according to ASTM E 84.

E. Cabinet: Galvanized steel, with removable panels.

F. Cabinet Finish: Cabinet parts and exposed recessed panels shall be cleaned, bonderized, phosphatized, and painted with a baked powder finish available in six colors. Finish shall meet ASTM B117 specifications (salt spray test).

G. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and with manual air vent. Coils shall be rated for a minimum working pressure of 300 psig and a maximum entering water temperature of 275 deg F, with manual air vent.

H. Filters: 1-inch- thick, pleated glass-fiber media in fiberboard frame, Farr 30/30 Pleated Panel Air Filter or equivalent.

I. Fan:

1. Centrifugal, with forward-curved, double-width wheels and fan scrolls made of galvanized steel or thermoplastic material; directly connected to motor.
2. Permanent split capacitor motors shall be run tested in assembled units. Motors shall have integral thermal overload protection with a maximum ambient operating temperature of 104°F. Motors shall be permanently. lubricated

J. Accessories

1. Control Devices: Unit-mounted fan-speed switch and line voltage wall-mounting thermostat.
2. Provide a unit-mounted disconnect switch.

2.3 UNIT HEATERS

A. Description: An assembly including casing, coil, fan, and motor in the following configurations as scheduled:

1. Sterling horizontal discharge configuration with horizontal, adjustable louvers in blow-through configuration.

B. Casing: Galvanized steel, with removable panels.

C. Cabinet Finish: Bonderize, phosphatized, and flow-coat with baked-on primer and manufacturer's standard paint applied to factory-assembled and -tested propeller unit heater before shipping.

D. Hot-Water Coil: Copper tube, 0.031-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering water temperature of 325 deg F, with manual air vent. Test for leaks to 375 psig underwater.

E. Propeller with aluminum blades directly connected to motor.

F. Fan Motors: shaded-pole or permanent-split capacitor, with integral thermal-overload protection.

G. Units mounted shall be equipped with an OSHA fan guard. Fan guards shall be welded steel, zinc plated or painted.

H. Accessories

1. Horizontal Configuration: Vertical louver (in addition to standard horizontal louver).
2. Control Devices: Unit-mounted fan-speed switch and line voltage wall-mounting thermostat.

2.4 SOURCE QUALITY CONTROL

A. Test unit heater coils according to ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before cabinet unit heater installation.

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

3.2 INSTALLATION

A. Install unit heaters level and plumb.

B. Install unit heaters to comply with NFPA 90A.

C. Hung unit heaters shall be suspended from structure with rubber-in-shear vibration isolators (rubber hangers).

3.3 CONNECTIONS

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

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

C. Install piping adjacent to machine to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing and report results in writing:

1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.

B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.5 CLEANING

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

B. After installing units, clean unit heaters internally according to manufacturers written instructions.

C. Install new filters in each cabinet unit heater within two weeks after Substantial Completion.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

1. Entries shall match data on the schedule of values and Contractor's construction schedule. Use updated schedules if revisions were made.
2. Include amounts for work completed following previous Application for Payment, whether or not payment has been received. Include only amounts for work completed at time of Application for Payment.
3. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.

B. Stored Materials: Include in Application for Payment amounts applied for acceptable, non-perishable materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.

1. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment, for stored materials.
2. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
3. Provide summary documentation for stored materials indicating the following:

    a. Value of materials previously stored and remaining stored as of date of previous Applications for Payment.
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END OF SECTION 23 82 39

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SECTION 23 83 16 - RADIANT-HEATING HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. State of Maine Department of Transportation, “Standard Specifications,” Revision December 2002, and any corrections, additions and revisions thereto, apply to this Section. If the Contractor discovers any ambiguity, error, omission, conflict, or discrepancy, Section 10 1. 3.6 Priority of Conflicting Contract Documents shall control.

1. Drawings and general provisions of the Contract, and Division 1 Specification Sections, apply to this Section.
2. Any supplements to any of the above specifications and or standards issued prior to issuance of this Project Manual, apply to this section.

1.2 SUMMARY

A. This Section includes radiant heating piping, including pipes, fittings, and piping specialties.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. PEX: Crosslinked polyethylene.

C. PEX/AL/PEX: Crosslinked polyethylene/aluminum/crosslinked polyethylene.

1.4 SUBMITTALS

A. Product Data: For each type of radiant heating pipe, fitting, manifold, specialty, and control.

1. For radiant heating piping and manifolds, include pressure and temperature rating, oxygen-barrier performance, fire-performance characteristics, and water flow and pressure drop characteristics.

B. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure. Additionally, the manufacturer must provide supporting documentation to meet the design criteria.

1. Shop Drawing Scale: Match drawing scale for relevant area.

C. Operation and Maintenance Data: For radiant heating piping valves and equipment to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PEX PIPE AND FITTINGS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
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1. Uponor Wirsbo Co. (Basis of Design)
2. Watts Radiant, Inc.; a division of Watts Water Technologies, Inc.
3. Viega

C. Pipe Material: (Pex A), cross linked Polyethelene manufactured by the (Engel) method. ASTM F 876. The use of (PERT) polyethelene raised temperature will not be permitted.

D. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

E. Fittings: ASTM F 1960, cold expansion method with Pex rings..

F. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

2.2 PEX/AL/PEX PIPE AND FITTINGS

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

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

1. Stadler-Viega.
2. Uponor Wirsbo Co.
3. Watts Radiant, Inc.; a division of Watts Water Technologies, Inc.

C. Pipe Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to ASTM F 1281.

D. Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

E. Fittings: ASTM F 1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).

F. Flame-Spread and Smoke-Developed Indexes: 25 and 50 or less, respectively, tested according to ASTM E 84.

G. Pressure/Temperature Rating: Minimum 100 psig and 210 deg F.

2.3 DISTRIBUTION MANIFOLDS

A. Manifold: Minimum NPS 1", engineered plastic,brass, copper, or stainless steel.

B. Main Shutoff Valves:

1. Factory installed on supply and return connections.
2. Two-piece body.
3. Body: Brass or bronze.
4. Ball: Bronze.
5. Seals: PTFE.
6. CWP Rating: 145 psig.
7. Maximum Operating Temperature: 220 deg F.

C. Manual Air Vents:

1. Body: Engineered Plastic or Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Key furnished with valve, or screwdriver bit.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: 1/8.
6. CWP Rating: 44 psig.
7. Maximum Operating Temperature: 194 deg F.

D. Balancing Valves:

1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
6. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
7. CWP Rating: Minimum 44 psig.
8. Maximum Operating Temperature: 194 deg F.

E. Thermometers:

1. Mount on supply and return connections.
2. Case: Dry type, metal or plastic, 2-inch diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, connecting element and pointer.
5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
6. Pointer: Black metal.
7. Window: Plastic.
8. Connector: Rigid, back type.
9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.
10. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

F. Mounting Brackets: Copper, or plastic or copper-clad steel, where in contact with manifold.

2.4 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch.
3. Tensile Strength: 20 lb, minimum.
4. Temperature Range: Minus 40 to plus 185 deg F.

2.5 CONTROLS

A. Temperature-control devices and sequence of operations are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations."

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Ensure that surfaces and pipes in contact with radiant heating piping are free of burrs and sharp protrusions.
2. Ensure that surfaces and substrates are level and plumb.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Install the following types of radiant heating piping for the applications described:

1. Piping in Interior Reinforced-Concrete Floors: PEX.

3.3 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop or Coordination Drawings.

B. Install radiant heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.

C. Connect radiant piping to manifold in a reverse-return arrangement.

D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.

E. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Division 08.

F. Refer to Division 23 Section "Hydronic HVAC Piping" for pipes and connections to hydronic systems and for glycol-solution fill requirements.

G. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Division 07.

H. Piping in Interior Reinforced-Concrete Floors:

1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
2. Space cable ties a maximum of 12 inches o.c., and at center of turns or bends.
3. Maintain 2-inch minimum cover.
4. Install a sleeve of 3/8-inch- thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
5. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.

I. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.

J. After system balancing has been completed, mark balancing valves to permanently indicate final position.

K. Perform the following adjustments before operating the system:

1. Open valves to fully open position.
2. Check operation of automatic valves.
3. Set temperature controls so all zones call for full flow.
4. Purge air from piping.

L. After the concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant heating system as follows:

1. Start system heating at a maximum of 10 deg F above the ambient radiant panel temperature, and increase 10 deg F each following day until design temperature is achieved.
2. For freeze protection, operate at a maximum of 60 deg F supply-water temperature.

3.4 FIELD QUALITY CONTROL

A. Prepare radiant heating piping for testing as follows:

1. Open all isolation valves and close bypass valves.
2. Open and verify operation of zone control valves.
3. Flush with clean water, and clean strainers.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Repair leaks and retest until no leaks exist.

C. Remove and replace malfunctioning radiant heating piping components that do not pass tests, and retest as specified above.

D. Prepare a written report of testing.

PART 4 - PAYMENT PROCEDURES

4.1 APPLICATIONS FOR PAYMENT

A. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments. Payment shall be based on percentage of work completed and cost of materials and equipment.

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END OF SECTION 23 83 16