ADDENDUM 01

RFB #CPPM 2026-015 BARROWS HALL CHILLER REPLACEMENT
UNIVERSITY OF MAINE

Date: March 19, 2026

To: Prospective Bidders

From: University of Maine System
5765 Service Building
Orono, ME 04469-5765

This Addendum forms a part of the Contract Documents and modifies the original Bid Documents and Specifications dated February 28, 2026. Portions of the bid and contract documents not altered by this Addendum remain in full force.

Acknowledge receipt of this Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

This Addendum consists of the following:

- *Questions with Response*
- *Specification Changes*
- *Drawing Changes*
- *Pre-Bid Attendance Sheet is attached*

QUESTIONS WITH RESPONSE:

1. "Schedule of Alternates" section 012300, part 3, para 3.1 A & B specifies TAB under the base bids however section 230500 para 1.10, B "TAB Readiness" specifies: "*The contractor shall allow adequate time for testing and balancing activities of the owner provided services*…". Is UM providing TAB services?

   Response: Yes, under the base bid, the TAB contractor shall adjust the existing circuit setters at the existing pump sets as required to restore chilled water flow through the existing air handlers with the new chiller and condenser water flows to both the new chiller (as scheduled) and clean room chiller (basement mechanical room). Under Alternate #1, TAB contractor shall dictate required chilled water DP setpoint for the new chilled water pumps and evaporator barrel DP requirements for the minimum flow bypass valve. Under Alternate #2, the TAB contractor shall set the new condenser water pump VFD as required to maintain design condenser water flow rates to both the new chiller and the existing clean room chiller.

2. Concerning Alternate #1 replace CHWP-1 & 2; will the existing CHWP skid expansion tank and chemical shot feeder be demolished along with the existing pumps and steel base?

   Response: No, the existing expansion tank and chemical shot feeder are intended to remain. Under each alternate, please remove enough of the existing support steel as required to facilitate the installation of the new pump sets. The steel beneath the expansion tank and the shot feeder may remain.

3. Referring to drawing MP-5, detail A7 for alternates 1 & 2; can you confirm that balance valves are not required?

   Response: Confirmed, balance valves are not required for new pumps. The pumps are specified with on-board VFD's which will be used to set the flows.

4. Referring to drawing MP-5, detail A7 for alternates 1 & 2; can you confirm that an isolation valve is not required on the pump discharges?

   Response: No, the isolation valves are required. In addition to the isolation valve shown at the suction side of the pump, furnish and install an isolation valve at the discharge side of the pump on the system side of the check valve.

5. Concerning the existing chiller demolition; who is responsible to drain and dispose of the chiller fluids?

   Response: Contractor is responsible for this scope

6. Drawing MP-5, detail A4 specifies "butterfly valves" however 233113, para 2.5, A specifies in Red *"Normally use ball valves for shut off duty"*. Which is correct?

   Response: Butterfly valves are acceptable for pipes larger than 4". Ball valves are preferred for pipes less than 4" diameter.

7. Is water treatment per 232113, paras 2.8 and 3.5 required? If so, does UM have a preferred water treatment vendor?

   Response: No, the University of Maine does not have a preferred vendor. The intent of the specification is that water analysis and treatment be completed to the extent required to meet the chiller manufacturer's recommendation for water quality, in order to not void any warranties.

8. Will the new chiller be pre-insulated or is the contractor responsible for providing/installing insulation?

   Response: It is the intent that the new chiller be shipped fully assembled and rigged into place as one unit. In that case, the chiller shall be completely factory insulated and require no field insulation. In the event, however, that the contractor and/or rigger choose to have

the chiller shipped in pieces for rigging in pieces, the contractor shall field insulate the evaporator barrel per chiller manufacturer's requirements.

9. Are non-corroding cooling towers constructed of composite materials approved by the University for installation?

   Response: Chiller shall meet the performance requirements of the basis of design unit under all operating conditions. Coordinate with all trades for differences in mounting requirements, electrical requirements, structural dunnage requirements, and piping requirements resultant of variations from the basis of design unit. Provide all accessories as specified for operation as specified. Additionally, The University of Maine is insured through Factory Mutual. As such, the chiller submittal shall be subject to review and approval by Factory Mutual and the chiller shall include all required provisions to meet their approval.

SPECIFICATION CHANGES

1. Specification Section 012300 – Alternates: **DELETE** the section in its entirety. **ADD** in its place, Specification Section 012300 – Alternates, revised and reissued for Addendum #1.
2. Specification Section 230500 – Common Work Results: **DELETE** the section in its entirety. **ADD** in its place, Specification Section 230500 – Common Work Results, revised and reissued for Addendum #1.
3. Specification Section 232113 – Hydronic HVAC Piping: **DELETE** the section in its entirety. **ADD** in its place, Specification Section 232113 – Hydronic HVAC Piping, revised and reissued for Addendum #1.
4. Specification Section 236416 – Centrifugal Water Chillers: **DELETE** the section in its entirety. **ADD** in its place, Specification Section 236416 – Centrifugal Water Chillers, revised and reissued for Addendum #1.

DRAWING CHANGES

1. **DELETE** Drawing MP-1 in its entirety. **ADD** in its place, Drawing MP-1, revised and reissued for Addendum #1.
2. **DELETE** Drawing MP-5 in its entirety. **ADD** in its place, Drawing MP-5, revised and reissued for Addendum #1.

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include, as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not indicated as part of alternate.

B. Execute accepted alternates under the same conditions as other Work of the Contract.

C. Schedule: A Part 3 "Schedule of Alternates" Article is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. 1: Replace Chilled Water Pumps CHWP-1 and CHWP-2.

1. Base Bid: The existing chilled water pumps remain to serve the new chiller. Re-balance the chilled water system to achieve as close to the scheduled flow rate for the new chiller as possible.
2. Alternate No. 1: Replace the existing chilled water pumps (CHWP-1 and CHWP-2) as scheduled on the drawings. Replace the existing chilled water bypass valve as noted on the contract drawings and revise the control sequence to control the new bypass valve from chiller evaporator barrel DP. Revise control sequence to modulate chilled water pump speed on chilled water system DP. Provide adjustments (TAB) to chilled water system DP setpoint for the new chilled water pumps and evaporator barrel DP setpoints for the minimum flow bypass valve control.

B. Alternate No. 2: Replace Cooling Tower CT-1 and Condenser Water Pumps CWP-1 and CWP-2.

1. Base Bid: The existing cooling tower and condenser water pumps remain as currently exist. Re-balance the condenser water pumps to reduce the flow rate through the condenser barrel for the new chiller to that scheduled while maintaining the scheduled flow rate for the existing Clean Room chiller in the basement.
2. Alternate No. 1: Replace the existing Cooling Tower (CT-1R) and replace the existing condenser water pumps (CWP-1 and CWP-2) as scheduled on the drawings. Re-balance the condenser loop as required to maintain design condenser water flow rates to both the new chiller and the existing clean room chiller.

END OF SECTION 012300

SECTION 230500 – COMMON WORK RESULTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this Section.

B. This section applies HVAC Division 23 sections.

1.2 GENERAL

A. Section 230500 includes items common to all the 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 a decision before start of any related work.

D. Consistency and Completeness: The contract documents are intended to include all components; however, the contract documents may not be perfect. Repetitive, common components (such as volume dampers, thermostats, condensate drains, trap primers, vent pipes, valves, etc.) are shown throughout. If a common component is missing in from the drawings, provide as similar per other areas. There will be no change orders for missing such components, the contractor shall provide consistent, complete, functioning systems.

E. Should the Drawings or the Specifications disagree in themselves or with each other, the Contractor shall provide the better quality or greater quantity of work and/or materials unless otherwise directed by written addendum to the Contract Documents.

F. Materials or work described in words, which so applied, have a well-known technical or trade meaning shall be held to refer to such recognized standards. Since the plans and specifications cover the dimensions and features of the work and do not set forth the analysis of the design, it is the duty of the Contractor fulfilling them to ascertain the true intent in any case where it is doubtful.

1.3 MANUFACTURERS INSTRUCTIONS

A. Provide equipment and components to comply with manufacturer's written installation instructions and published drawings.

B. Follow manufacturer’s instructions for inspection, start-up, calibration, commissioning, and testing.

1.4 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.

B. The contractor shall become familiar with the Efficiency Maine Business Program including available incentives and the application and review process. Efficiency Maine is available to assist in the application process and can be reached at https://www.efficiencymaine.com/at-work/. Contractor must contact EM prior to submittals to review the project equipment and scope.

1. https://www.efficiencymaine.com/at-work/ci-incentive-program/
2. Review plans and specifications for compliance with Efficiency Maine standards for applicable systems and technologies.
3. Review plans and specifications for incentive opportunities.

C. The project schedule shall reflect and accommodate the time required to achieve application pre-approval from Efficiency Maine (EM). No equipment shall be purchased until pre-approval is received from EM.

D. Invoices shall be forwarded to EM within 60 days of the completion of the 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. As a minimum, obtain rebates for the following:

1. High efficiency chiller.

2. Smart pumps

1.5 DEFINITIONS

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

B. "Provide": Furnish and install, complete and ready for the intended use.

C. “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.

D. 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.

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

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

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

H. 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.

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

1.6 SUBMITTALS

A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain Name of project; name of prime professional; name of prime contractor; description or names of equipment, materials, and items; and complete identification of locations at which materials or equipment are to be installed. Individual piecemeal or incomplete submittals will not be accepted. Similar items, (all types specified) shall be submitted at one time. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Shop Drawings will be given a general review only.

1.7 SUBSTITUTIONS

A. Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner

must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.

2. Requested substitution does not require revisions to the Contract Documents.
3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
4. Substitution request is fully documented and properly submitted.
5. Requested substitution will not adversely affect Contractor's Construction Schedule.
6. Requested substitution has received necessary approvals of authorities having jurisdiction.
7. Requested substitution is compatible with other portions of the Work and shall be acceptable to all contractors involved.
8. Equipment electrical characteristics different than scheduled may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at no additional cost.
9. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
10. Requested substitution has been coordinated with other portions of the Work.
11. Requested substitution provides specified warranty.

1.8 QUALITY ASSURANCE

A. 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. Installer Qualifications: Work shall be done by skilled mechanics shall have successfully completed an apprenticeship program or another craft training program.

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

1.9 COORDINATION

A. Coordinate use of project space and sequence of installation of work, which is indicated diagrammatically on drawings. Follow routings shown, 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.

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 deficient items or conditions found during this project, including the testing, adjusting, and balancing period.

B. In order that 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. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy.

C. The Drawings and Specifications indicate adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to provide 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.

D. Complete operational readiness of the HVAC systems also requires that the following be accomplished:

1. Distribution Systems:

a. Verify installation for conformity to design. 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. RGD'S and terminal devices shall be provided and secured in a fully open position.
d. Air handling systems and associated apparatus shall be sealed to eliminate uncontrolled bypass or leakage of air. 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 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. Fans shall be operating and verified for freedom from vibration, proper fan rotation.
g.
h. Bearings shall be greased.
i. Terminal units shall be provided 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; valves are fully open. Examine HVAC system and equipment installations to verify that indicated balancing devices are properly provided, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation
   b. Valves shall be set to their fully open position. After the system is flushed and checked for proper operation, 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.
   c. Record motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating. Thermal overload protection is in place.
   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 air vents shall be provided 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. Heat transfer coils shall be checked for correct piping connections.

3. Building Automation System (BAS)

   a. The BAS Contractor shall verify that control components are provided in accordance with project requirements and are functional.
   b. The BAS Contractor shall verify that controlling instruments are calibrated and set for design operating conditions except for 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 software and interfaces to communicate with the system.
   c. The BAS Contractor shall thoroughly check 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 shall thoroughly check 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 PROJECT REQUIREMENTS

A. The Contractor shall cooperate with the Owner to minimize conflicts with the Owner's operations.

B. The Contractor shall study 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 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. Keep driveways and entrances serving premises clear and available to Owner. Schedule deliveries to minimize use of driveways and entrances and minimize space and time requirements for storage of materials and equipment on-site.

D. Follow the recommended procedures of the SMACNA IAQ Guidelines for Occupied Buildings under Construction.

E. Continuity of Services: The building will be in use during construction operations. Maintain existing systems in operation within rooms of building. Schedules for various phases of contract work shall be coordinated with other trades and with Owner’s Representative. Provide, as part of the contract, temporary plumbing and mechanical and electrical connections and relocations as required to accomplish the above. 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. Notify Owner at least two days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions. Indicate method of providing temporary utilities. Do not proceed with utility interruptions without Owner's written permission.

F. Cutting And Patching: Provide temporary support of Work to be cut. Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

1. Where existing services/systems are required to be removed relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
2. Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay. Cut in-place construction to provide for installation of other components or performance of other construction and subsequently patch as required to restore surfaces to their original condition.
3. Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original installer; comply with original installer's written recommendations.
4. Patch construction by filling, repairing, refinishing, closing, and similar operations following performance of other Work. Patch with durable seams that are as invisible as

possible. Provide materials and comply with installation requirements specified in other Sections. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing. Clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

5. Any structural member weakened or impaired by cutting, notching, or otherwise shall be reinforced, repaired, or replaced to be left in safe structural condition in accordance with the local building code requirements.
6. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
7. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

PART 2 - PRODUCT

2.1 PRODUCT CRITERIA

A. Any costs incurred due to deviations from basis of design unit shall be responsibility of the contractor.

B. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 5 years.

C. 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.

D. 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.

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

F. 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.

G. Asbestos products or equipment or materials containing asbestos shall not be used.

2.2 PROGRAMMABLE 3-PHASE LINE VOLTAGE MONITORS

A. Provide for all inverter-driven equipment.

B. Provide an ICM Controls Model #ICM450A or equal, for motor protection from premature failure and damage caused by common voltage faults such as phase unbalance, over/under voltage, phase loss and phase reversal.

1. Voltage: Universal, 190-600 VAC
2. Simultaneous 3-phase true RMS voltage monitoring
3. Factory calibrated.
4. 3-phase voltages simultaneously displayed on LCD
5. Fault memory
6. Fault monitoring: High / low voltage, voltage unbalance, phase loss, phase reversal
7. Simple configuration
8. Fully adjustable variables
9. Modbus RS485 communications
10. LED indicators
11. Common ¼" quick connect terminations.

2.3 IDENTIFICATION

A. Equipment:

1. Terminology: Match schedules as closely as possible.
2. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:
   a. Lettering Size: Minimum letter height of 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.
   b. Stencil Material: Fiberboard or metal.
   c. Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

B. In addition to the equipment tag, equipment located above the ceiling that requires servicing shall be labeled on the ceiling grid using a labeling machine.

C. Piping Identification Devices

1. Manufactured Pipe Markers, General: Seton, Brady, or approved equal; preprinted, color-coded, with lettering indicating service, and showing direction of flow.
2. 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. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length. Size of letters and length of color field per ASME A13.1.
3. Pipes with OD, Including Insulation; Full-band snap-around pipe markers extending 360 degrees around pipe at each location. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow. Length of color field and size of letters shall be proportional to pipe OD.

4. Types: Self-adhesive type: Seton Opti-Code; Snap-around type: Seton Setmark; Wrap-around type: Seton Ultra-mark; PVF over-laminated polyester construction seals in and protects graphics; suitable for outdoor or harsh environments.

D. Valve Tags & Schedules

1. 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. Valve Schedules: For each piping system, on standard-size bond paper. Also save in PDF format. 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. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws. Frame: aluminum. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

E. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing. Size: 3 by 5-1/4 inches minimum. Large-size primary caption such as "DANGER". Color: Yellow background with black lettering.

2.4 PIPE JOINING MATERIALS

A. Provide per local code.

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. 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. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Press Connections

1. Basis-of-Design Product: Subject to compliance with requirements, provide Viega LLC; ProPress, Apollo, or approved equal.
2. Press ends shall have Viega Smart Connect, Apollo Leak Before Press, or similar technology designed into the fitting itself, allowing identification of an un-pressed fitting during pressure testing. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.

3. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of ASME B16.51 and IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed, or an alternative supplied by the fitting manufacturer.
4. Steel: Cold Press Mechanical Joint Fitting shall conform to material requirements of ASTM A420 or ASME B16.3 and performance criteria ANSI/CSA LC4. Sealing elements for press fittings shall be HNBR. Sealing elements shall be factory installed, or an alternative supplied by the fitting manufacturer. Piping and fittings shall comply with CSA LC-4 and local codes.

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.

K. 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.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657. Plain-End Pipe and Fittings: Use butt fusion. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Provide dielectric isolation at the connection of dissimilar metals. Provide brass ball valves or fittings; or Watts Series LF3000 (lead free) or approved equal.

2.5 SLEEVES & ESCUTCHEONS

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

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

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

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

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

F. Provide penetration system where service pipes penetrate through foundation wall or floor. Make installation watertight. Mechanical Sleeve Seals: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve; Thunderline Link-Seal, Advanced Product & Systems, LLC, Garlock, or approved equal.

1. Sealing Elements: EPDM 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.

G. 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 covers the opening. Escutcheons shall have setscrews for maintaining a fixed position against a surface.

2.6 ROOF PIPING

A. Roof Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping. Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration. Bases: One or more; plastic. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

B. Roof Pipe Penetrations: Thybar TCC-3 curb system with cover and pipe boots.

1. Prefabricated roof curb to be manufactured of prime galvanized steel construction, 20, 18, 16 or 14 gauge as required, meeting ASTM A653/653M, with welded corners and with seams joined by continuous welds. Roof curb shall be internally reinforced with angles 48" on center, factory insulated with 1-½" thick 3# density fiberglass insulation, and factory installed wood nailers. Height to be 18" above roof deck or as detailed. Top of all roof curbs shall be level, with pitch built into curb when deck slopes.

2. ABS Thermoplastic cover on top of curb.
3. Graduated Boots Molded or Weather-Resistant Plastisol
4. SS pipe clamps, 2 per boot.

2.7 HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

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

1. B-Line Systems, Inc.
2. Carpenter & Patterson, Inc.
3. Grinnell Corp.
4. Hubbard Enterprises/Holdrite
5. National Pipe Hanger Corp.
6. Piping Technology & Products, Inc.
7. Unistrut
8. Anvil International, Inc.
9. Empire

B. Provide in accordance with MSS SP69 - Manufacturers Standardization Society: Pipe Hangers and Supports- Selection and Application. Steel pipe hangers and supports shall have the manufacturer’s name, part number, and applicable size stamped on the part itself for identification.

C. The materials of pipe hanging and supporting elements shall be in accordance with MSS SP-58. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications." Do not allow dissimilar metals to come into contact.

D. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel." 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. Delegated-Design Submittal: For hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Show fabrication and installation details and include calculations. Provide for the following: trapeze pipe hangers, metal framing systems, pipe stands, equipment supports.

F. Hangers:

1. Uninsulated pipes 2 inch and smaller: Adjustable steel swivel ring (band type) hanger, Type 10, B-Line B3170; Adjustable steel swivel J-hanger, Type 5, B-Line B3690;

Malleable iron ring hanger, Type 12, B-Line B3198R or hinged ring hanger, B3198H.Adjustable steel clevis hanger, Type 1, B-Line B3100.

2. Uninsulated pipes 2-1/2 inch and larger: Adjustable steel clevis hanger, Type 1, B-Line B3100.
3. Insulated Hot piping: 2 inch and smaller pipes: use adjustable steel clevis with galvanized sheet metal shield. Type 1, B-Line B3100 with Type 40, B-Line B3151 series insulation protection shield. 2-1/2 inch and larger pipes: Type 41 or Type 43 with Type 39A/39B, B3160-B3165 series pipe covering protection saddle.
4. Insulated Cold piping: use adjustable steel clevis with galvanized sheet metal shield. Type 1, B-Line B3100 with Type 40, B-Line B3151 series insulation protection shield.
5. Copper Tubing Supports Hangers shall be sized to fit copper tubing outside diameters. Adjustable steel swivel ring (band type) hanger, Type 10, B-Line B3170CT. Malleable iron ring hanger, Type 12, B-Line B3198RCT or hinged ring hanger B3198HCT. Adjustable steel clevis hanger, Type 1, B-Line B3104CT. For supporting copper tube to strut use plastic inserted vibration isolation clamps, B-Line BVT series.
6. Plastic Pipe Supports: V-Bottom clevis hanger with galvanized 18-gauge continuous support channel, Type 1, B-Line B3106 and B3106V plastic pipe support channel, to form a continuous support system for plastic pipe or flexible tubing.

G. Pipe Clamps: When flexibility in the hanger assembly is required due to horizontal movement, use pipe clamps with weldless eye nuts, Type 4, B-Line B3140. For insulated lines use double bolted pipe clamps, Type 3, B-Line B3144.

H. Multiple or Trapeze Hanger: Trapeze hangers shall be constructed from 12-gauge roll formed ASTM A1011 SS Grade 33 structural steel channel, 1-5/8 inch by 1-5/8-inch minimum, B-Line B22 strut or stronger as required. Mount pipes to trapeze with 2-piece pipe straps sized for outside diameter of pipe, B-Line B2000 Series.

I. Wall Supports: Pipes 4” and smaller: Carbon steel J-hanger, B-Line B3690. Pipes larger than 4”: Welded strut bracket and pipe straps, Type 31 light welded steel bracket, B-Line B3064. Provide Type 32 or Type 33 for heavier loads.

J. Floor Supports: Hot piping under 6 inch and cold piping: Carbon steel adjustable pipe saddle and nipple attached to steel base stand sized for pipe elevation. Type 38 adjustable pipe saddle, B-Line B3093 and B3088T base stand; or Type 39, B3090 and B3088 base stand. Pipe saddle shall be screwed or welded to appropriate base stand. Hot piping 6 inch and larger: Adjustable Roller stand with base plate, Type 46, B3118SL. Adjustable roller support and steel support sized for elevation, B-Line B3124.

K. Vertical Supports: Steel riser clamp sized to fit OD of pipe, Type 8, B-Line B3373.

L. Supplementary Structural Supports: 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.

M. Beam Clamps shall be used where piping is to be suspended from building steel. Clamp type shall be selected based on load to be supported, and load configuration. C-Clamps shall have locknuts and cup point set screws, Type 23, B-Line B351L. Refer to manufacturer's recommendation for setscrew torque. Retaining straps shall be used to maintain the clamps position on the beam where required.

N. Concrete Inserts: Cast in place spot concrete inserts shall be used where applicable; either steel or malleable iron body, Type 18, 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. 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.

O. For air conditioning and other vibrating system applications, use a clamp that has a vibration dampening insert and a nylon inserted locknut. For copper and steel tubing use B-Line BVT-Series Vibraclamps. For larger tubing or piping subjected to vibration, use neoprene or spring hangers as required. For base mounted equipment use vibration pads, molded neoprene mounts, or spring mounts as required.

P. Accessories

1. 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.
2. Shields shall be 180-degree galvanized sheet metal, 12-inch minimum length, 18-gauge minimum thickness, designed to match outside diameter of the insulated pipe, B-Line B3151.
3. 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.

Q. Indoor Finishes: 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. 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®. 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®.

R. Outdoor Finishes: Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. Hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.

S. Unistrut (MFMA) Manufacturer Metal Framing System:

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

    a. Unistrut Corporation
    b. Cooper B-Line, Inc.
    c. Flex-Strut Inc.
    d. Thomas & Betts Corporation.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with in-turned lips. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
5. Coating: Unistrut Perma-green or similar.

2.8 BRAIDED EXPANSION LOOPS (MANUFACTURED ONLY, NO FIELD FABRICATED)

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

    a. Metraflex Co.
    b. Flex Hose Co., Inc.
    c. Flexicraft

B. Flexible loops shall consist of two flexible sections of hose and braid, two 90° elbows, and an 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. Flexible loops shall impart no thrust loads to system support anchors or building structure. Loops shall be provided in a neutral, pre-compressed or pre-extended condition as required for the application. For steam service, loops must be provided with flexible legs horizontal to prevent condensate buildup. Provide and guide per manufacturer's recommendations. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings. For natural gas service, connectors shall be A.G.A. certified. Basis of Design: Flexible expansion loops to be "Metraloop" as manufactured by the Metraflex Company.

C. Loops for domestic hot water shall be NSF-372 lead free certified.

D. For tight pipe runs, provide nested loops.

E. Anchors: 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. Clamp to pipe.

F. Guides: 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.

2.9 THERMOMETERS AND PRESSURE GAUGES

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.

B. The proper range will be selected so that the operating temperature/pressure of the material being measured will fall approximately in the middle of the scale.

C. 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.

D. Thermowells: Provide fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem. Material shall be compatible with the piping. 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. Cap: Threaded, with chain permanently fastened to socket.

E. Pressure gauges shall be 3½" dial size with a flangeless cast aluminum case, stainless steel friction ring and glass window. The movement will be brass with a bronze bourdon tube and brass socket. The 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. Provide 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.
5. Needle Valves: Trerice 735 Series; NPS 1/4 brass or 316 stainless steel needle type.

2.10 MISCELLANEOUS

A. Grout: 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.

B. Equipment shall be vibration 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. Work shall be conducted, installed, and completed in a neat and professional manner reflecting a minimum level of competent workmanship.

B. 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 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 the contractor where necessary to avoid interferences and clearance difficulties.

C. Fabricate based on field measurements.

D. Corrections or comments made on the shop or coordination drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for: confirming and correcting quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of other trades; and performing work in a safe and satisfactory manner.

E. 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 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 work thoroughly clean fixtures, exposed materials, and equipment.

F. Provide piping, ductwork, and equipment to allow maximum headroom unless specific mounting heights are indicated. Provide equipment level and plumb, parallel, and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

G. Provide 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.

H. Coordinate location of piping, ductwork, sleeves, inserts, hangers, and equipment. Locate to clear other construction, services, and utilities.

I. Provide piping and ductwork in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

J. Provide systems above accessible ceilings to allow sufficient space for ceiling panel removal.

K. Verify final equipment locations for roughing-in.

L. Do not enclose, cover, or put into operation until inspected and approved by authorities having jurisdiction.

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

N. Any hot work operations that are performed during this project shall be permitted by use of the FM Global Hot Work Permit System. The FM Global Hot Work Permit System shall be used to

supervise all hot work operations (cutting, welding, brazing, grinding, soldering, etc.,) performed outside of any designated welding areas. A written policy statement shall specify who has the authority to issue permits on all shifts. In addition, a constant fire watch shall be continued for 1 hr. after work is completed and the area shall be monitored for an additional 3 hrs. after that.

3.3 PIPING INSTALLATIONS

A. Provide 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.

1. Provide piping to permit valve servicing.
2. Provide equipment and other components to allow right of way for piping installed at required slope.
3. Provide free of sags and bends.
4. Provide unions or flanges at connections to equipment.
5. Provide fittings for changes in direction and branch connections.
6. Make allowances for application of insulation.

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

C. Use transition fitting to join dissimilar piping materials. Connect piping in sizes indicated, but not smaller than sizes of unit connections.

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

E. Plastic piping: Piping shall be installed to avoid damage from adjacent light fixtures. In certain construction situations, these plastic pipes may be installed near recessed light fixtures in ceilings. Light fixtures may have exterior temperatures as high as 194°F.

F. Plumbing: General layout shown, provide piping and components as required by the local plumbing code. A licensed master plumber shall perform or supervise the work and provide layouts, piping, and fittings as required by code.

3.4 PIPING JOINT CONSTRUCTION

A. Pipe and tube required by the applicable standard to be cleaned and capped shall be delivered to the job site with factory-applied endcaps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture. Protect stored pipe and tube from moisture and dirt. Elevate above grade. When stored inside, do not exceed the structural capacity of the floor. Protect fittings, flanges, and piping specialties from moisture and dirt. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

B. Joints shall be fabricated, joined, and tested per the piping and fitting manufacturer's instructions. Joint preparation, setting and alignment, joining process, timing, hanger spacing, and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.

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

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

E. Installer Qualifications

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

F. Provide dielectric isolation at the connection of the dissimilar piping (copper and steel).

G. 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.

H. 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/A5.8M.

I. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

J. Press connections:

1. The joints shall be pressed using the tools approved by the manufacturer.
2. Always examine the pipe to ensure it is fully inserted into the fitting prior to pressing the joint.
3. Pipe ends shall be cut on a right angle (square) to the pipe.
4. Copper: The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tools approved by the manufacturer.
5. Steel: Pipe ends shall be reamed chamfered, and paint, lacquer, grease, oil, or dirt shall be removed from the pipe end with an abrasive cloth, or with the Rigid MegaPress pipe end prep tool. Sealing elements shall be verified for the intended use. Visually examine the fitting sealing element to ensure there is no damage. Utilizing a Viega insertion depth inspection gauge mark the tube wall, with a felt tip pen, at the appropriate location, or insert the pipe fully into the fitting and mark the pipe wall at the face of the fitting.

K. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid or flexible, where required, grooved-end-pipe couplings. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. A Victaulic factory trained field representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically review the product installation. The contractor shall remove and replace any improperly installed products.

L. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators. Bevel plain ends of steel pipe. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

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

N. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix. PVC Piping: Join according to ASTM D 2855.

3.5 PIPE PENETRATIONS, SLEEVES, & ESCUTCHEONS

A. Pipe penetrations shall be sealed, provide sealants for pipe penetrations

B. Provide allowance for thermal expansion and contraction of copper tubing passing through a wall, floor, ceiling, or partition by wrapping with an approved tape or pipe insulation or by installing through an appropriately sized sleeve.

C. Sleeve Clearance: Sleeve through floors, walls, partitions, and beams 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. Provide sleeves for pipes passing through concrete and masonry construction. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint. Cut sleeves to length for mounting flush with both surfaces. Provide sleeves in new walls and slabs as new walls and slabs are constructed. Provide steel pipe sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Piping through concrete or masonry shall not be subject to any load from the building construction.

1. Sleeves are not required in drywall construction.
2. Sleeves are not required for core-drilled holes. Provide core drilling as required.

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- Pipe Penetrations: Provide sleeve-seal systems in sleeves at service piping entries into building. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and provide in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

G. Escutcheons:

1. Provide escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork.
2. Provide escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
3. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

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.

3.6 PIPE HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or provide intermediate supports for smaller diameter pipes as specified for individual pipe hangers. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Provide per manufactures recommendations and calculations.

D. Thermal-Hanger Shield Installation: Provide in pipe hanger or shield for insulated piping.

E. Fastener System Installation: Provide powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Provide fasteners according to powder-actuated tool manufacturer's operating manual. Provide mechanical-expansion anchors in concrete after concrete is placed and completely cured. Provide fasteners according to manufacturer's written instructions.

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

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

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

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

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

K. Provide 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

L. Pipe Slopes: Provide hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by plumbing code and ASME B31.9 for building services piping. Piping shall be supported in such a manner as to maintain its alignment and prevent sagging.

M. Insulated Piping: Attach clamps and spacers to piping.

1. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
2. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

N. Equipment Supports: Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor. Grouting: Place grout under supports for equipment and make bearing surface smooth. Provide lateral bracing, to prevent swaying, for equipment supports.

O. Metal Fabrications: Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

P. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

Q. Hanger and Support Schedule

1. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
2. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
3. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Hanger Spacing

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

2. Load Distribution: Provide hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment. Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading.
3. Space and provide hangers with the fewest practical rigid anchor points.
4. Piping shall be supported at intervals sufficiently close to maintain correct pipe alignment and to prevent sagging or grade reversal.
5. Pipe shall be supported at branch ends and at changes of direction.
6. Provide hangers for steel piping with the following maximum horizontal spacing and minimum rod sizes:

    a. NPS ¾ to 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
    b. NPS 1-1/4: Maximum span, 8 feet; minimum rod size, 3/8 inch.
    c. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
    d. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
    e. NPS 2-1/2 to 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
    f. NPS 4 to 5: Maximum span, 10 feet; minimum rod size, 5/8 inch.
    g. NPS 6 to 8: Maximum span, 10 feet; minimum rod size, 3/4 inch.
    h. NPS 10 to 12: Maximum span, 10 feet; minimum rod size, 7/8 inch.

7. Provide hangers for copper piping with the following maximum horizontal spacing and minimum rod sizes:

    a. NPS ½ and 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
    b. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
    c. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
    d. NPS 1-1/2 to 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
    e. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
    f. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
    g. NPS 4: Maximum span, 10 feet; minimum rod size, 1/2 inch.
    h. Maximum vertical steel and copper pipe attachment spacing: 10 feet.

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

3.7 VALVE INSTALLATION

A. Valves shall be installed in accordance with the manufacturer’s recommendations.

B. Provide valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown. Locate valves for easy access and provide separate support where necessary.

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

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

E. Provide strainers on supply side of each control valve and elsewhere as indicated or recommended by component manufacturer to have strainer protection. Provide valved drain and hose connection on strainer blow down connection.
   1. Provide with provisions for service clearance.
   2. Remove and clean strainer after 24 hours of operation and after 30 days of operation.

F. 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.

G. 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 connections to screw-type control valves.

H. Provide check valves at each pump discharge and elsewhere as required to control flow direction.

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

3.8 IDENTIFICATION

A. Provide equipment markers on each item of scheduled equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated. Locate markers where accessible and visible. Equipment located above the ceiling that requires servicing shall be labeled on the ceiling using a labeling machine.

   1. Letters shall be ¼" high, black.
   2. Label equipment above ceiling that requires servicing or access. Locate labels on the ceiling grid, adjacent to the ceiling tile that provides the best access to the valve or item that requires servicing.

B. Piping Identification:

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

      a. Near each valve and control device.
      b. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
      c. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
      d. At access doors and similar access points that permit view of concealed piping.
      e. Near major equipment items and other points of origination and termination.
      f. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

g. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

2. Directional Flow Arrows: Arrows shall be provided to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
3. Apply “Electric Traced” labels to the outside of heat-traced insulation.

C. Provide 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. Mount valve schedule on wall in accessible location in each major equipment room. Provide (2) copies of valve schedules in digital format.

D. Relocate mechanical identification materials and devices that have become visually blocked by other work. Clean faces of mechanical identification devices.

3.9 THERMOMETERS AND PRESSURE GAUGES

A. Provide thermometers and adjust vertical and tilted positions. Provide thermowells with extension on insulated piping. Provide separable sockets in vertical position in piping tees.

B. Provide pressure gauges in piping tees with pressure-gauge valve located on pipe at most readable position. Provide valve and snubber in piping for each pressure gage for fluids.

C. Calibrate according to manufacturer's written instructions, after installation.

D. Adjust faces to proper angle for best visibility. Clean windows and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

3.10 BRAIDED EXPANSION LOOP INSTALLATION

A. Provide and guide per manufacturers’ installation instructions and Mechanical Contractors Association of America “Guidelines for Quality Piping Installations”. Flexible hose expansion loop return fittings shall be supported to allow movement.

B. Nesting Clearance. Often several Metraloops are nested inside of each other, when this is the case, the installer shall verify that there is enough clearance between the Metraloops after insulation to allow for the full expected movement.

C. Provide pipe anchors according to expansion fitting manufacturer's written instructions.

1. Provide 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. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
4. Concrete Anchors: Attach by fasteners, follow fastener manufacturer's written instructions.

D. A pipe guide shall be provided 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.

3.11 ERECTION OF SUPPORTS AND ANCHORAGES

A. Fasten wall-hanging items securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated. Fasten recessed-type items to reinforcement built into walls.

B. Wood: Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor materials and equipment. 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. Provide fasteners without splitting wood members. Attach to substrates as required to support applied loads.

C. Metal: Provide in accordance with Division 5. 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.

D. Grouting: Provide per manufacturer’s instructions. Mix and provide grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors. Clean surfaces that will encounter 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.

3.12 FIRESTOPPING

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

B. UL-Classified Systems shall be provided for rated walls and floors.

C. Engage an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to provide firestop products per specified requirements.

D. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are provided according to specified requirements.

E. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

F. Provide components for each through-penetration firestop system that are needed to provide fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

G. General: Use only through-penetration firestop system products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance. Keep areas of work accessible until inspection by authorities having jurisdiction.

H. Inspecting Agency: Owner may engage a qualified, independent inspecting agency to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

I. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and provide new materials to produce systems complying with specified requirements.

3.13 PAINTING

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

3.14 ROOFING

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

B. Roof Pipe Stand Installation: Provide per manufactures recommendations and calculations. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount them on a smooth roof surface. Do not penetrate roof membrane. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.

C. Roof Pipe Penetrations: Provide curb system with cover and pipe boots.

D. Do not locate mechanical equipment within 10-feet of the roof edge.

E. Roof Edge Fall Protection: Basis of Design: Keegard “Rooftop Guardrail for Narrow Spaces”, or equal. Provide freestanding/non-penetrating roof edge protection system, including pipe railings, uprights, bases, counterweights, and fittings. Freestanding counterweighted guardrail system with 42 inches minimum height to provide a pedestrian egress barrier on the roof to withstand a minimum load of 200 lb. in any direction to the top rail per OSHA Regulation 29 CFR 1910.23. Pipe: Steel, 1-1/2 inches schedule 40, galvanized, galvanized or stainless-steel construction. Provide galvanized steel bases are galvanized with a rubber pad on underside of the component (set on roof, without disturbing existing adhered roof membrane).

3.15 PROJECT CLOSEOUT

A. Starting and Adjusting

1. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace them with new units, and retest.
2. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
3. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Provide commissioning per manufacturer's instructions. This start-up shall include verification of proper installation, system initiation, adjustment, and fine tuning.
5. Start-up shall not be considered complete until the sequence of operation, including alarms, has been sufficiently demonstrated to the Owner or Owner’s designated representative. This jobsite visit shall occur only after hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer’s start-up request form.

B. Follow Closeout procedures as per Division 1.

C. Provide Demonstration and Training in accordance Division 1.

D. Provide Project Record Documents in accordance with Division 1. In addition, per ASHRAE 90.1-2016: Provide record drawings of the actual installation to the building owner. Record drawings shall include, as a minimum, the location and performance data on each piece of equipment; general configuration of the duct and pipe distribution system, including sizes; and the terminal air or water design flow rates.

E. Provide Operation and Maintenance information in accordance with Division 1. In addition, per ASHRAE 90.1: Provide an operating manual and a maintenance manual to the building owner. Manuals shall include, at a minimum, the following:

1. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.
2. Operation manuals and maintenance manuals for each piece of equipment and system requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.
3. Names and addresses of at least one service agency.

4. HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined set points shall be permanently recorded on control drawings at control devices or, for digital control systems, in programming comments.

END OF SECTION 230500

SECTION 232113 – HYDRONIC HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:

1. Division 23 Section "Common Work Results"
2. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories.
3. Division 23 controls section for temperature-control valves and sensors.

1.2 SUMMARY

A. This Section includes piping and specialties for hydronic HVAC piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Piping
2. Hydronic specialties
3. Chemical treatment.

B. Delegated-Design Submittal: Braided Expansion Loops

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.

1.4 INFORMATIONAL SUBMITTALS

A. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.6 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.

E. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.7 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.

C. Coordinate pipe sleeve installations and penetrations with other trades.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Grooved Mechanical-Joint Fittings and Couplings:

    a. Victaulic Company of America.
    b. Anvil
    c. Grinnell Corporation.

2. Balancing Valves:

    a. Griswold Controls.
    b. ITT Bell & Gossett
    c. Taco, Inc.
    d. Tour & Anderson
    e. IMI Flow Design
    f. Griswold Controls
    g. Watts Industries Inc.
    h. Caleffi
    i. Nexus

3. Hydronic Pressure-Reducing Valves:

    a. Amtrol, Inc.
    b. Armstrong Pumps, Inc.
    c. Conbraco Industries, Inc.
    d. ITT Bell & Gossett
    e. Spence
    f. Caleffi
    g. Watts Industries, Inc.

4. Safety Valves:

    a. Amtrol, Inc.
    b. Armstrong Pumps, Inc.
    c. Conbraco Industries, Inc.
    d. ITT McDonnell & Miller.
    e. Kunkle Valve Division.
    f. Spence
    g. Caleffi
    h. Watts Industries Inc.

5. Expansion Tanks, Air Separators, and Hydronic Specialties:
    a. Spirovent
    b. ITT Bell & Gossett
    c. Taco, Inc.
    d. Spirax Sarco
    e. Watts Industries Inc.
    f. Wessels
    g. Patterson
    h. Thrush

i. Armstrong
j. Flamco

6. Air Vents and Vacuum Breakers:

a. Armstrong International, Inc.
b. Barnes & Jones, Inc.
c. ITT Hoffman
d. Caleffi
e. Spirotherm
f. 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. DWV Copper Tubing: ASTM B 306, Type DWV.

C. Fitting Standard: Copper fittings shall conform to ASME B16.18, ASME B16.22 or ASME B16.26.

D. Press Fitting: Viega Pro Press - Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed, or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect) feature design (leakage path). Provide a smart connect feature to assure leakage of liquids and/or gases from inside the system past the sealing element of an un-pressed connection. The function of this feature shall be to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.

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: Material Group: 1.1. End Connections: Butt-welding. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Victaulic or approved equal.
2. Grooved Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron, ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 234, Grade WPB forged steel fittings with grooves or shoulders constructed to accept Victaulic grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Couplings: Ductile-iron housing and synthetic rubber gasket of central cavity pressure-responsive design (Grade “E” EPDM for water services –30°F to 230°F or Grade “EHP” EPDM for water services rated –30°F to 250°F); with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

    a. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9; Victaulic Style 07 (Zero-Flex®) or Style 107 Quick-Vic® Installation-Ready design.
    b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Victaulic Style 75 or 77.
    c. Flange Adapters: Ductile iron housing, flat face, for use with grooved end pipe and fittings, for mating directly with ANSI Class 125, 150, and 300 flanges. Victaulic Style 741 or 743.

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

J. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets 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.

K. 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.

L. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 HYDRONIC VALVES

~~A. Normally use Ball valves for shut off duty: 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 600 psi 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. Butterfly Valves

1. Basis of Design: Center Line Series 200; Lug Type, cast iron, drilled and tapped lug body, ductile iron disc, 416SS shaft, bronze bushing, EPDM seat.
2. Valve bodies shall have extended necks to provide for 2-1/4" insulation as needed.
3. Comply with MSS SP-67.
4. Compatible with ANSI 125/150 flanges. Dead-end capacity to 200 psi.
5. Operators: 6” and smaller: handle with infinite adjustment; 8” and larger: gear w/balance-stop hand wheel. Valves located 7 feet or higher: provide gear/chain wheel.
6. Approved Manufacturers: Watts, Hammond, Nibco, Milwaukee, or approved equal.

D. Bronze Globe Valves, Class 125:

1. Description:

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

E. Bronze Globe Valves, Class 150:

1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

F. Iron Globe Valves, Class 125:

1. Description:

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

G. Iron Globe Valves, Class 250:

1. Description:

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

H. Wafer Check valves: Provide wafer style, butterfly type, spring actuated check valves designed to be installed with gaskets between two standard Class 125 flanges. Construct iron body valves with pressure containing parts of valves with materials conforming to ANSI/ASTM A 126, Grade B. Support hanger pin by removable side plug; Class 125, cast iron body, stainless steel trim, bronze disc, Buna-N seal:, Watts BF/DBF series, Metraflex 700 Series, Nibco W920-W, Stockham WG970, Hammond 9253, Milwaukee 1400, or approved or equal.

I. 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. Comply with the following standards for design, workmanship, material and testing: Bronze Valves: MSS SP – 80; Cast Iron Valves: MSS SP – 71.
2. Construct valves of pressure casting free of any impregnating materials. Construct disc and hanger as one piece. Support hanger pins by removable side plug.
3. 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.
4. 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.
5. 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.

J. 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.

K. 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.

2.6 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: Spirotherm Spirotop, or equal; maintenance-free, designed to vent automatically with float principle; solid-brass body and nonferrous internal parts; 150-psig working pressure; 270°F maximum temperature; NPS 1/2 inlet connection; ½” male thread at vent point for pressure-testing or remote venting of unwanted gases. The Spirotop has a unique "dry" vent design that helps prevent the system fluid from reaching the spring actuated Viton

seat and seal assembly, which is the cause of most conventional air vent failures. Air vent shall be dry: release air, not water.

1. The unique valve mechanism is guaranteed not to leak and cannot be shut off.
2. Specially constructed air chamber to protect the valve mechanism from dirt.
3. Sufficient volume to handle pressure fluctuations.
4. A reliable vacuum breaker for system draining.
5. Leak and dirt resistant.

C. Inline Air-Dirt-Magnet Separator: Spirotherm Spirocombi air & dirt separator with magnet. Eliminates air and system from dirt and debris.

1. Horizontal or vertical pipe installation (360°).
2. Shell: Brass
3. Vent Head: Brass
4. Float: Non-Ferrous
5. Seal: Viton
6. O Ring: Viton/EPDM
7. Coalescing Medium: Copper; Eliminates 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system.
8. Magnet: Neodymium; separates dirt particles and ferrous material using powerful magnets around flow path.
9. Max. Working Pressure: 150 psig
10. Max. Operating Temperature: 270°

D. In-Line Air Separators: Taco Air Scoop, Spirotherm, or equal; enlarged design with internal baffles slows the water velocity to separate the air from solution. One-piece cast iron with an integral weir designed to decelerate system flow to maximize air separation at a working pressure up to 125 psig and liquid temperature up to 300 deg F. Each Air Scoop shall have a 1/8” vent connection on top for the installation of a Taco 400-3 or 416-1 Hy-Vent, and a 1/2” bottom tapping for a diaphragm expansion tank.

E. 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. 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”. 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).

F. Differential Pressure Bypass Valve

1. Basis-of-Design Product: Subject to compliance with requirements, provide products by Caleffi North America; 519 Series or comparable product by one of the following:

   a. Bell & Gossett (Xylem).
   b. Taco Comfort Solutions.

2. Description: Used in systems with a fixed-speed circulating pump supplying several zones controlled by two-way zone valves. Ensures that the head pressure of the pump is proportional to the number of two-way valves being closed. It will bypass the differential pressure created by the pump as the zone valves close, thus eliminating water hammer noise.
3. Body Material: Brass.
4. Valve Plug: Brass.
5. Valve Plug Gasket and O-ring Seals: Peroxide-cured EPDM.
6. Union Seals: Asbestos free nitrile, butadiene rubber.
7. Control Knob: ABS.
8. Spring: Stainless steel.
9. Maximum Working Pressure: 150 psig.
11. Connections: Union.
12. Temperature Range: 32 to 23°F.
13. Flow Rates:

   a. Size: NPS 3/4 up to 9 GPM.
   b. Size: NPS 1 up to 40 GPM.
   c. Size: NPS 1-1/4 up to 45 GPM.

G. Chilled water buffer tanks shall be as manufactured by Cemline Corporation or approved equal.

2.7 TEST PLUGS

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

1. Peterson Equipment Co., Inc.
2. Flow Design, Inc.
3. Trerice, H. O. Co.
4. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
5. Weiss Instruments, Inc.

B. Description: “Pete’s Plug II”, a ¼” fitting to receive either a temperature or pressure probe 1.8” OD.

C. Body: Solid brass with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping. Core Inserts: Nordel, an ethylene-propylene based synthetic rubber.

D. Minimum Pressure and Temperature Rating: 500 PSIG at 275 deg F.

2.8 WATER TREATMENT FOR CLOSED LOOP HYDRONIC SYSTEMS

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

1. Sentinel
2. Anderson Chemical Company.
3. Aqua-Chem, Inc.
4. Barclay Water Management, Inc.
5. General Electric Company; GE Water & Process Technologies.
6. H-O-H Water Technology, Inc.
7. Metro Group, Inc. (The); Metropolitan Refining Div.
8. Nalco; an Ecolab company.
9. Watcon, Inc.

B. Performance Requirements

1. Provide water treatment for closed-loop hydronic systems.
2. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
3. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, equipment manufacturer's specific requirements, and requirements and guidelines of authorities having jurisdiction.
4. Closed hydronic systems, ~~including~~ shall have the following water qualities:

    a. pH: Maintain a value within 8.2 to 9.5.
    b. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
    c. Total Hardness : <150 ppm as $caCO_3$.
    d. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
    e. Soluble Copper: Maintain a maximum value of 0.20 ppm.
    f. TSS: Maintain a maximum value of 10 ppm.
    g. Ammonia: Maintain a maximum value of 20 ppm.
    h. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
    i. Microbiological Limits:

        1) Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
        2) Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
        3) Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
        4) Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
        5) Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.9 GLYCOL

A. DuPont Dowfrost HD or approved equal; the propylene glycol fluid to be used in such a system shall meet the following requirements: The fluid shall be industrially inhibited propylene glycol (phosphate-based). The fluid shall be easily analyzed for glycol concentration and inhibitor level. The fluid shall be easily re-inhibited using inhibitors readily available from the fluid manufacturer. The fluid shall pass ASTM D1384 (less than 0.5 mils penetration per year for all system metals). The fluid shall be dyed bright yellow to aid in leak detection

PART 3 - EXECUTION

3.1 HYDRONIC PIPING APPLICATIONS – ABOVE GROUND

A. Chilled Water, NPS 4 and Larger: Schedule 40 steel pipe with welded or flanged joints; or grooved mechanical-joint couplings.

B. Makeup water piping: Type L copper.

C. Condenser Water, NPS 4 and Larger Schedule 40 steel pipe with welded, flanged, or grooved mechanical-joint couplings.

D. Chemical Feed Piping for Condenser Water Treatment: Chlorinated polyvinyl chloride (CPVC), Schedule 80, ASTM F441.

3.2 HYDRONIC PIPING INSTALLATIONS

A. Refer to Division 23 Section "Common Work Results" for installation of:

1. Basic piping requirements.
2. Joint construction requirements.
3. Hanger, support, and anchor devices.
4. Firestopping
5. Sleeves and Escutcheons
6. Dielectric fittings
7. Valves
8. Mechanical Identification

B. Hydronic piping systems shall be provided to permit the system to be drained. Provide 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.

C. Provide piping at a uniform grade of 0.2 percent upward in direction of flow. Pipe size at connections to equipment shall be distribution main size, not connection size. Reduce pipe sizes using eccentric reducer fitting installed with level side up. 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.

D. Provide safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Provide safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements. Check the settings and operation of each safety valve, including valves furnished by heater manufacturer. Record settings.

E. 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 flexible hoses at least four pipe fittings, including tee in main.

F. Terminal Equipment Connections

1. Size for supply and return piping connections shall be same as for equipment connections.
2. Provide control valves in accessible locations close to connected equipment.
3. Arrange piping with offsets to allow for expansion, as well as terminal unit removal.

3.3 HYDRONIC SPECIALTIES INSTALLATION

A. Provide 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 provided on the suction side of the system pumps. Expansion tank shall be tied into system piping near air separator and system fill line. Provide piping to compression tank with a 2 percent upward slope toward tank.

C. Expansion tanks: Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

D. Air eliminator, dirt separators and hydraulic separators shall be mounted in a straight run of horizontal piping in a perfectly upright position to allow the vent to operate freely and/or dirt to settle.

E. Hydraulic Separators: The primary loop shall be purged of air with the secondary terminal loop shutoff valves closed. The primary loop shall be cleaned of debris by starting the primary pumps and continuously circulating water in the primary loop. The system shall be cleaned by frequently cleaning the start-up screens in the primary pump suction diffusers until the screens do not collect any more debris. Once the suction diffuser start-up screens are clean then the shutoff valves to the secondary terminal loops can be opened. The secondary terminal loops

shall be purged of air by opening the air vents on the terminal units. When the secondary terminal unit piping is purged of air then the circulators can be started.

3.4 CONTROL VALVE INSTALLATION

A. Perform the following as directed by the BAS contractor:

1. Provide 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.

3.5 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the water characteristics described in Part 2.

B. Provide bypass chemical feeders in each hydronic system.

1. Provide in upright position with top of funnel not more than 48 inches above the floor.
2. Provide feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
3. Provide NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.

C. 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 per second, if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Provide 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 as approved by the commissioning agent.

D. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water. Circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system, if possible, to circulate at velocities not less than 6 feet per second. Circulate each section for not less than four hours. Blow-down all strainers or remove and clean as frequently as necessary. Drain and prepare for final flushing.

E. 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.

F. Close and fill system as soon as possible after final flushing to minimize corrosion. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

G. Fill systems that glycol solutions to the concentrations indicated in the equipment schedules.

3.6 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Provide blinds in flanged joints to isolate equipment.
5. Provide safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment to specified values.
7. Adjust & commission the pressure differential bypass valve.
8. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 236416 - CENTRIFUGAL WATER CHILLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Centrifugal water chillers.
2. Packaged refrigerant-recovery unit.
3. Heat-exchanger, brush-cleaning system.

1.2 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input, using consistent units for any given set of rating conditions.

B. DDC: Direct digital control.

C. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

D. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated according to the method defined by AHRI 550/590 (AHRI 551/591) and referenced to AHRI standard rating conditions.

E. kVAR: Kilovolt-ampere reactive.

F. NPLV: Nonstandard part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated according to the method defined by AHRI 550/590 (AHRI 551/591) and intended for operating conditions other than the AHRI standard rating conditions.

G. SCCR: Short-circuit current rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
2. Performance at AHRI standard conditions and at conditions indicated.
3. Performance at AHRI standard unloading conditions.
4. Minimum evaporator flow rate.
5. Minimum condenser flow rate.

6. Refrigerant capacity of chiller.
7. Oil capacity of chiller.
8. Fluid capacity of evaporator, condenser.
9. Characteristics of safety relief valves.
10. Minimum entering condenser-fluid temperature.
11. Performance at varying capacities with constant design condenser-fluid temperature. Repeat performance at varying capacities for different condenser-fluid temperatures from design to minimum in [**5 deg F (3 deg C)**] increments.
12. Force and moment capacity of each piping connection.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Seismic Qualification Certificates: For chillers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Quality-Control Certifications: For chillers.

D. Field quality-control reports.

E. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each chiller to include in emergency, operation, and maintenance manuals.

B. Instructional Videos: Including those that are pre-recorded and those that are recorded during training.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Tool Kit:

1. A tool kit specially designed by chiller manufacturer for use in servicing chiller(s) furnished.

2. Special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Chiller Tool Kit." Text size must be at least 1 inch (25 mm) high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size must be at least 1/2 inch (13 mm) high.

B. Touch-up Paint: [**32-oz. (1-L)**] container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship chillers from the factory fully charged with refrigerant.

B. Ship each chiller with a full charge of refrigerant. Charge each chiller with nitrogen if refrigerant is shipped in containers separate from chiller.

C. Ship each oil-lubricated chiller with a full charge of oil.

1. Ship oil factory installed in chiller.

D. Package chiller for export shipping in totally enclosed crate with bagging.

1.8 WARRANTY

A. When warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

B. Provide manufacturer’s warranty for 18 months from the date of shipment from the factory or 12 months from commissioning; whichever comes first. Warranty shall cover parts and labor required to remedy defects in materials or workmanship for the entire chiller. Perform warranty work with manufacturer’s factory-trained and factory-employed service technician.

C. Provide manufacturer's warranty for 18 months from the date of shipment from the factory or 12 months from commissioning; whichever comes first. Warranty shall cover parts and labor required to remedy defects in materials or workmanship for the entire chiller. Perform warranty work with manufacturer's factory-trained and factory-employed service technician.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. York YMC2 (Basis of Design)

B. Trane

C. Daikin

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Centrifugal chillers are to withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: 1.0.

B. Condenser-Fluid Temperature Performance:

1. Startup Condenser-Fluid Temperature: Chiller is to be capable of starting with an entering condenser-fluid temperature of 55 deg F (13 deg C).
2. Minimum Operating Condenser-Fluid Temperature: Chiller is to be capable of continuous operation over the entire capacity range indicated with an entering condenser-fluid temperature of 65 deg F (18 deg C).
3. Make factory modifications to standard chiller design if necessary to comply with performance indicated.

C. Site Altitude: Chiller is to be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

D. ASHRAE Compliance:

1. ASHRAE 15 for safety code for mechanical refrigeration.
2. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.
3. ASHRAE/IES 90.1.

E. ASME Compliance: Fabricate and label chillers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, as applicable to chiller design. For chillers charged with R-513A, refrigerant, include an ASME U-stamp and nameplate certifying compliance.

F. 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.

G. Comply with requirements of Underwriters Laboratories, and include label by a qualified testing agency showing compliance.

H. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system are to automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought online.
2. Refer to Drawings for equipment served by back-up power systems.
3. Provide means and methods required to satisfy requirement, even if not explicitly indicated.

I. Outdoor Installations:

1. Chiller must be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a 25-year period, with minimal degradation due to exposure to outdoor ambient conditions.
2. Chillers are equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past 30-year period.

2.3 GENERAL DESCRIPTION

A. Packaged centrifugal chiller including the following: evaporator, motor and compressor, capacity control device, condenser with integral sub cooler, refrigerant metering device, lubrication system, motor starter, control panel with user interface, and – if required – a refrigerant purge system.

B. Provide chiller utilizing an HFC refrigerant that has an Ozone Depletion Potential (ODP) of ZERO, and that has no refrigerant production phase-out date and no phase out date for equipment that uses that refrigerant.

C. Provide chiller to meet or exceed the scheduled performance within the limits of the scheduled parameters.

D. Vibration Isolation:

1. Chiller manufacturer is to furnish vibration isolation for each chiller.

2. Spring Isolator:

   a. Stable in operation and designed for not less than 30 percent reserve deflection beyond actual operating conditions.
   b. Design isolators so that the Kx/Ky ratio will be 1.0 or more for stability.
   c. Provide PVC or neoprene-coated springs and hot-dip, galvanized-steel components. Provide aluminum components that are etched and painted. Provide nuts, bolts, and washers that are zinc electroplated.
   d. Isolators are to be adjustable and with an open spring, having one or more coil springs attached to a top compression plate and a baseplate.
   e. An elastomeric pad with a minimum thickness of 0.25 inch (6 mm) is to be bonded to the baseplate.
   f. Spring assembly is to be removable and fit within a welded-steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation.
   g. Isolated restraining bolts are to not be engaged during normal operation and are to connect the top plate and lower housing to prevent the isolated equipment from rising when drained of fluid.
   h. Select isolators for a nominal 1-inch (25-mm) deflection.
   i. Integrate seismic restraints in applications that require seismic requirements.

E. Refrigerant isolation valves: two butterfly valves, one on the compressor discharge line and one on the liquid line.

2.4 HEAT EXCHANGERS

A. General requirements: evaporator and condenser

1. Heat exchanger type:
   a. Evaporator: Shell and tube, hybrid falling film design
   b. Condenser: Shell and tube, flooded design
2. Construct in accordance with the current ANSI/ASHRAE-15 Safety Code for Mechanical Refrigeration and ASME Pressure Vessels Code and shall bare the ASME stamped nameplate.
3. Shells: Carbon steel with fusion welded seams
4. Tubes: Internally rifled, externally enhanced, individually cleanable and individually replaceable from either chiller end, and roller expanded into tube sheets.
5. Tube supports: Carbon steel, 3/8” thick minimum, no more than 4 feet apart, self-supporting and welded to the shell.
6. End sheets: Carbon steel, 1” thick minimum.
7. Water boxes: Steel, bolted to end sheet, cover plate bolted to box, taps for vent and drain.
8. Pressure Relief: automatically reseating relief valves. Rupture discs are not acceptable.

B. Evaporator

1. Waterside working pressure: 150 psig or 300 psig
2. Water boxes: Compact (end nozzle locations) or marine (side nozzle connections) with flanged connections.
3. Provide water box hinges on both ends of the heat exchanger.
4. Tubes: Copper, removable from either end, minimum tube wall thickness of 0.035" at the plain lands contacting the intermediate tube supports and end sheets.
5. Suction baffle: Installed along the entire length of the evaporator.
6. Sight glass: Located such that the proper refrigerant charge is near the center of the glass when the machine is off.

C. Condenser

1. Waterside working pressure: 150 psig or 300 psig
2. Water boxes: Compact (end nozzle locations) or marine (side nozzle connections) with flanged connections.
3. Provide water box hinges on both ends of the heat exchanger
4. Tubes: Copper, removable from either end, minimum tube wall thickness of 0.035" at the plain lands contacting the intermediate tube supports and end sheets.

2.5 REFRIGERANT FLOW CONTROL

A. Variable orifice

B. Refrigerant level sensing: Monitor refrigerant level in the condenser; report refrigerant level back to unit control panel and control chiller accordingly.

C. Refrigerant level control: Adjust valve position via control panel to optimize refrigerant level.

2.6 COMPRESSOR

A. Single stage or multi stage

B. Fully accessible housing with vertical circular joints.

C. Direct driven

D. Magnetic bearings

1. Levitated shaft position shall be actively controlled and monitored by an X-, Y-, and Z-axis digital posi¬tion sensor.

2. The compressor shall be capable of coming to a controlled, safe stop in the event of a power failure by diverting stored power from the DC bus to the magnetic bearing control system.

E. Mechanical linkage system that continuously monitors compressor-discharge gas characteristics and optimizes diffuser spacing to minimize impeller gas-flow disruptions.

F. The driveline (compressor and motor) and chiller starter shall be individual unit assemblies allowing for independent inspection, service, and repair/replacement. If an integrated driveline and starter package is utilized which is not fully field repairable, the supplier must provide one spare package with the unit.

G. The chiller shall utilize a single compressor that delivers the specified performance at all load and lift conditions.

2.7 MOTOR

A. Semi-hermetic permanent magnet motor or semi-hermetic induction motor. Semi-hermetic motors must include motor winding temperature RTDs, one per phase.

B. Electrical connection: Steel terminal box with gasketed front access cover; overload and overcurrent transformers.

2.8 REFRIGERANT PURGE SYSTEM (NEGATIVE PRESSURE MACHINES)

A. Refrigerant purge system is required if refrigerants with an Ozone Depletion Potential (ODP) greater than ZERO are provided.

B. Operates automatically at all load and head pressure conditions. Does not operate when the machine is idle.

C. Efficiency: Maximum of .002 pounds of refrigerant per pound of air at design conditions, not to exceed .007 at any operating condition in a 90°F room.

D. Provide a plot of purge efficiency from 100% load to 10% load, using AHRI schedule condenser water relief (4 °F per 10% reduction in load).

E. If separate canisters are required to meet these efficiencies, then provide disposal to an EPA-approved disposal site for the life of the chiller. To maintain purge efficiency, provide the virgin refrigerant and labor required to replace the lost refrigerant.

F. If a refrigerant purge system is required, it shall be inspected and adjusted by the manufacturer at the end of each year for the first ten years of operation to ensure that the release of ozone depleting substances is minimized. A written report shall be forwarded to the owner each year to confirm completion.

2.9 POSITIVE PRESSURE SYSTEM (NEGATIVE PRESSURE MACHINES)

A. Operates automatically when chiller is idle to prevent non condensables from entering the system.

B. Factory install pressurization unit, including heater, wiring, pump, piping, valves, and controls.

C. Heater: Of sufficient capacity to pressurize machine above atmospheric pressure within 2 hours.

D. Controls: On / off / auto switch to automatically maintain positive pressure during idle periods.

E. Valves: Check valves and balancing valve

2.10 SOURCE QUALITY CONTROL: TESTS AND INSPECTIONS

A. Heat Exchangers (evaporator and condenser):

1. Design and test in full conformance to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
2. Hydrostatically test evaporator and condenser refrigerant side at 1.3 times design working pressure AFTER tubing using LIQUID REFRIGERANT.
3. Alternately to item ‘2’ above, test at 1.1 times design working pressure AFTER tubing, using an approved air/gas mixture.

B. Compressor Components:

1. Leak tested at design working pressure using air under water.
2. Hydrostatic strength test at 1.5 times design working pressure
3. To ensure UL label qualification, manufacturer shall perform a hydrostatic strength test at 3 times design working pressure every year on the compressor castings.
4. Statically and dynamically balance each impeller.
5. Overspeed test each impeller at 120% of its maximum design RPM.

C. Motor

1. Balance rotor in accordance with ISO 1940 G2.5 (performed by motor manufacturer).
2. High-potential test stator for dielectric strength for 60 seconds per UL1995 and 984 and the following formula: 2 * RATED VOLTAGE + 1000 (performed by chiller manufacturer).

D. Chiller air run test for 30 minutes:

1. Measure current and voltage across each phase.
2. Operate control panel, test functionality and log instrument readings at 10-minute intervals.
3. Operate oil pump motor and search lubrication system for leaks (if applicable

4. Check compressor oil pressure (if applicable).
5. Vibration readings on driveline assembly in the horizontal, vertical and axial planes.
6. After the test, remove and replace oil filter (if applicable).

E. Chiller leak integrity testing: Pressurize entire system to design working pressure. Leak test using soap and water. Repair any leaks and repeat test until leak tight.

F. Vacuum hold testing: Evacuate system to 500 microns and hold for one hour. Ensure that pressure does not rise more than 150 microns during the hour. Repair and repeat until passes.

2.11 CONTROL PANEL

A. Type: Microprocessor based, stand alone

B. Provide integration with the existing campus Building Automation System (Johnson Controls, Inc) for operation as specified in Section 230993.

C. Scope: Chiller operation, monitoring of chiller sensors, actuators, relays and switches, and display of all operating parameters.

D. Capability: Stable chiller operation at 36 °F leaving chilled water temperature without warnings or shutdowns; no freezing or slushing of chilled water.

E. Enclosure: Lockable, NEMA 1

F. Information Display: 10.4” (minimum) color liquid crystal display (LCD) mounted on control panel enclosure door. Access to the screen shall be controlled by the YORK Chiller Access Manager feature.

G. User interface: Operating parameters displayed in a user-friendly, color and graphical format.

H. Keypad: Universal type with soft-keys

I. Height: Eye level and readable and operable without the need for ladder or stool.

J. Temperature rating: 0 to 40 °C

K. System status information: Displayed on screen at all times, including the following as a minimum:

1. System status
2. System details
3. Control source (remote or local)
4. User access level
5. Date and time
6. Startup sequence timer
7. Shutdown sequence timer

L. Status messages: In color according to importance, indicate the following as a minimum:
1. Ready to start
2. Cycling shutdown – chiller will automatically restart
3. Safety shutdown – chiller requires manual restart
4. Soft shutdown – chiller requires manual restart
5. System run (with countdown timers)
6. Systems coast down (with countdown timers)
7. Start inhibit and inhibit mode (anti-recycle, vane motor switch open (if applicable), excess motor cur¬rent)
8. Vanes closing before shutdown (if applicable)

M. System operating information, including the following as a minimum:

1. Return and leaving chilled water and condenser water
2. Evaporator and condenser refrigerant saturation temperatures
3. Sub-cooling refrigerant temperature
4. Evaporator and condenser pressure
5. Evaporator tube and condenser tube small temperature difference
6. Compressor discharge temperature
7. Oil sump temperature (if applicable)
8. Oil pump pressure differential (if applicable)
9. Percent of motor full load current
10. Input power
11. Kilowatt hours
12. Operating hours
13. Prerotation vane position (if applicable)
14. Refrigerant level position (condenser)
15. Motor winding temperature (each phase)
16. Average motor winding temperature
17. VSD – Output frequency
18. VSD – Output voltage (each phase)
19. VSD – Current (each phase)
20. VSD – Input current limit setpoint
21. VSD – Total supply KVA
22. VSD – Total power factor
23. VSD - Voltage total harmonic distortion (each phase)
24. VSD – Current total demand distortion (each phase)
25. VSD – DC bus voltage
26. VSD – DC bus current
27. VSD – Input and output Peak and RMS voltages and currents (each phase)
28. VSD – Internal ambient temperature
29. UPS Battery voltage
30. VGD Position
31. Discharge Pressure
32. Motor Housing and Winding Temperatures
33. MBC – Positions

34. MBC – Currents
35. MBC – Temperatures
36. MBC – Rotor Elongation
37. MBC – Motor Speed

N. Programmable setpoints including the following, as a minimum:

1. Chilled liquid temperature (setpoint and range)
2. Chilled liquid temperature cycling offset (shutdown and restart)
3. Motor current limit (%)
4. Pull-down demand (limit and time)

O. Schedule function: Programmable six week schedule for starting and stopping the chiller, pumps and cooling tower.17

P. Regional functionality: System language and units selection

Q. Warning messages including the following, as a minimum:

1. Real time clock failure
2. Condenser or evaporator transducer error
3. Setpoint override
4. Condenser high pressure limit
5. Evaporator low pressure limit
6. MBC – Vibration
7. MBC – Landing counter high
8. Excess Surge Detection
9. Motor – High Housing, Rotor, and Winding Temperatures
10. Motor – High Current Limit
11. VSD – DC Bus Active
12. Liquid Level Setpoint Not Achieved
13. Loss of Subcooler Liquid Seal
14. Condenser – Freeze Threat From Low Pressure

R. Safety Shutdowns: Trigger a safety shutdown for any of the following, as a minimum:

1. Evaporator – low pressure
2. Condenser – high pressure
3. Condenser – high pressure contacts open
4. Auxiliary safety – contacts closed
5. Compressor discharge – high or low refrigerant temperature
6. Oil – high temperature (if applicable)
7. Oil – high or low differential pressure (if applicable)
8. Oil – pump pressure setpoint not achieved (if applicable)
9. Control panel – power failure
10. Motor or starter – current imbalance
11. Motor – high housing, winding, and rotor temperatures

12. Watchdog – software reboot
13. Sensor – failure or out of range
14. Transducer – failure or out of range
15. Surge Protection – Excess Surge
16. MBC – internal fault
17. MBC – high bearing temperature or current
18. MBC – startup failure
19. MBC – speed signal fault
20. MBC – overspeed fault
21. MBC – communication
22. MBC – rotor elongation
23. MBC – oscillator fault
24. MBC – rotor contraction
25. MBC – unauthorized rotation
26. MBC – high and low voltage
27. VSD – shutdown, requesting fault data
28. VSD – stop contacts open
29. VSD – 105% motor current overload
30. VSD – input current overload
31. VSD – high phase input and motor baseplate temperatures (each phase)
32. VSD – precharge lockout
33. VSD – ground fault
34. VSD – motor current total harmonic distortion (THD) fault
35. VSD – inverter or rectifier program fault
36. VSD – phase motor and input DCCT (each phase)
37. VSD – high total demand distortion
38. VSD – high phase input and motor current (each phase)
39. VSD – line voltage phase rotation
40. VGD Actuator Fault
41. VGD Positioning Fault
42. Safety Stop

S. Safety Shutdowns: For each safety shutdown, indicate the following, as a minimum:

1. System status and details
2. Day and time of shutdown
3. Cause of shutdown
4. Type of restart required

T. Cycling Shutdowns: For each cycling shutdown, indicate the following, as a minimum:

1. Multiunit cycling – contacts open
2. System cycling – contacts open
3. Oil – low temperature (if applicable)
4. Oil – low temperature differential (if applicable)
5. Control panel – power failure
6. Leaving chilled liquid – low temperature
7. Leaving chilled liquid – flow switch open

8. Condenser – flow switch open
9. Control panel – schedule
10. VGD Actuator – serial communications
11. Evaporator – low pressure
12. Condenser – freeze threat – flow switch open
13. Control Panel – loss of control voltage
14. MBC - position
15. MBC – low frequency displacement
16. MBC – vibration
17. MBC – speed signal fault
18. MBC – startup failure
19. MBC – serial communications fault
20. VSD shutdown – requesting fault data
21. VSD – fault contacts open
22. VSD – initialization failed
23. VSD – gate driver (indicate phase)
24. VSD – single phase input power
25. VSD – high or low DC bus voltage
26. VSD – pre charge: low DC bus voltage
27. VSD – pre charge: DC bus voltage imbalance
28. VSD – high internal ambient temperature
29. VSD – logic board power supply
30. VSD – low phase input and motor baseplate temperatures (each phase)
31. VSD – logic board processor
32. VSD – run signal
33. VSD – high phase input and motor current (each phase)
34. VSD – DC bus pre-regulation
35. VSD – input DCCT offset (each phase)

U. Security Access: controlled through YORK Chiller Access Manager which will provide users dynamic access codes so that changes in the control panel can be traced back to a specific user. Users will need to set up an account at www.yorkchilleraccessmanager.com in order to be able to generate access codes.

1. Access Levels are defined by different levels of user capability:
   a. View: open to anyone; view set points, but no changes can be made
   b. Standard: comes with the purchase of the chiller; provides access to items for daily operation, allows local or remote control of chillers, and changing of set points
   c. Enhanced: can be accessed by qualified service personnel who have a subscription; in the event that maintenance or service is necessary
   d. JCI Service: generally reserved for Johnson Controls Service personnel only with access to proprietary advanced diagnostic features and tools

2. For details of what is available in the Standard and Enhanced access levels, please refer to the Operating Manual.

V. Chiller information screen including on-screen display of the following, as a minimum:

1. Model number
2. Chiller serial number
3. Control panel serial number
4. Manufacturer contract number
5. Design voltage
6. Refrigerant type
7. Starter type
8. Original factory chiller rating information

W. Data tracking and trend display including on-screen graphical display of the following, as a minimum:

1. Parameters selected from a list of a minimum of 140 possibilities
2. Data collected once per second up to once per hour for each parameter
3. Data trend lines displayed for a minimum of 5 parameters at once

X. History: Store last ten shutdowns and display all system parameters at the time of shutdown.

Y. Memory: Non-volatile type containing operating program and setpoints, capable of retention for 10 years without memory loss, despite AC or backup battery power loss.

Z. Terminal strip has be clearly numbered to accept field interlock wiring.

AA. Remote communications: Via electrical contacts, control panel capability to indicate the following as a minimum:

1. Ready to start contacts
2. Safety shutdown contacts
3. Cycling shutdown contacts
4. Running contacts

BB. Remote communications: Via 4-20 mA or 0-10V analog signals, control panel capability to adjust the fol¬lowing as a minimum:

1. Leaving chilled liquid setpoint
2. Current limit setpoint
3. Chiller start and stop

CC. Data logging and printing: Via RS-232 or similar, control panel capability for exporting at user-program¬mable intervals:

1. All system operating data
2. Shutdown and cycling messages
3. Operating details of last 10 cycling or safety shutdowns

DD. Optionally send data to the cloud for:

1. Remote servicing and inspection
2. Fault detection and diagnostics
3. Data dashboarding and health reporting

2.12 COMPRESSOR MOTOR STARTER: VARIABLE SPEED DRIVE

A. General: Variable Speed Drive (VSD) compressor motor starter to start motor and control motor speed by controlling the frequency and voltage of the electrical power supplied to the motor.

B. Drive type: Pulse width modulated (PWM) utilizing insulated gate bipolar transistors (IGBTs).

C. Control Logic: Independently control motor speed and pre rotation vane (PRV) position for optimum efficiency and operational stability. Base motor speed and PRV position on a minimum of 4 inputs: leaving chilled water temperature, return chilled water temperature, evaporator refrigerant pressure, condenser refrigerant pressure; Verify motor speed and PRV position and also use as inputs to the control logic.

D. Power Factor: At all loads and speeds, provide a minimum of a .97 power factor.

E. Capacitors shall not require scheduled replacement. If capacitors do not meet this requirement, the chiller manufacturer shall provide three spare sets of capacitors per compressor for the building owner’s stock.

F. Enclosure: NEMA-1 type with hinged access door with door interlock, lock and keys, and padlockable

G. Packaging: Factory mounted on chiller, piped to cooling circuit; wired to control panel and compressor motor; entire package (including active harmonic filter) shall be UL listed

H. Cooling: Cool drive pole assembly components and internal ambient air via fluid-cooled, closed loop; all starter components accessible for service and replacement without opening the chiller’s main refrigerant circuit.

I. Factory run test: Perform an electrical and mechanical run test of VSD starter prior to shipment to verify proper wiring and phasing.

J. Factory settings: Set starting design current and current overload settings prior to shipment.

K. Harmonic Distortion: Provide a drive and chiller system with an integrated active harmonic filter mounted inside the starter cabinet. System must generate harmonic distortion levels less than the following, measured at the input side of the drive:

1. Current: 5% maximum current total demand distortion

L. Inrush amperage: Limited to the design full load amperage of the chiller.

M. Protective devices: provide the following, as a minimum:

1. Electronic current-sensing overloads (1 per phase) – with indicating message on the control panel and reset button; shut down chiller upon detection of operating current exceeding 105% full load amperage.
2. High instantaneous current overload – with indicating message on the control panel and reset button; shut down chiller upon detection of starting current exceeding 115% of design inrush starting current for 1 second.
3. Phase rotation insensitivity
4. Single phase failure protection circuit with indicating light – shut unit down if power loss occurs in any phase at startup.
5. High temperature safety protection system on IGBTs with indicating light and reset button; via thermistors embedded on IGBT heat sinks – shut unit down if IGBT temperature exceeds acceptable limits.
6. Power fault protection for momentary power interruptions – interrupt power to the compressor motor within 4 line cycles upon detection of power interruptions longer than ¾ of a line cycle.
7. High and low line voltage protection.

N. Features: Factory mount and wire the following as a minimum:

1. Control transformer: 115volt and sized to power control panel and all unit controls.
2. Electrical lugs: Sized to accept the copper power lines required by the chiller.
3. Single point power: From electrical lugs at starter, power all powered devices on the chiller including control panel, control devices, oil pump (if applicable) and refrigerant purge.
4. Circuit-breaker disconnect: Door interlocked; ground fault protection; minimum 65,000A short circuit withstand capacity per UL 508.

O. Control panel readouts: Display on the control panel and provide to BAS via communication port the following as a minimum:

1. Output frequency
2. Output voltage
3. Output current (each phase)
4. Input power (kW)
5. Energy consumption (kWh)
6. Elapsed running time
7. Three phase voltage total harmonic distortion (THD)
8. Three phase current total demand distortion (TDD)
9. Total unit power factor
10. Total supply KVA

2.13 FINISHES

A. Dry chiller components for shipment, including inside of water boxes and tubes.

B. Blast and clean chiller surfaces thoroughly. Apply prime coat for painting.

C. Paint all exposed surfaces with alkyd-modified, vinyl enamel machinery paint, including all factory-applied insulation for consistent color matching. If not painted in the factory, paint over insulation in the field with manufacturer's standard paint and color.

2.14 OPTIONS

A. Insulation package: For chillers shipped in one piece, to be rigged into place as a single unit, the chiller shall be shipped factory insulated. Where the chillers are shipped disassembled to rigged in pieces, the contractor shall field insulate the chiller in accordance with the manufacturer's recommendations. Insulate, whether factory or field installed shall include evaporator, end sheets, suction line, liquid line and other cold surfaces and shall consist of 3/4" or 1-1/2" closed-cell neoprene foam insulation. Adhere with vapor-proof cement. Water boxes and nozzles must be field insulated with removable covers over bolts.

B. Flow Sensors: thermal type: Factory installed in chilled and condenser water nozzles and factory wired to chiller control panel.

C. Flow Switches: Differential pressure type and shipped loose for field installation and field wiring to chiller control panel in chilled and condenser water nozzles.

D. Eddy Current Testing: Heat exchanger tube testing **shall be performed at the chiller manufacturing facility** to ensure tube quality and longevity. A test report shall be provided and will include the following as a minimum:

1. List of test equipment used and equipment settings.
2. Test data reports and accompanying strip charts of calibrations and tubes with significant defect and typical indications.
3. Statistical summary of defect indications.
4. Recommendations concerning tube condition, tube replacement, tube removal for evaluation and future frequency of testing.
5. Approval by an ASNT Level III eddy current technician.

E. Control System Interface: DDC type and shall provide the following, as a minimum:

1. Export system operating data.
2. Accept setpoint adjustments for chilled water setpoint and demand limit.
3. RS-232 communication: BACNet MS/TP is the default communication protocol unless otherwise noted.

4. Field commissioning assistance by manufacturer's technician.

~~F. Seismic Certification:~~

~~1. Available seismic certification in accordance with IBC 2009 based on shake table testing performed in accordance with AC-156.~~

2.15 ACCESSORIES

A. Refrigerant recovery unit consisting of the following as a minimum:

1. Portable, self-contained package, lawn mower configuration
2. Refrigerant compressor
3. Water-cooled condenser
4. Refrigerant filter drier
5. Suction and discharge pressure gauges
6. Refrigerant isolation valves
7. Relief valves
8. Two 8-foot long hoses
9. Controls: Permanent circuit with all safety devices
10. Wheels and swivel casters with lock brakes
11. Warranty: 1 year parts, starting from date of shipment
12. AHRI certified

B. Refrigerant receiving tank consisting of the following as a minimum:

1. Self contained package
2. Receiving tank: Horizontal, pitched toward tank drain
3. Capacity: Hold the charge of largest chiller with 20% capacity remaining at 90°F
4. Two sight glasses
5. Pressure gauge
6. Refrigerant isolation valves
7. Relief valves
8. Float cutoff switch
9. Oil heater (if applicable)
10. Warranty: 1 year parts, starting from date of shipment
11. ASME stamped

C. Refrigerant storage and recycling system:

1. Self contained package
2. Receiving tank: Horizontal, pitched toward tank drain
3. Capacity: Hold the charge of largest chiller with 20% capacity remaining at 90°F
4. Two sight glasses

5. Refrigerant compressor
6. Oil separator and heater (if applicable)
7. Water-cooled condenser
8. Refrigerant filter drier
9. Suction and discharge pressure gauges
10. Refrigerant isolation valves
11. Relief valves
12. Two 8-foot long hoses
13. Float cutoff switch
14. Controls: permanent circuit with all safety devices
15. AHRI certified and ASME stamped
16. Warranty: 1 year parts, starting from date of shipment

D. Spring vibration isolators (for above-grade floor installations): Provide four spring-type, level-adjusting, 1" deflection vibration isolators with non-skid pads for each support point.

~~2.16 VERIFICATION OF PERFORMANCE:~~

~~A. Execute test per AHRI Standard 550/590.~~

~~B. One representative from both the owner and the engineer shall witness test. Manufacturer shall pay food, lodging and transportation expenses for two witnesses.~~

~~C. AHRI Points Test: Factory test each chiller for capacity and efficiency at the four standard AHRI rating points:~~

~~1. 100% load and 85 °F entering condenser water temperature (ECWT) and design flow rates~~
~~2. 75% load and 75 °F ECWT and design flow rates~~
~~3. 50% load and 65 °F ECWT and design flow rates~~
~~4. 25% load and 65 °F ECWT and design flow rates~~
~~5. 25% load and 55 °F ECWT and design flow rates~~

~~D. Cold Condenser Water Test: Factory test each chiller for capacity and efficiency at the four standard AHRI rating points:~~

~~1. 100% load and 55 °F entering condenser water temperature (ECWT) and design flow rates~~
~~2. 75% load and 55 °F ECWT and design flow rates~~
~~3. 50% load and 55 °F ECWT and design flow rates~~
~~4. 25% load and 55 °F ECWT and design flow rates~~

~~E. Extended Duration Test: Factory test each chiller for capacity and efficiency at the four standard AHRI rating points for four hours:~~

~~1. 100% load and 85 °F entering condenser water temperature (ECWT) and design flow rates~~

~~2. 75% load and 75 °F ECWT and design flow rates~~
~~3. 50% load and 65 °F ECWT and design flow rates~~
~~4. 25% load and 65 °F ECWT and design flow rates~~
~~5. 25% load and 55 °F ECWT and design flow rates~~

~~F. Should a unit fail any test, treat unit with a permanent remedy at manufacturer's expense until the test is successfully passed.~~

~~G. Provide test data and results in a report to the owner.~~

~~H. After the test and prior to shipment, perform the following:~~

~~I. Check / change oil filter (if applicable).~~

~~1. Drain oil from sump (if applicable).~~
~~2. Drain water from boxes and heat exchangers and dry thoroughly.~~
~~3. Remove refrigerant and pressurize refrigerant side to 5 psig with dry nitrogen unless shipping with refrigerant in unit.~~
~~4. Follow procedures in PART 1, Section 1.07 (SHIPMENT).~~

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine chillers before installation. Reject chillers that are damaged.

B. Examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, control and electrical connections to verify actual locations, sizes, and other conditions affecting chiller performance, maintenance, and operations before equipment installation.

1. Chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and control and electrical connections.

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

3.2 INSTALLATION OF CENTRIFUGAL WATER CHILLERS

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. Install chillers on support structure indicated.

D. Equipment Mounting:

1. Install chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Maintain clearances required by governing code.

G. Chiller manufacturer's factory-trained service personnel are to charge chiller with refrigerant and fill with oil if not factory installed.

H. Install separate devices furnished by manufacturer and not factory installed.

1. Chillers shipped in multiple major assemblies are to be field assembled by chiller manufacturer's factory-trained service personnel.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping," Section 232116 Hydronic Piping Specialties," and Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to chillers, allow space for service and maintenance.

C. Evaporator-Fluid Connections:

1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gauge.
2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, thermometer, plugged tee with shutoff valve and pressure gauge, flow meter, and drain connection with valve.
3. Make connections to chiller with a flange.

D. Condenser-Fluid Connections:

1. Connect to condenser inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gauge.
2. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, thermometer, plugged tee with shutoff valve and pressure gauge, flow meter, and drain connection with valve.
3. Make connections to chiller with a flange.

E. Refrigerant-Pressure Relief Device Connections:

1. For chillers installed indoors, extend vent piping to the outdoors without valves or restrictions.
2. Comply with ASHRAE 15.
3. Connect to chiller pressure relief device with flexible connector and dirt leg with drain valve.

F. For chillers equipped with a purge system, extend purge vent piping to the outdoors. Comply with ASHRAE 15 and ASHRAE 147.

G. Connect each chiller drain connection with a drain valve, which is full size of drain connection. Connect drain pipe to drain valve with union, and extend drain pipe to terminate over floor drain.

H. Connect each chiller water box vent connection with a manual vent, which is full size of vent connection.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection. Nameplate is to be laminated phenolic layers of black with engraved white letters at least 1/2 inch (13 mm) high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and DDC control system for remote monitoring and control of chillers. Comply with requirements in Section 230993 "Sequence of Operation for HVAC."

D. Install nameplate on face of chiller control panel indicating the control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate is to be laminated phenolic layers of black with engraved white letters at least 0.5 inch (12.7 mm) high.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that refrigerant charge is sufficient and chiller has been leak tested.
3. Verify that pumps are installed and functional.
4. Verify that thermometers and gauges are installed.
5. Operate chiller for run-in period.
6. Check bearing lubrication and oil levels.
7. Verify that refrigerant pressure relief device is vented outside.
8. Verify proper motor rotation.
9. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
10. Verify and record performance of fluid flow and low-temperature interlocks for evaporator and condenser.
11. Verify and record performance of chiller protection devices.
12. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

B. Inspect field-assembled components, equipment installation, piping, controls and electrical connections for proper assembly, installation, and connection.

C. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

D. Prepare test and inspection startup reports.

3.7 WARRANTY PERIOD TESTING

A. Within one month(s) of warranty period expiration, perform testing, analysis, and reporting indicated for each chiller.

B. Eddy Current Testing:

1. Solicit services of a third-party testing agency, specializing in such analysis, to perform testing of evaporator and condenser tubes, to ensure tube quality and longevity.
2. Submit test report to Owner, including, at a minimum:

    a. List of equipment used and equipment settings.

b. Test data reports and accompanying strip charts of calibrations.
c. Identify tubes with significant defects and typical indications.
d. Statistical summary of defect indications.
e. Recommendations concerning tube condition, tube replacement, tube removal for evaluation, and future frequency of testing.
f. Approval by an American Society for Nondestructive Testing, Level III eddy current technician.

C. Oil Analysis:

1. Take oil sample and solicit services of a third-party testing agency, specializing in such analysis, to perform oil analysis.
2. Submit analysis results and recommendations to Owner.

D. Refrigerant Analysis:

1. Take refrigerant sample and solicit services of a third-party testing agency, specializing in such analysis, to perform refrigerant analysis.
2. Submit analysis results and recommendations to Owner.

E. Site Access and Scheduling:

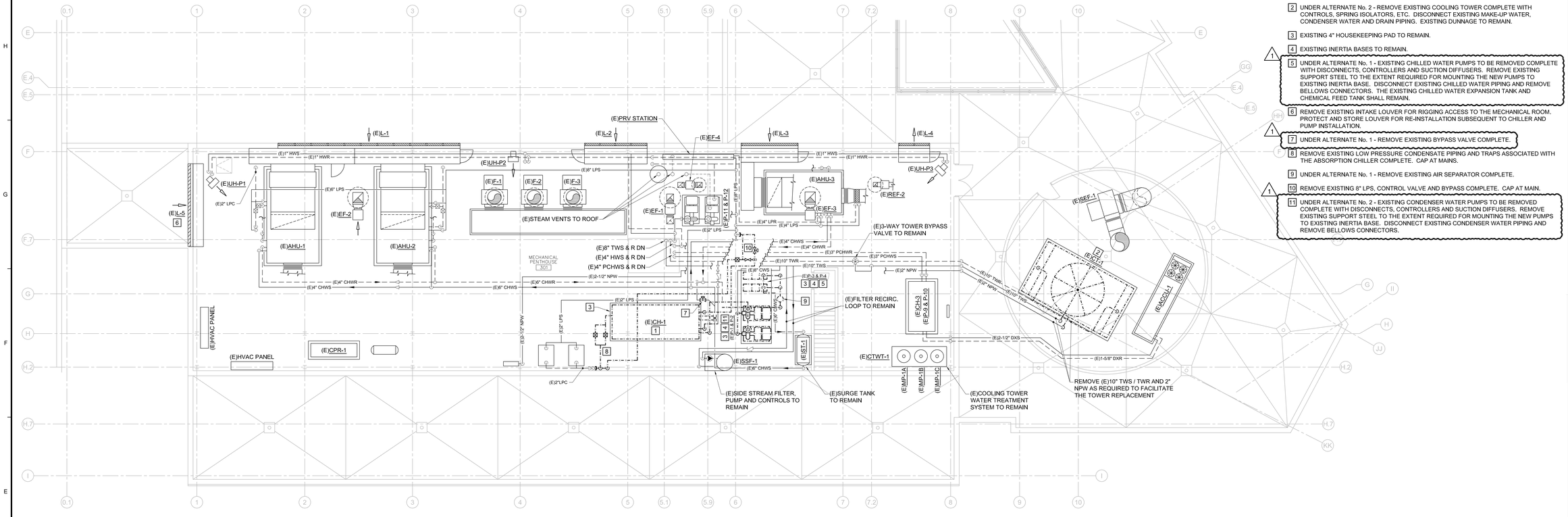
1. Contact Owner to schedule testing at least 30 days in advance of testing.
2. Make mutually agreeable schedule adjustments to accommodate Owner's request for testing.
3. Review, with Owner, requirements for visitors in advance of testing.
4. Comply with Owner requirements for visitors while on-site.

3.8 DEMONSTRATION

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

1. Instructor must be factory trained and certified.
2. Provide not less than eight hours of training.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training is to be held at Project site.

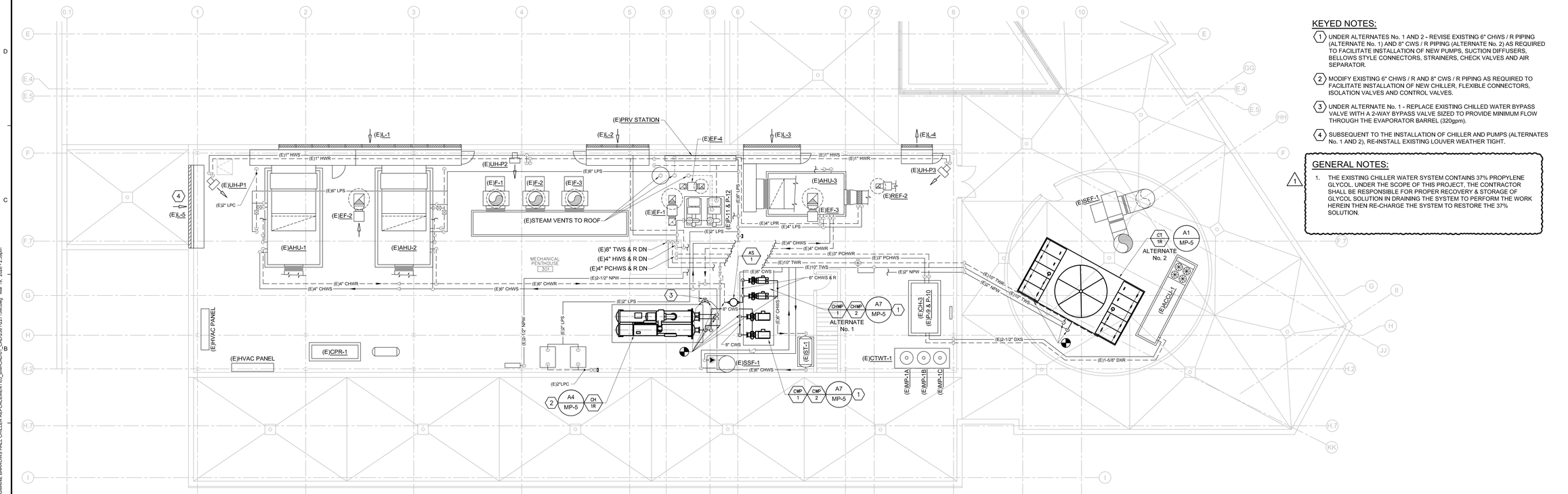
END OF SECTION 236416



DEMOLITION KEYED NOTES:

1. REMOVE EXISTING CHILLER COMPLETE WITH CONTROLS.
2. UNDER ALTERNATE No. 2 - REMOVE EXISTING COOLING TOWER COMPLETE WITH CONTROLS, SPRING ISOLATORS, ETC. DISCONNECT EXISTING MAKE-UP WATER, CONDENSER WATER AND DRAIN PIPING. EXISTING DUNNAGE TO REMAIN.
3. EXISTING 4" HOUSEKEEPING PAD TO REMAIN.
4. EXISTING INERTIA BASES TO REMAIN.
5. UNDER ALTERNATE No. 1 - EXISTING CHILLED WATER PUMPS TO BE REMOVED COMPLETE WITH DISCONNECTS, CONTROLLERS AND SUCTION DIFFUSERS. REMOVE EXISTING SUPPORT STEEL TO THE EXTENT REQUIRED FOR MOUNTING THE NEW PUMPS TO EXISTING INERTIA BASE. DISCONNECT EXISTING CHILLED WATER PIPING AND REMOVE BELLOWS CONNECTORS. THE EXISTING CHILLED WATER EXPANSION TANK AND CHEMICAL FEED TANK SHALL REMAIN.
6. REMOVE EXISTING INTAKE LOUVER FOR RIGGING ACCESS TO THE MECHANICAL ROOM. PROTECT AND STORE LOUVER FOR RE-INSTALLATION SUBSEQUENT TO CHILLER AND PUMP INSTALLATION.
7. UNDER ALTERNATE No. 1 - REMOVE EXISTING BYPASS VALVE COMPLETE.
8. REMOVE EXISTING LOW PRESSURE CONDENSATE PIPING AND TRAPS ASSOCIATED WITH THE ABSORPTION CHILLER COMPLETE. CAP AT MAINS.
9. UNDER ALTERNATE No. 1 - REMOVE EXISTING AIR SEPARATOR COMPLETE.
10. REMOVE EXISTING 8" LPS, CONTROL VALVE AND BYPASS COMPLETE. CAP AT MAIN.
11. UNDER ALTERNATE No. 2 - EXISTING CONDENSER WATER PUMPS TO BE REMOVED COMPLETE WITH DISCONNECTS, CONTROLLERS AND SUCTION DIFFUSERS. REMOVE EXISTING SUPPORT STEEL TO THE EXTENT REQUIRED FOR MOUNTING THE NEW PUMPS TO EXISTING INERTIA BASE. DISCONNECT EXISTING CONDENSER WATER PIPING AND REMOVE BELLOWS CONNECTORS.

E1 — MECHANICAL DEMOLITION PART PLAN
1/8" = 1'-0"



KEYED NOTES:

1. UNDER ALTERNATES No. 1 AND 2 - REVISE EXISTING 6" CHWS / R PIPING (ALTERNATE No. 1) AND 8" CWS / R PIPING (ALTERNATE No. 2) AS REQUIRED TO FACILITATE INSTALLATION OF NEW PUMPS, SUCTION DIFFUSERS, BELLOWS STYLE CONNECTORS, STRAINERS, CHECK VALVES AND AIR SEPARATOR.
2. MODIFY EXISTING 6" CHWS / R AND 8" CWS / R PIPING AS REQUIRED TO FACILITATE INSTALLATION OF NEW CHILLER, FLEXIBLE CONNECTORS, ISOLATION VALVES AND CONTROL VALVES.
3. UNDER ALTERNATE No. 1 - REPLACE EXISTING CHILLED WATER BYPASS VALVE WITH A 2-WAY BYPASS VALVE SIZED TO PROVIDE MINIMUM FLOW THROUGH THE EVAPORATOR BARREL (320gpm).
4. SUBSEQUENT TO THE INSTALLATION OF CHILLER AND PUMPS (ALTERNATES No. 1 AND 2), RE-INSTALL EXISTING LOUVER WEATHER TIGHT.

GENERAL NOTES:

1. THE EXISTING CHILLER WATER SYSTEM CONTAINS 37% PROPYLENE GLYCOL. UNDER THE SCOPE OF THIS PROJECT, THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROPER RECOVERY & STORAGE OF GLYCOL SOLUTION IN DRAINING THE SYSTEM TO PERFORM THE WORK HEREIN THEN RE-CHARGE THE SYSTEM TO RESTORE THE 37% SOLUTION.

A1 — MECHANICAL PART PLAN
1/8" = 1'-0"

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P: 207.221.2260
F: 207.221.2266
Allied Engineering
A Salas O'Brien Company

STATE OF MAINE — ANTHONY S. DAVIS No. 8834 — LICENSED PROFESSIONAL ENGINEER

REVISIONS

NUMBER	DATE	BY	DESCRIPTION
1	03-19-2026	AEI	ADDENDUM No. 1

Date: 10-13-2026
Drawn By: REW
Checked By: ASD
Project Mgr: ASD
Project No: 2 561-22715
Cad File: 2561-22715M.DWG
Graphic Scale: 0 1"

MECHANICAL AND MECHANICAL DEMOLITION PLANS

UNIVERSITY OF MAINE
BARROWS HALL CHILLER REPLACEMENT
ORONO, MAINE

ISSUED FOR CONSTRUCTION ~ 13 JANUARY, 2026

MP-1

AIR SEPARATION / EXPANSION TANK SCHEDULE - ALTERNATE No. 1

SYSTEM	PRIMARY HEATING	
AIR-DIRT SEPARATOR	AS-1	
MANUFACTURER	SPIROTHERM	
MODEL	VDT800FAM	
TYPE	AIR, DIRT, MAGNET	
INLET/OUTLET	6"	
BLADDER-TYPE EXPANSION TANK	EXISTING TO REMAIN	

COOLING TOWER SCHEDULE - ALTERNATE No. 2

TAG	CT-1
LOCATION	ROOF
MANUFACTURER	BAC
MODEL	XES3E-1222-07M
TOWER FLOW RATE	1,340
HOT WATER TEMP	95
COLD WATER TEMP	85
WET BULB TEMP	78
MOTOR HP	20
MOTOR RPM	
MOTOR EFFICIENCY	PREMIUM
MOTOR DUTY	VFD
MOTOR CONFIG	DIRECT DRIVE/ENDURADRIVE
BASIN HEATER KW	2@1KW
ELECTRICAL	480/3
LENGTH	21' 6 1/2"
WIDTH	11' 9 3/4"
HEIGHT - LESS FAN GUARD & RAILS	11' 9"
SHIPPING WEIGHT, LBS	12,343
OPERATING WEIGHT, LBS	24,623

WATER COOLED CHILLER SCHEDULE

	UNIT	CH-1R
GENERAL	STATUS	NEW
	TYPE	CENTRIFUGAL
	MANUFACTURER	YORK
	MODEL	YMC2-S1055BAS
	TONS	300
	RIGGING WEIGHT	14,207 LBS
	REFRIGERANT TYPE	R-513A
	REFRIGERANT CHARGE	894 LBS
	KW/TON	0.635
	IPLV, KW/TON	0.3855
EVAPORATOR	GPM	650
	PASSES	2
	ENT WATER TEMP °F	56.0
	LVG WATER TEMP °F	44.0
	MAX PD, FT-H20	25.5
	FOULING FACTOR	0.0001
CONDENSER	GPM	860
	PASSES	2
	ENT WATER TEMP °F	85.0
	LVG WATER TEMP °F	95.0
	MAX PD, FT-H20	18.6
	FOULING FACTOR	0.00025
ELECTRICAL	DISC. SW. FURN BY.	CHILLER MFR.
	STARTER TYPE	VFD - UNIT MOUNTED
	V-PH-HZ	480-3-60
	CHILLER INPUT POWER, KW	190.4
	MOTOR RLA	525
	MOTOR OLTA	546
	CHILLER RLA	250
	CHILLER INRUSH AMPS	250
	MAX CIRCUIT BREAK	500
	MCA	313

NOTES:
1. THE CHILLER SHALL INCLUDE ALL REQUIRED ACCESSORIES AND CONTROLS FOR FUTURE OPERATION IN A LOW TEMPERATURE BRINE/PROPYLENE GLYCOL APPLICATION. IT IS ANTICIPATED THAT THE FUTURE SYSTEM WILL BE REQUIRED TO PROVIDE 20-22 DEG F CHILLED WATER FOR AN ICE STORAGE SYSTEM. OPTIONS SHALL INCLUDE BUT NOT BE LIMITED TO ADDITIONAL EVAPORATOR BARREL INSULATION, REVISED HEAD PRESSURE CONTROLS FOR "SMART FREEZE" LOW TEMPERATURE OPERATION, AND FREEZE PROTECTION CONTROLS FOR THE CONDENSER BARREL
2. PERFORMANCE SCHEDULED HEREIN IS BASED UPON 37% PROPYLENE GLYCOL.

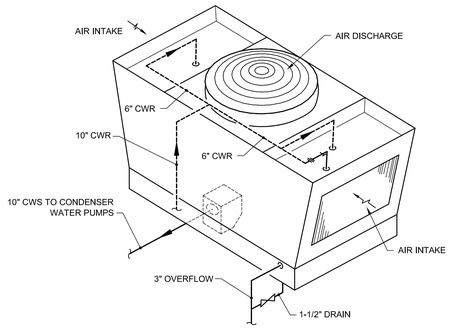
HYDRONIC PUMP SCHEDULE

TAG	SYSTEM	MFR.	MODEL	SUCT X DISCH	TYPE	PUMPED FLUID	PERFORMANCE				ELECTRICAL				ELECTRICAL COORDINATION				NOTES
							GPM	HEAD	RPM	NPSH	BHP	NOL HP	MOTOR HP	VOLTS/PH (60 Hz.)	STARTER TYPE	STARTER FURN. BY	BOTH PUMPS RUN?	DISC. SWITCH FURN BY	
CHWP-1	CHILLED WATER	GRUNDFOS	NBSE 040-095-4P	5 X 4	INTEGRAL VARIABLE SPEED	37% PG	650	75	1,697	9.89	14.7		20	460/3	INTEGRAL	------	NO, LEAD-LAG	DIV 26	1, 2
CHWP-1	CHILLED WATER	GRUNDFOS	NBSE 040-095-4P	5 X 4	INTEGRAL VARIABLE SPEED	37% PG	650	75	1,697	9.89	14.7		20	460/3	INTEGRAL	------	NO, LEAD-LAG	DIV 26	1, 2
CWP-1	CHILLED WATER	GRUNDFOS	NBSE 050-110-4P	6 X 5	INTEGRAL VARIABLE SPEED	WATER	860	75	1,635	9.9	20.3		25	460/3	INTEGRAL	------	NO, LEAD-LAG	DIV 26	1, 3
CWP-1	CHILLED WATER	GRUNDFOS	NBSE 050-110-4P	6 X 5	INTEGRAL VARIABLE SPEED	WATER	860	75	1,635	9.9	20.3		25	460/3	INTEGRAL	------	NO, LEAD-LAG	DIV 26	1, 3

NOTES:
1. PROVIDE VARIABLE FLOW MODE.
2. PUMP SHALL BE FURNISHED AND INSTALLED UNDER ALTERNATE No. 1.
3. PUMP SHALL BE FURNISHED AND INSTALLED UNDER ALTERNATE No. 2.

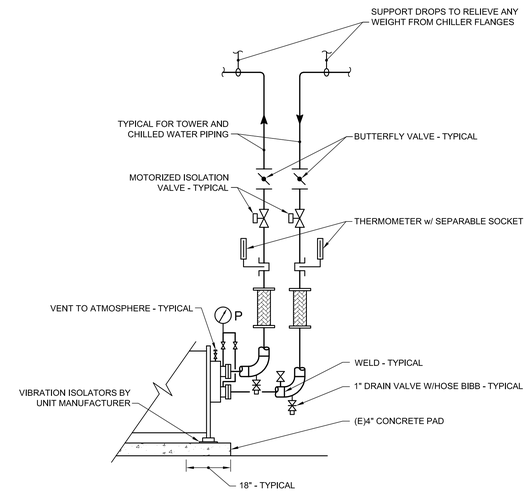
D1 MECHANICAL SCHEDULES

NONE



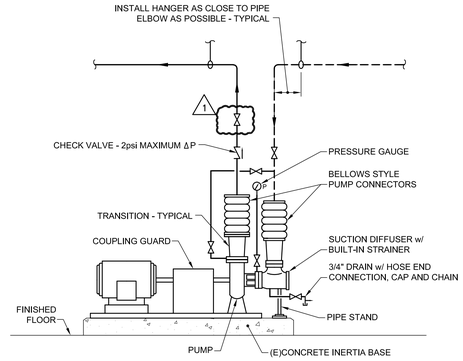
A1 SINGLE CELL COOLING TOWER PIPING CONNECTIONS DETAIL - ALTERNATE No. 2

NOT TO SCALE



A4 ABSORPTION CHILLER PIPING CONNECTIONS DETAIL

NOT TO SCALE



A7 BASE MOUNTED END SUCTION PUMP DETAIL - ALTERNATE No. 1 AND No. 2

NOT TO SCALE

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STATE OF MAINE — ANTHONY G. DAVIS No. 8834 — REGISTERED PROFESSIONAL ENGINEER

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Project Mgr: ASD
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MECHANICAL DETAILS AND SCHEDULES

UNIVERSITY OF MAINE
BARROWS HALL CHILLER REPLACEMENT
ORONO, MAINE

MP-5

ISSUED FOR CONSTRUCTION – 13 JANUARY, 2026

University of Maine System
Project 5100779
UM Barrows ESRB Chiller Replacement
Pre-Bid Meeting - Contractor Walk Through
Tuesday, March 10, 2026 - 9 am

Attendees

Contractor	Contact Person	Phone Number	Email
CCB Construction	Brian Turgeon	907-212-9925	bturgeon@CCB-inc.com
ESB	Chuck Young	207-692-3379	cyoung@esboulos.com
J.J. Murphy	Jim Levesque	207-752-1358	JLevesque@JJMconstruct.com
ABM	Steve [illegible]	207-416-9808	Sallen@abmchs.com
JCI	Austin Sheehan	207-249-2040	
JCI	Troy Sheehan	207-233-3079	troy.s.sheehan@jci.com
Sylas O'Brien	Tony Davis	207-838-8296	anthony.davis@sylasobrien.com
Sullivan and Merritt	Doug McDougal	207-659-3727	dmcdougal@smcinc.net
Sullivan and Merritt	L Vanadestine	207-745-4759	lvanadestine@smcinc.net
Black Bear Crane	Tony DelMonaco	207-944-5320	tony@blackbearcrane.com

END OF ADDENDUM 01