

## SECTION 23 00 10 - GENERAL REQUIREMENTS FOR MECHANICAL WORK

The General Conditions, any Supplementary General Conditions, and Division 1 - General Requirements are hereby made a part of this Section as fully as if repeated herein.

### PART 1 - GENERAL

#### 1.01 SCOPE

- A. This project generally involves all work related to the construction of the West Campus Dining Hall, and other work indicated or required to accomplish intent, including but not limited to:
  - 1. Fire Protection (Division 21)
  - 2. Plumbing (Division 22)
  - 3. Mechanical/HVAC (Division 23)
  - 4. Electrical (Division 26)
  - 5. Coordination with other Divisions/trades as needed to assure intended construction/operation result.
- B. The Contract Documents are prepared with the intent that all work required by this Division shall be the joint responsibility of the respective Division Contractor (Division 21, 22, and 23, as applicable) and the General Contractor/Construction Manager. The respective Division Contractor shall obtain competent, qualified subcontractors as required. Special qualifications for contractors and subcontractors are listed in respective sections of these specifications. Should Contractors (e.g., respective Divisions and/or General Contractor/Construction Manager) separate this work in any fashions other than intended, Contractors shall be responsible for ensuring all work required by the intent of Contract Documents is completed.
- C. The fire protection, plumbing, electrical, architectural, structural, civil, landscape, food service, and any vendor drawings, and all related specifications, shall be considered a part of Division 23 in that they, too, establish the requirements and limitations of work to be performed under this Division.
- D. Division 1 coordination: Refer also to Division 1 for related conditions. Coordinate and comply accordingly.
  - 1. Most stringent requirement applies: Should respective Divisions 21, 22 and 23 and Division 1 requirements differ, the most stringent (with regard to cost) shall govern the proposal. Obtain clarification from the Architect/Engineer if/as needed.

#### 1.02 RESPONSIBILITY

- A. General: Each contractor and subcontractor of any tier shall perform its work, including all coordination with other trades as is required for or is beneficial to the work, consistently with the intent of the contract documents in order to achieve the construction and operating

intents. This duty shall exist regardless of the extent of enforcement or administration of the contract documents by the Owner, by authorities having jurisdiction, by the Architect/Engineer, or by other applicable parties.

- B. Procedures used in the administration of the contract documents by the Architect/Engineer shall not relieve the contractor/subcontractors of this duty, and the Architect/Engineer shall not have the duty to identify all deficiencies in contractor's/subcontractor's work.

### 1.03 DRAWINGS

- A. Diagrammatic: Contract drawings are diagrammatic in nature and give general locations and approximate sizes of equipment, piping, ductwork, etc. Determine exact locations, dimensions, elevations, etc., from field measurements, constructability planning, and related conditions prior to purchasing equipment or materials, and prior to fabricating or installing piping, ductwork, equipment, controls, and related systems.
- B. Coordination of drawings of other trades: Refer also to all related fire protection, plumbing, electrical, architectural, structural, civil, landscape, food service, vendor, etc., drawings, and coordinate work accordingly. Plan work and coordinate with other trades to avoid conflicts.
- C. Examination of drawings, specifications, and site conditions: Prior to proposal, the Contractor/subcontractors shall visit the site and shall be held to have carefully examined the drawings, specifications, and site conditions in order to fully understand the operation, intent, and scope of all work, in the respective Divisions 21, 22 and 23, and all coordination and construction requirements thereof.
- D. Submittals coordination: Refer also to subsection **1.10 – Submittals below for information regarding drawings and available electronic files.**
- E. Record drawings coordination: Refer also to subsection 2.02– Record Drawings/As-builts below for information regarding drawings and available electronic files.

### 1.04 INTENT

- A. Comprehensive: All equipment, materials, and labor that may be necessary to complete work in accordance with the INTENT of these plans and specifications shall be provided by the Contractor at the Contractor's cost. The job shall be proposed, installed, and commissioned complete and consistent with intent in every respect.
- B. Conflicts or ambiguities: Where conflicts or ambiguities arise within the drawings or amongst the drawings, specifications, and site/field conditions, the most stringent condition with regard to cost shall govern the proposal. Obtain clarification from the Architect/Engineer prior to purchasing equipment, fabricating and installing systems, and proceeding with the work.
- C. No additional costs for complying with intent: No additional costs shall be permitted for remedial or additional measures required to correct work not provided according to the intent of the documents, as determined by the Architect/Engineer.

### 1.05 CODES, STANDARDS, PERMITS, FEES AND CONTRACTOR'S LICENSE

- A. Trades licensure: Each contractor/subcontractor shall be duly licensed in their respective trade(s), and shall be held to be knowledgeable in construction that conforms to code and the highest quality construction practices affecting the respective trade(s). Proposals/Bids shall include conforming to all applicable codes and to the highest quality construction standards and practices. Each contractor shall comply with all applicable local, state and national codes and standards, and shall secure and pay for all applicable costs, fees, permits, and licenses. No additional costs shall be allowed for these items.
- B. Highest standard: Should the plans and specifications exceed the required minimum standards as set out in the codes, standards, and ordinances, the requirements constituting the highest engineering and construction standards shall govern.
- C. Coordination with utilities and authorities having jurisdiction: The Contractor shall give notices, obtain permits, file necessary plans, prepare documents and obtain necessary approval of authorities having jurisdiction. All costs required for permits, inspection fees, connection fees, capital recovery fees, licenses, taxes, and insurance shall be paid by the Contractor.
- D. Utility standards: Construction shall be in accordance with standards and requirements of utilities and authorities having jurisdiction.

#### 1.06 EXAMINATION OF SITE

- A. General: All contractors and subcontractors submitting proposals for this work shall visit the site, shall be held to have examined it prior to proposal, and shall take into consideration existing conditions that may affect the work. No information given on the plans shall relieve the contractor of this responsibility. No additional costs shall be allowed for failure to examine the site and verify existing conditions. No additional costs shall be allowed for failure to coordinate all utility services and costs prior to proposal.

#### 1.07 CONNECTION TO UTILITIES AND SITE SYSTEMS

- A. SAFETY NOTE: Perform all work with highest regard to safety.
  - 1. Excavate by hand and with caution to locate all utilities/systems in the bounds of the areas to be excavated prior to machine excavation. Proceed with safety and caution so that no utility/system is damaged or interrupted.
  - 2. Should any service be interrupted, Contractor shall repair it immediately and at the Contractor's expense.
- B. Prior to proposal, verify and coordinate all required connections and/or relocations of utilities with civil drawings and specifications AND with utility companies. Perform such work in accordance with utility company regulations. Pay all applicable fees and costs, including those for any extensions, modifications, relocations, meters, and/or connections.
- C. Determine all costs of work to be performed by utilities, if any, and include costs of such work to be borne by Owner, if any, in proposal.
- D. The contractor shall verify locations of all above ground and marked utilities prior to proposal.

- E. Refer also to Division 1 - General Requirements, and comply with those requirements regarding underground utilities.

#### 1.08 VIBRATION AND NOISE

- A. General: Each of the various pieces of equipment shall operate without objectionable vibration or noise. All rotating equipment shall be statically and dynamically balanced and shall be mounted, supported, isolated and fastened so that vibration shall not exceed acceptable or specified levels.
- B. Guidelines for specific measures: The specific type of noise and/or vibration isolation to be installed shall, as a minimum, be in accordance with the more stringent of: 1) Table 47, "Selection Guide for Vibration Isolation", Chapter 47, 2011 ASHRAE HVAC Applications; 2) as indicated by drawings or specifications.

**Submit to Architect/Engineer for review.**

- C. Remedial measures: If, in the opinion of the Architect/Engineer, objectionable noise and/or vibration or transmission thereof to the building occurs, the contractor shall execute remedial measures as may be necessary to eliminate such unsatisfactory operating conditions, and the work and material thereby required shall be provided at the Contractor's expense to the extent the installation does not comply with the intent.

#### 1.09 QUALIFICATIONS AND WARRANTY

- A. General: By submitting a proposal for work, each contractor and subcontractor of any tier confirms and warrants:
  - 1. that it is properly qualified to perform the work intended by the Contract Documents;
  - 2. that it has the proper training, expertise, experience, manpower, skills, quality control procedures, and commitment to properly perform the intended work within the allowable schedule;
  - 3. and that it has the appropriate quantity of appropriately skilled personnel it will assign to the work who: will understand the intent; will anticipate issues, suitably in advance; and will obtain clarifications that might be needed.
- B. Materials and labor: At a minimum, each contractor, and all materials/equipment suppliers, shall guarantee all materials and labor furnished by respective entity for a period of one year unless otherwise noted. Both materials and labor shall be fully warranted by both Contractor and Manufacturer.
  - 1. Manufacturer's labor warranty shall include labor due to remedial work required on its product or equipment, provided such remedial work is not due to improper installation, in which case the labor shall be responsibility of the Contractor. Manufacturers are responsible for assuring proper installations as part of respective manufacturer's startup. Manufacturer's required warranty does not replace or preclude contractor's warranty for remedial work and acceptably installed conditions and performance.
  - 2. Refer also to Division 1 and Uniform General and Supplementary Conditions.

## 1.10 SUBMITTALS

**Note: As an aid to the Contractor, all bold print in Division 23 specifications text relates to a submittal requirement.** (If non-bolded submittal requirements exist, comply also with them and kindly advise Architect/Engineer of same for clarification in future projects.)

A. **Refer to Division 0 Sections (e.g., General Conditions) and to Division 1 Sections, (e.g., 01 33 000 – Submittals Procedures).**

B. **Specification copy mark-ups: To communicate the Contractor's compliance with the intent of the contract documents, and to expedite the submittal review process, the following information shall be provided in the submittals:**

1. Spec copies mark-ups: For each product which is addressed by the specifications, **submit copies of the relevant sections or subsections** of these specifications with edits or notations to illustrate compliance, or, if applicable, to illustrate recommended exceptions, deviations, or alternatives from the specific text of the section or subsection. (In absence of such notation(s) it shall be understood that no exceptions are taken.)
2. Legible hand-written notations in the margins (or electronic equivalents) are preferred, except when more lengthy (attached) explanations are necessary to convey or justify the recommended submittal.
3. Do not re-type or re-word process the affected specifications with modifications embedded into the text. Receipt of any such representations shall be understood to mean full compliance with the intent of the documents as interpreted by the Architect/Engineer.
4. Provide such mark-ups for applicable elements of Parts 2 and 3 of the specifications.
5. Provide other information required by the specifications and/or customarily provided by the Contractor/vendor.

C. **Materials/Products/Systems Submittals:** At a minimum, provide the following submittals.

Also provide other, additional or supplemental submittals where such products or materials may occur in other specification Sections and the Drawings.

1. Basic Materials - piping, valves, accessories, fire resistance penetration details, heat trace, expansion compensation, vibration/noise isolation, anchors and guides, identification and other basics from Section 23 01 00 – Basic Materials and Methods for Mechanical Work.
2. Pumps (also see HVAC equipment below), as presented in Section 23 01 60-Pumps.
3. Piping Systems Insulation (including mock-up requirements) as presented in Section 23 02 00 – Piping Systems Insulation.
4. Fire Protection Systems - NOTE: This submittal is for general Division 21 and Division 23 coordination review only, as it shall be the delegated design

responsibility of the licensed Fire Protection Subcontractor to properly design and install the fire protection system in accordance with project requirements and all applicable codes, regulations, and standards, and in accordance with these specifications.

Refer also to Division 21.

5. Plumbing systems, including water heaters, mixing valves, fixtures and trim, domestic hot water temperature maintenance system, plumbing specialties, tanks, purified water systems, pumps, etc.

Refer also to Division 22.

6. HVAC equipment - air handlers, coils, terminal units, fans, filters, etc.
7. Electric Heaters, as presented in Section 23 06 20 – Electric Heaters.
8. Custom Air Handling Units, as presented in Section 23 08 58 – Custom Air Handling Units with Coils.
9. Fans, as presented in Section 23 08 60 – Fans.
10. Filters, as presented in Section 23 08 80 – Filters and Accessories
11. Terminal Units, as presented in Section 23 08 90 – Air Distribution.
12. Ductwork and accessories, including insulation and installation, as presented in Section 23 08 90 – Air Distribution.
13. Controls and instrumentation, as presented in Section 23 09 51- Controls and Instrumentation.
14. Qualifications of manufacturers' technical representatives who will be responsible for on-site inspections, tests, and commissioning activities particular to the product, material, or system.
15. Test, Adjust, and Balance (TAB), as presented in Section 23 09 70 – Testing, Adjusting, and Balancing.
  - a. Provide TAB coordination submittal when TAB is provided outside the scope of this Division (e.g., Owner's Third Party TAB Contractor, by A/E, or by other party as may apply.)

**D. Shop drawings Submittals**

1. General:
  - a. Software platform: Confirm software platform used to produce shop drawings is acceptable to Owner/Engineer so compatibility amongst all parties can be verified. Contractor(s) shall provide all Object Enablers (OE) required for custom content to be displayed correctly outside the Architect/Engineer's authoring application software.

- b. Scale: Submitted shop drawing scale shall be no smaller than 1/4" = 1'-0" and all geometry shall be produced double lined.
- c. Predominantly mechanical areas: Provide detailed shop drawings submittal for mechanical rooms,, air handling units, and roof duct/fan systems. Include plan and at least two (2) sections/elevations.
- d. Above ceilings: Provide detailed shop drawings submittal for sections/elevations of floor plan above ceiling systems. Include plan and at least four (4) sections/elevations per floor or plan sheet area.
- e. Greatest congestion: Coordinate with Architect/Engineer to select locations of sections/elevations prior to their preparation. (Intent is to select areas of greatest congestion and therefore areas with the greatest need for coordination.)

Shop drawings produced/coordinated in 3D: As an alternative to sections/elevations, Contractor may submit 3D PDF electronic file(s) for Engineer review. 3D PDF Export Settings shall include Orthogonal Views: Left, Top, Front, Right, Bottom, and Back.

- f. Interrelationships: Illustrate interrelationships of other related equipment and systems (HVAC, flow measurement locations [TAB coordination], duct/equipment access doors, equipment service accessibility, wall/partition and ceiling access panels, valves, dampers, piping, plumbing, fire protection, controls, lighting, conduit, devices, ductwork/piping supports, etc.).
- g. Anchors, guides, supports: Provide detailed shop drawings submittal for all pipe anchors, guides, expansion/contraction elements, and for all vertical pipe riser supports (bottom, intermediate, top).
- h. Licensing agreements: Refer also to Section 2.02 – Record Drawings/As-builts, for information related to Contractor's requirements for execution of licensing agreements prior to use of contract document reproducibles and/or electronic files of drawings (which do not constitute contract documents).
- i. Record drawings: Shop drawings are not to be submitted as final As-built record drawings. Contractor shall modify Engineer's base electronic files to reflect "as constructed conditions" for As-builts.

2. Coordination/Modeling:

- a. Coordinate shop drawings pre-requisites: Prior to shop drawing submission, prior to purchasing and installing equipment and fixtures, prior to fabricating duct or piping systems, and prior to any rough-ins, coordinate such installations with other trades. Prepare coordinated shop drawings based on such coordination and fabricate/install systems accordingly.
- b. Preparation and protocol: Prepare coordinated shop drawings as presented herein. In addition, comply with Prime Contractor's 3D Coordination Protocol or BIM Execution Plan.

- 1) Conduct clash detection/resolution meetings and submit the coordinated model (in native Autodesk Navisworks .NWD file format), including clash viewpoints, developed by all trades for Engineer review. Any unresolvable discrepancies/conflicts shall be brought to the attention of the Engineer.
  - c. Engineer's electronic files: Contractor is advised that some of Engineer's electronic files may have been produced in 3D, and that this application may allow further conveniences and economy in production of shop drawings, coordination drawings, record drawings, and in the execution of the work.
  - d. LOD 300: Via Building Information Modeling (BIM) or Virtual Design and Construction (VDC) initiatives, contractor shall provide a minimum Level of Development (LOD) 300 model using a 3D software platform approved by Engineer. All model elements shall be modeled as specific assemblies that are accurate in terms of size, shape, location, quantity, and orientation.
    - 1) At a minimum, objects to be modeled include: all equipment; equipment housekeeping pads; all space constraints (i.e., access/maintenance zones, including code required clearances); ductwork; diffusers/grilles; piping; valves; piping specialties; insulation; hangers and supports; VFDs; controls cabinets; electrical panels and pertinent devices; light fixtures; and conduits > 1".
  - e. Submit Model: In addition to submission of plan drawings and sections/elevations as specified elsewhere, submit complete electronic model. Coordinate with A/E to verify software platform(s) to be used in submission.
- E. **Field Mock-ups:** Provide field mock-up of components/subsystems used repeatedly in the project construction for Architect/Engineer's review. Examples of mock-up items include:
1. Terminal units with associated ducts, controls, access provisions and surrounding piping, electrical, etc.
  2. Airflow measuring dampers (AFMDs), with associated duct, controls, access provisions, and surrounding piping, electrical, etc.
  3. Fire rated penetrations
  4. Piping insulation
  5. Fire dampers, smoke dampers, and fire/smoke dampers, each constructed with duct access doors, duct smoke detectors, and access provisions as applicable.
  6. Mock-ups identified in other specification sections and the drawings.
  7. Other components as requested by the Architect/Engineer.



- F. **Returned without review:** Submittals not in compliance with all above requirements shall be returned without further review.

#### 1.11 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Brochures:

1. **Submit, at the same time as product submittals, but under a separate cover:** copies of operating and maintenance instructions, service manuals, and parts lists applicable to each item of equipment furnished.
2. As a part of Records for Owner:
  - a. **Submit one (1) electronic copy** for Owner/Engineer's review and approval.

Delivery of required documents is a condition of final acceptance.

- B. Operation and maintenance instructions shall include all nameplate data and design parameters.
1. Clearly distinguish between information that pertains to the particular equipment and information which does not.
- C. Refer also to Division 1 Sections for additional requirements.

#### 1.12 COORDINATION, SUPERVISION, AND FIELD REPORTS

- A. Comprehensive proposals: Each Contractor's proposal shall include the necessary detail and interconnection work to coordinate his work with the work of other trades.
- B. Supervision: Each Contractor shall keep competent supervisory personnel experienced in the particular trades, building types, and systems types involved on the job whenever work is being performed which affects their trade. At a minimum, supervisory personnel shall hold a master's license in their respective trade and shall have a minimum of five years supervisory experience in projects of comparable systems. Such superintendents and foremen shall be assigned (full time) to the project throughout its duration.
1. All licensed work (plumbing, pipe fitting, sheet metal, air conditioning, welding, electrical, etc.) shall be supervised by at least one (1) licensed journeyman or master. A journeyman/master craftsman shall be on site whenever work is being performed in the respective trade.
  2. All personnel performing plumbing work shall, as a minimum, be licensed with the Texas State Board of Plumbing Examiners as an apprentice or higher.
  3. All personnel performing mechanical (HVAC) work, at a minimum, shall be registered with Texas Department of Licensing and Regulations.
  4. Unless the local code is more restrictive, the ratio of apprentice craftsmen to a journeyman/master craftsman shall not exceed three (3) to one (1).

5. All licensed/registered workers shall carry their license on their person while performing work and shall present the license to the Architect/Engineer and Owner's representative upon request.
  6. The terms "apprentice," "journeyman," and "master" are as defined by the local or state ordinances and/or regulations.
- C. Field reports/punch lists:
1. Address promptly: Field reports and punch lists generated by the Architect/Engineer (or Contractor) shall be promptly addressed by the Contractor **and submitted back to the Architect/Engineer by the Contractor within two weeks of their dates of issue** (or within other periods if so indicated by the particular field report/punchlist).
  2. Certification: **Return submittal** shall indicate the status of the items (i.e., complete, in progress, future). Where the item is indicated as being complete, it shall be certified by subcontractor field superintendent (or similar responsible party), and such initial shall signify that the responsible party personally verified on site that appropriate completion of remedial actions were taken. Contractor's project managers not intimately involved with the field activities shall not be acceptable responsible parties for this certification.
  3. Replies: Where replies or comments are offered by the contractor/subcontractor, they are to be included or attached, as appropriate. Legible, handwritten replies on original field report are suitable. Where separate sheet replies are offered, attach a copy of the field report/punch list for reference.

#### 1.13 STORAGE OF MATERIALS

- A. Each contractor shall provide temporary storage facilities suitable for equipment stored at the job site. Storage facilities shall be weatherproof and lockable as required.
- B. Materials or equipment that become wet or damaged during storage or before building is complete shall be removed and replaced at the Contractor's expense.
- C. Refer also to Division 1.

#### 1.14 PROTECTION OF BUILDING AND MATERIALS

Each Contractor shall take necessary precautions to prevent damage to buildings and to the work of other trades.

#### 1.15 SITE OBSERVATION

Site observation by the Architect/Engineer is for the express purpose of verifying general compliance by the Contractor with Contract Documents, and shall not be construed as construction inspection or supervision nor indication of approval of manner or location in which work is being performed. Nor shall site observation be an indication of approval that work is being performed in a safe manner.

#### 1.16 OTHER CONDITIONS

- A. Additional governing requirements exist: Each Contractor is reminded that he shall also comply in all respects with the General Conditions, Supplementary General Conditions, Invitation to Bid/ Propose, Instructions to Bidders/ Proposers, Supplementary Instructions to Bidders/ Proposers, Advertisement of Proposal, and other governing parts of these specifications and the contract documents.
  - B. Changes in Work: Any changes in work occasioned in the course of construction of the project shall be valued in accordance with the contract documents by comparing the net difference in value of the work before and after the change. "Missed" items or specification elements, or Contractors' interpretive procedures during proposal preparation shall not be considered in the change valuation. Nor, unless specifically defined in these contract documents, shall change proposals be calculated with any additional costs factors beyond those which would have been used had the change work been included in the original bid/proposal documents (including addenda). The work presented by the contract documents, and any changes thereto, shall alone establish the net value of any changes.
  - C. References in this division to industry-wide standards or nationally recognized testing agencies shall denote the latest edition of such publications.
- 1.17 DEFINITIONS: (NOTE: THESE DEFINITIONS ARE INCLUDED HERE TO CLARIFY THE DIRECTION AND INTENTION OF THIS SPECIFICATION. THE LIST GIVEN HERE IS NOT COMPLETE. FOR FURTHER CLARIFICATION AS REQUIRED, CONTRACTOR SHALL CONTACT THE ARCHITECT/ENGINEER.)
- A. Basis of Design: Equipment and materials identified in drawing schedules and identified by example in Specifications represent the intended Basis of Design. Unless otherwise indicated, first listed manufacturers within the specifications shall be considered to be the Basis of Design. Any equipment or materials provided by the Contractor must meet or exceed the performance and construction quality of the Basis of Design.
  - B. Contractor: The entity or entities responsible for construction of the project. The term is inclusive of the trades at all tiers (e.g., subcontractors) as well as the entity having overall responsibility for the construction. The term includes General Contractor, Construction Manager, Prime Contractor, and Design-Builder as applicable for a given delivery method of a construction project.
  - C. Architect/Engineer, Architect, Engineer: The entity or entities responsible for the design of the project are intended to be inclusive of the prime design consultant(s) and any sub-consultant(s) authoring drawings, specifications, or other parts of the construction documents. (The terms do not necessarily require these design professions to be a Prime Consultant if, for example, the project design does not include design discipline/professional.)
  - D. Concealed / Exposed: "Concealed" areas are those areas which cannot be seen by the building occupants. "Exposed" areas are all areas which are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms.
  - E. Indicated: The term "indicated" is a cross-reference to graphic representations, notes or schedules on drawings, other paragraphs or schedules in the Specifications, and similar means of recording requirements on contract documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used in lieu of "indicated," it is for the purpose of

helping reader locate the cross-reference, and no limitation of location is intended except as specifically noted.

- F. Directed, Requested, etc.: Where not otherwise explained, terms such as “directed”, “requested”, “authorized”, “selected”, “approved”, “required”, “accepted”, and “permitted” mean “directed by Architect/Engineer”, “requested by Architect/Engineer” and similar phrases. However, no such implied meaning will be interpreted to extend Architect/Engineer’s responsibility into Contractor’s responsibility for complying with the Contract Documents, nor into the Contractor’s area of construction supervision and job safety.
- G. And/Or: Where “and/or” is used in these Specifications or on the Drawings, it shall mean that situations exist where either one or both conditions occur or are required and shall not be interpreted to permit an option on the part of the Contractor.
- H. Approve: Where used in conjunction with Architect/Engineer’s response to submittals, requests, applications, inquiries, reports, and claims by Contractor, the meaning of term “approved” will be held to limitations to Architect/Engineer’s responsibilities and duties as specified in General and/or Supplementary Conditions. In no case will “approval” by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect/Engineer’s responsibility into Contractor’s responsibility for complying with the Contract Documents, nor into the Contractor’s area of construction supervision and job safety.
- I. As required: Where “as required” is used in these Specifications or on the drawings, it shall mean that situations exist that are not necessarily described in detail or indicated that may cause the Contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result.
- J. Furnish:
  - 1. The term “furnish” is used to mean “supply and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar operations.”
  - 2. Where “furnish” applies to work for which installation is not otherwise specified, “furnish” in such case shall mean “furnish and install.”
- K. Install: The term “install” is used to describe operations at project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations.
- L. Provide: The term “provide” means to furnish and install, complete, tested, and ready for intended use.
- M. Substantial Completion: The contract documents provide that Substantial Completion requires not only installation, but also performance, acceptance, including but not limited to: start-up reports; Contractor’s Commissioning reports; Test, Adjust, and Balance completion with final report accepted; controls testing and readiness report; and completion of Commissioning Verification activities.

## PART 2 - PRODUCTS AND AS-BUILT/RECORD DRAWINGS

### 2.01 MATERIALS

GENERAL: Refer to Division 1, and comply with the requirements therein.

- A. Standard of quality: All materials shall be new and of the quality specified. Materials shall be free from defects. Where manufacturer's names are mentioned in these specifications or on the plans, it has been done in order to establish a standard of quality and construction. It shall be the Contractor's responsibility to verify that any permitted substituted equipment will fit in space available.
- B. Individual and Joint responsibility: Contractor(s), Manufacturer(s), and supplier(s) providing materials for the Work shall individually and jointly review the intended application of the specified and proposed materials, and shall be responsible for confirming the intended application is appropriate for the specific product.
- C. Transportation and storage: Contractor will be responsible for transportation of his materials to and on the job, and will be responsible for the storage and protection of his materials and work until the final acceptance of the job. Failure to do so will be sufficient cause for rejection or replacement of any item in question. Materials or equipment that becomes wet or damaged during storage or before building is complete shall be removed and replaced at the Contractor's expense.
- D. Hazardous materials prohibited, certification required: Products containing any asbestos, lead, or other hazardous materials shall not be allowed nor provided. No asbestos-containing materials, equipment, or products are permitted. **Prior to closeout, contractor shall submit certificate stating that no asbestos or lead-containing materials, equipment, or products have been incorporated into the project.**

### 2.02 RECORD DRAWINGS/AS-BUILTS

GENERAL: Refer to Division 1, and comply with the requirements therein.

- A. Electronic files: The Contractor/subcontractor shall request the pertinent electronic drawing files related to the project prior to the creation of coordinated shop drawings at the beginning of the project, and again at the end of the project prior to the creation of the electronic as-built record drawings.
  - 1. **Execute and submit Part 4 - Electronic File Transfer Agreement** included in this Section. Each contractor/subcontractor shall sign this revocable licensing agreement for the use of electronic files, and shall adhere to the Architect/Engineer's requirements regarding use, re-use, transfer, and presentation of the information contained in electronic files, which are copyrighted materials. In no fashion whatsoever shall such acquisition of files yield any presentation, ownership, or reuse rights (excepting re-use rights specifically and solely for the use of this project). Electronic files will not be provided until this licensing agreement has been executed.
  - 2. Not a substitute for contract documents: The Contractor is reminded and advised these electronic files are not contract documents, and shall not be considered a substitute for them. The electronic files are only and strictly a tool offered by the

Engineer and Owner as an aid to the Contractor in the execution of the Contractor's project responsibilities.

### PART 3 - INSTALLATION AND RECORDS FOR THE OWNER

#### 3.01 INSTALLATION

- A. General: All equipment, materials, fixtures, and systems shall be installed consistently with the intent of the contract documents, and also with manufacturer's approvals in accordance with manufacturer's written recommendations and instructions. It shall be the responsibility of the Contractor to verify such prior to installation and fabrication in order that any discrepancies can be resolved prior to installation.
- B. Hangers/supports: All drilling for expansion bolts, hangers, and other supports shall be done by this Contractor under the guidance of the General Contractor/Construction Manager, structural engineering construction documents, and structural construction trades.
- C. Cutting/coring/drilling approval: Unless specifically noted in both Division 23 AND structural drawings, no floors, joists, beams, girders, trusses, webs, columns, bracing, bridging, load-bearing walls, bond beams, lintels, or other structural elements shall be cored, drilled, or cut by the Contractor without first obtaining written permission from the Architect/Engineer.
- D. Blockouts and sleeves: Unless specifically noted in both Division 23 AND structural drawings, no block-outs/frame-outs or sleeves in floors or structural members shall occur without first obtaining written permission from the Architect/Engineer.
- E. Equipment connections: Verify all connections to equipment prior to rough-in/installation.
- F. Remedial measures: Contractor shall bear the costs of all remedial measures which might be required due to failure to comply with the above general installation directives, including Owner's costs related to it or its consultants correcting the unacceptable installation (including those for evaluating, identifying, troubleshooting, or correcting the condition.) In the case of Owner costs, payments shall be made via deductions from amounts owed the Contractor (or if during or after warranty, by reimbursement from the manufacturer or Contractor to the Owner).
- G. Asbestos prohibition: Materials, equipment, or products containing asbestos, lead or other hazardous substances are not permitted.

#### 3.02 WORKMANSHIP

- A. Highest grade: Use only thoroughly trained and experienced supervisory personnel and workmen completely familiar with the systems and components involved and with the manufacturer's recommended methods of installation.
  - 1. In all respects, the workmanship shall be of the highest grade, and all construction shall be done according to the best practices of the trade.
  - 2. Any work not meeting these requirements, as determined by the Architect/Engineer, shall be replaced or rebuilt at Contractors' expense.

3. Visible signs of improper workmanship shall be grounds for requiring dismantling and further testing of joints, assemblies, systems, etc. to determine sufficient workmanship. Such testing and repairs shall be at the contractor's expense.
- B. Square to building lines, plumb, and level: Unless otherwise indicated, piping and conduit shall be concealed and installed level, plumb, and square to the building lines.
- C. Fully operational: Install complete, thoroughly check, correctly adjust, clean, test, commission, and leave ready for Owner's operations all equipment, materials, and systems provided under this contract.
- D. Readily accessed: Install all systems as required to gain easy, safe, and full access to mechanical room and above ceiling systems for service, adjustment, inspection and/or removal/replacement.
- E. Exposed systems in finished areas: Prior to purchase and installation of any exposed (in finished areas) piping, raceway (controls, etc.), or equipment, plan work and coordinate closely with other trades to determine exact locations of exposed elements.
  1. Chalk or otherwise suitably mark all such routings, equipment outlines, etc., and secure Architect/Engineer's approval prior to proceeding. Coordinate with other trades to provide color coding of chalking/routings/markings, as required, to distinguish systems (e.g., electrical = red, mechanical = blue, fire protection/plumbing = green).
- F. Demonstration of experience: When requested by the Architect/Engineer or other Owner's representative, Contractors and Subcontractors shall submit information demonstrating company and supervisory personnel (superintendents, foremen, etc.) experience in this type and size of project acceptable to the Architect/Engineer. Such information shall include: list of all similar projects within the last ten (10) years, with Division 23 construction costs and with names and phone numbers of Owner, Architect, and Engineers; superintendents/foremen on those projects; and superintendents/foremen proposed for this project. (If accepted, Contractor shall provide the proposed superintendents/foremen for this project, unless others are requested or accepted by Owner.) Contractors shall have successfully completed not less than three comparable facilities within the last ten (10) years.

### 3.03 CLEANING AND PAINTING

- A. Cleaning: Each Contractor shall at all times keep the premises free from accumulations of waste materials or rubbish caused by his employees or work. At completion of the job, each contractor shall remove all of his tools, scaffolding and surplus materials, and shall leave the area "broom clean."
- B. Painting:
  1. General: As indicated herein or in other sections, Contractor shall paint equipment, ductwork, piping and materials furnished under this contract, including all equipment not factory painted.
  2. Ferrous materials: After thoroughly wire brushing, apply one coat of industrial rust inhibitor and two coats of industrial machinery enamel to all non-galvanized ferrous

pipe/duct supports, non-galvanized ductwork, and non-galvanized uninsulated ferrous piping:

- a. exposed outside;
- b. in finished areas inside;
- c. in non-finished areas inside such as mechanical/equipment areas or rooms.

3. Copper piping:

- a. nonfinished areas: Copper piping will not be painted but shall be thoroughly cleaned.
- b. exposed copper in finished areas: Where residing in finished occupied spaces, copper pipe cleaning shall remove tarnished or heat discolored piping and leave the copper in a clean and bright condition.

4. Touch-up: Factory finishes and field applied finishes shall be cleaned and touched-up with enamel in color to match original finish.

5. Insulated systems: Refer also to Section 23 01 00 - Basic Materials and Methods, and Section 23 02 00 - Piping Systems Insulation.

6. Division 9 coordination: Coordinate proposal and execution with the requirement of Division 9 and the Prime Contractor, (or Construction Manager, Design-Builder).

3.04 HANDLING OF OWNER-FURNISHED EQUIPMENT

- A. The Contractor shall relocate, receive, store, install, connect, and/or test, and shall verify and ensure proper operation of all Owner-furnished equipment. Contractor shall be responsible for such equipment from time of receipt to accepted installation.

3.05 RECORDS FOR THE OWNER

- A. **Refer to Division 1 and Owner's Uniform General Conditions.**



#### PART 4 – ELECTRONIC FILE TRANSFER AGREEMENT

At the Contractors' request, **TG&W Engineers, Inc.** is providing electronic files for the Contractors' convenience and use in the preparation of shop drawings, record drawings, and/or other construction purposes related to TAMU West Campus Dining Hall, subject to the following terms and conditions:

The Engineer's electronic files are compatible with the latest version of Autodesk software platforms. The Engineer makes no representation as to the compatibility of these files with the Contractors' hardware or software.

Data contained on these electronic files are part of the Engineer's copyrighted instruments of service and shall not be used by the Contractor(s) or anyone else for any purpose other than those stated in the first paragraph of this Agreement. Any use or reuse by the Contractor(s) will be at the Contractors' sole risk and without liability or legal exposure to the Owner, the Architect, or the Engineer. The Contractor(s) agrees to make no claim or cause of action of any nature against the Owner, the Architect, or the Engineer, or the Engineer's officers, directors, employees, agents or sub-consultants that may arise out of or in connection with the Contractors' use of the electronic files.

The Contractor(s) agrees to keep the "NOTICE" block of information on all electronic files and hard copies of these documents in accordance with the text in said "Notice." The Contractor(s) accepts the responsibility for preventing the transmission of these files to any other party(ies). The Contractor(s) shall restrict its use of the electronic files solely for the purposes intended in accordance with this Agreement.

Any other party who wishes to acquire electronic files shall do so by separate agreement with the Engineer. The Contractor(s) shall not transmit or share such files with another party.

The Contractor(s) shall, to the fullest extent permitted by law, indemnify, defend, and hold the Engineer harmless against all damages, liabilities or costs, including reasonable attorneys' fees and defense costs, arising out of or resulting from the Contractors' possession or use of these electronic files.

These electronic files are not construction documents. Differences may exist between these electronic files and corresponding hard-copy construction documents. The Engineer makes no representation regarding the accuracy or completeness of the electronic files the Contractor(s) receives. In the event that a conflict arises between the signed or sealed hard-copy construction documents prepared by the Engineer and the electronic files, the signed or sealed hard-copy construction documents shall govern. The Contractor(s) is responsible for determining if any conflict exists. By the Contractors' use of these electronic files, the Contractor(s) is not relieved of the Contractors' duty to fully comply with the contract documents, including, and without limitation, the need to create, perform, check, and confirm the Contractors' work, and to coordinate it with that of other contractors/ subcontractors/trades/suppliers for the project.

Because information presented on the electronic files can be modified, unintentionally or otherwise, the Engineer reserves the right to remove all indicia of ownership and/or involvement from each electronic display.

Upon execution of this Agreement, the Engineer will furnish the required electronic files to those undersigned such that the Contractor(s) may more easily fulfill their specified project responsibilities.

Under no circumstances shall delivery of the electronic files for use by the Contractor(s) be deemed a sale by the Engineer, and the Engineer makes no warranties, either express or implied, of merchantability and fitness for any particular purpose. In no event shall the Owner, the Architect, or the Engineer be liable for any loss of profit or any consequential damages as a result of the Contractors' use or reuse of these electronic files.

I (undersigned) have read and accept the terms and conditions of this Agreement.

Contractor	Signature	Date
Contractor	Signature	Date
Contractor	Signature	Date
Contractor	Signature	Date
Contractor	Signature	Date
Contractor	Signature	Date
Contractor	Signature	Date
Contractor	Signature	Date
Contractor	Signature	Date
Contractor	Signature	Date
Contractor	Signature	Date
Engineer's Authorized Personnel	Signature	Date

Texas Firm Registration No. 12278 | 3701 Executive Center Drive, Suite 257 | Austin, Texas 78731

END OF SECTION

SECTION 23 01 00 - BASIC MATERIALS AND METHODS FOR MECHANICAL WORK

The General Conditions, any Supplementary General Conditions, and Division 1 - General Requirements are hereby made a part of this Section as fully as if repeated herein.

PART 1 - GENERAL

1.01 SCOPE

- A. Piping Systems: Provide all labor and materials, valves, accessories, specialties, and appurtenances necessary for complete and working piping systems including, but not necessarily limited to:
  - 1. Condensate drainage
  - 2. Hydronic Systems
    - a. Above ground and, as applicable, below ground
    - b. Heating water
    - c. Chilled water
- B. Valves
- C. Piping accessories and specialties
  - 1. Cathodic protection
  - 2. Flow measuring stations
  - 3. Make-up and blowdown water meters
  - 4. Unions and flanges/gaskets
  - 5. Dielectric connections
  - 6. Escutcheon plates
  - 7. Thermowells
  - 8. Thermometers
  - 9. Air vents
  - 10. Pressure taps and gauges
  - 11. Jointing sealants
  - 12. Pipe penetration sealing materials

- 13. Air separators
- 14. Strainers
- 15. Pump suction guides
- 16. Triple-duty/combination valves
- 17. Vacuum breakers and relief valves
- 18. Catch basins
- 19. Drain valves for coils and equipment
- 20. Flexible hoses
- 21. Quick connections
- D. Expansion Compensation
- E. Hangers, Supports, and Anchors
- F. Identification
- G. Vibration Isolation
- H. Access Panels
- I. Equipment Pads/Supports/Curbs
- J. Painting (General)

#### 1.02 RELATED SECTIONS

- A. 22 10 00 – Basic Materials and Methods for Plumbing Work
- B. 23 00 10 – General Requirements for Mechanical Work
- C. 23 02 00 – Piping Systems Insulation

#### 1.03 SUBMITTALS

- A. **Refer to Section 23 00 10, including the requirement for specification copy mark-ups.**

### PART 2 - PRODUCTS

#### 2.01 PIPE AND FITTINGS

- A. General

1. Comply with standards: All piping materials shall be manufactured and tested according to applicable ANSI, ASTM, AHRI, and ASME standards.
2. Domestically manufactured: Unless otherwise indicated by Basis of Design exceptions, all piping, valves, and piping accessories shall be domestically manufactured in the U.S.A.
3. Carbon steel piping exposed to earth backfill.
  - a. Protection for bare exterior surfaces of field joints, fittings, specials and short lengths of pipe shall be as follows:
    - 1) clean rust, paint, chalk, or foreign material from surface to be coated by sandblasting or wire brushing;
    - 2) apply primer to clean surface (without drips or runs) to a distance beyond that to be coated by tape, after primer is dry, apply polyethylene pipewrap tape (minimum 12 mil) in spiral fashion with tension and overlap (minimum 50%); overlap pipe coating a minimum of two (2) inches; primer and tape to be PolyKen Primer and PolyKen No. 826 Corrosion Protection Tape; or
    - 3) apply two (2) coats of Koppers bitumastic "Super-Service Black" wrap with eight (8) ounce tar saturated canvas membrane; apply a third coat of Koppers bitumastic, and; apply a final wrap of kraft paper conforming to AWWA C203.
  - b. Protection for bare exterior surfaces of field joints, fittings, specials and short lengths of pipe shall be as follows:
    - 1) clean rust, paint, chalk, or foreign material from surface to be coated by sandblasting or wire brushing;
    - 2) apply primer to clean surface (without drips or runs) to a distance beyond that to be coated by tape, after primer is dry, apply polyethylene pipewrap tape (minimum 12 mil) in spiral fashion with tension and overlap (minimum 50%); overlap pipe coating a minimum of two (2) inches; primer and tape to be PolyKen Primer and PolyKen No. 826 Corrosion Protection Tape; or
    - 3) apply two (2) coats of Koppers bitumastic "Super-Service Black" wrap with eight (8) ounce tar saturated canvas membrane; apply a third coat of Koppers bitumastic, and; apply a final wrap of kraft paper conforming to AWWA C203.
  - c. Cathodic Protection: In addition to coating and wrapping:
    - 1) For each section of (uninsulated) steel pipe with no more than 20 feet of developed length of pipe underground, provide a five (5) pound sacrificial anode (in a sand bedding) connected to the steel pipe with factory terminal point or cad welded to pipe.

- 2) Delegated design: For more extensive piping systems, procure the services of a company specializing and experienced in the design of cathodic protection systems of similar service in this geographical area, to design and supervise the installation of a complete cathodic protection system. Use sacrificial anodes of size and material recommended, and provide the number of anodes required to provide a minimum twenty-five (25) year life of the underground piping system. **Submit drawings showing locations, size and materials of cathodic protection system** to Architect/Engineer for review prior to procurement and installation.
  - d. Coatings and wrappings shall extend to approximately six (6) inches above grade.
  4. Provide factory burial ribbon with tracer wire for all below grade plastic piping systems.
- B. Piping Systems Materials
1. Consistent materials: Piping systems shall use consistent materials throughout each system. Materials for each piping system shall not be "mixed." Exception: where required due to above/below grade conditions; allowed due to inside building/outside building conditions; or where indicated by drawings or specifications.
  2. Lead prohibited: Lead-containing solders shall not be used at any place in any system.
  3. Condensate Drainage Piping
    - a. Air conditioning systems
      - 1) Inside building and above grade:
        - a) Type "DWV" or "M" hard copper tubing with solder-type wrought copper fittings joined with 95/5 (tin/antimony) solder or 100% lead-free tin/silver solder.
        - b) Schedule 40 galvanized steel with galvanized screwed malleable iron fittings.
        - c) Schedule 40 PVC with heavy duty industrial grade (gray) solvent cemented joints and purple primer. Minimum size for horizontal runs shall be 1". Fittings for 1-1/4" and larger to be DWV pattern. In no case shall PVC be run through ducts or plenums. (Refer also to support intervals required, Part 3.).
      - b. Condensing type combustion systems (e.g., furnaces, boilers, heating water heaters)

- 1) Schedule 40 CPVC with heavy duty industrial grade (gray) solvent cemented joints and approved primer. Minimum size for horizontal runs to be 1". In no case shall plastic be run through ducts or plenums. Refer also to support intervals required, Part 3.
  - 2) Primer shall be equal to IPS Corp. "Weld-On" P-68 or P-70 purple primer. CPVC cement shall be equal to IPS Corp. "Weld-On" 724 industrial CPVC cement.
4. Above Ground Heating Water Piping and Chilled Water Piping,
- a. Piping 2 inches and smaller shall be:
    - 1) ASTM A53 standard weight seamless black steel piping with ANSI/ASTM B16.3 Class 150 malleable iron screw fittings, or;
    - 2) ASTM B88 Type L hard drawn copper with solder-type wrought copper fittings joined with 95/5 solder, or;
    - 3) As indicated on the drawings.
  - b. Piping 2-1/2 inches and larger shall be consistently applied throughout the respective system as follows:
    - 1) ASTM A106 standard weight seamless black steel piping with ASTM A234 forged steel welded type fittings.
      - a) As a voluntary alternate only, ASTM A53 standard weight, welded seam, black steel piping may be provided.
  - c. For all steel chilled water piping:
    - 1) Corrosion inhibiting coating: Coat all black steel chilled water piping and components with corrosion inhibiting reactive gel equal to Polyguard "RG-2400LT," or "RG-CHW."
    - 2) Installation: Install per manufacturer's recommendations, using "AccuTrowel" applicator to achieve a uniform 25 MIL thickness of the gel.
    - 3) Surface preparation: Clean all surfaces to be gel coated according to SSPC-SP 1. Remove all rust, oil, grease, cutting oils, dirt and other contaminants. Use suitable solvents, steam cleaning with detergent, or fresh water wash with detergent. Follow with thorough fresh water rinse. Surfaces must be free of all oil, grease, dirt and other contaminants.
      - a) Alternatively, prepare piping surface using SSPC - SP 2: "Hand Tool Cleaning" or SSPC - SP 3: "Power Tool Cleaning" methods.
    - 4) Exception: factory pre-insulated piping.

- d. Mixed materials: Where both steel and copper material are used in the piping system, use consistently throughout the system and provide dielectric unions (flanges/kits) at interconnections. In such conditions, it is generally intended that steel piping be used on the system side of isolation (balance) valves, and copper piping be used on the equipment side of isolation (balance) valves. Obtain permission from Architect/Engineer for departures from this general intent.
  - e. Where specific materials are indicated on drawings for certain piping sections or systems, comply with drawings.
5. Direct Buried Heating and Chilled Water Piping
- a. General: Provide a complete factory HDPE piping system designed for below grade heating and chilled water distribution.
    - 1) Delegated Design: The system supplier/manufacturer shall be responsible for complete design of the HDPE piping system. Information contained in the drawings shall be used for reference, but shall not be relied upon without manufacturer's confirmation.
  - b. Quality Control:
    - 1) Minimum experience: The system supplier shall have manufactured systems of the composition defined herein for at least ten years.
    - 2) Analysis: Each system layout shall be analyzed by the piping system manufacturer to determine stresses on the carrier pipe and anticipated thermal movement of the service pipe. Heating water piping shall be designed for a minimum temperature change of 150°F. Chilled water piping shall be designed for a minimum temperature change of 60°F. The system design shall be in strict conformance with ASTM D-2774 Standard Practice for Underground Installation of Thermoplastic Pressure Pipe, latest edition.
    - 3) Installation/Inspection: Factory trained field supervision shall be provided for the critical periods of installation: unloading, field joint instruction, field joint inspection, and testing.
    - 4) Field reports: **Manufacturer shall submit written field report** documenting system installed in approved and acceptable manner and documenting procedures and results of tests/inspections.
    - 5) All fused joints shall be prepared using a data logging system. Each joint shall be uniquely identified with a permanent marker. The data log shall include:
      - a. Operator's initials
      - b. Date and time of fusing



- c. Pre-heat temperature and duration (if used)
  - d. Fusing pressures, temperatures, and duration
  - e. Ambient air temperature
  - f. Geo-reference for location of fused joint. This geo-reference shall be updated after the completion of laying the pipe.
- c. **Submit factory-prepared shop drawings detailing fittings, jointing method, expansion compensation, anchors and thrust blocking, expansion pillows, installation methods, etc.**
- 1) Shop drawings shall be prepared and submitted in 3D.
  - 2) Submit also NWD file (Navisworks) import of the 3D model.
  - 3) Illustrate piping elevations and slopes with respect to finished grade elevations (below grade piping) and building finished floor elevations (below building/crawlspace piping).
- d. Service/Carrier pipe shall be Extra High Molecular Weight Plus (EHMW Plus) High Density Polyethylene (HDPE) pipe with fused joints. Pipe shall be manufactured with PE4710 resin. For chilled water a minimum of SDR 17 is required. For heating water a minimum of SDR 11 is required. All heating water pipe shall be manufactured with DOW Intrepid 2499 resin for higher temperature applications.
- e. Expansion ells, expansion loops, and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system.
- f. Pipe and fittings insulation: Basis of Design – Gilsulate 500 insulation.
- 1) The insulation shall be a dry, free flowing granular product formulated from selected inert, inorganic materials. It shall be non-toxic, non-flammable, and completely free of asbestos. It shall require no mixing prior to installation, and no curing. It shall be completely compatible with all materials typically used for piping in the service temperature range of +35°F to +230°F. It shall be of sufficient density so any stones or rocks inadvertently falling on insulation will not penetrate or migrate into or through insulation during placement and back-filling operations.
  - 2) The insulation shall be composed of granular particles that cohesively bond with each other to form a closed cell compacted mass that effectively isolates pipe surfaces from air, water, moisture and chemicals. The granules shall be surface treated to render it hydrophobic. The compacted insulation shall be capable of withstanding up to 12,000 psf (58,000 kg/M<sup>2</sup>) at the manufacturer's recommended density.

- 3) The insulation shall have a thermal coefficient of heat conductivity (K factor) of no more than 0.60 BTU/hr. /ft<sup>2</sup>/°F/in. at manufacturer's recommended use density and a mean temperature of 175°F and 0.65 at a mean temperature of 300°F by the guarded hot plate method of ASTM C-277. If an insulation with higher thermal conductivity is proposed, bidding shall be based on the equivalent amount of insulation required to minimize heat loss/gain to that which would result with the thermal conductivities specified in the proceeding sentence.
- 4) Electrical resistivity of the insulation shall be greater than 10<sup>12</sup> Ohm-cm.
- 5) The insulation coverage thickness shall not be less than indicated in these specifications.

Pipe Size (in)	Minimum Insulation Thickness (in)
1-6	Chilled Water - 6"
1-6	Heating Water - 6"

- g. The internal pipe shall be hydrostatically tested to 100 psig or 1.5 times the operating pressure, whichever is greater.
- h. Field joints installation:
  - 1) Insulation materials used must be capable of being placed and consolidated to prescribed density prior to any backfilling operation. Use of backfill to provide compaction of the material is not acceptable.
  - 2) Excavate trench as near as possible to the required width of piping and insulation and pile backfill all on one side. Install pipes with required guides, supports, and anchors as shown on drawings and specifications. Perform pressure testing.
  - 3) Grade and compact trench under pipes leaving required space for specified thickness of insulation. Clean any dirt or debris off pipes.
  - 4) Precut gypsum board with attached spacers on the exterior may be driven into place. Horizontal spacers are used to determine envelope width. Leave forming in place. Forms are held away from pipes by temporary spacers which must be removed as insulation is installed and consolidated. Side forms must not extend above the finished consolidated insulation level of the envelope.
  - 5) Provide compact sand or clean backfill behind the forms to pipe height.
  - 6) All standing water shall be removed prior to placing insulation.

- 7) To minimize dust, empty the bags near pipes with as little “free fall” as possible. Fill trench to mid pipe height and consolidate. Remove spacers and temporary supports as work progresses.
  - 8) Add additional layers of insulation and consolidate to specified thickness and density. A rod type concrete vibrator with a 1½ - 2” diameter head is the best and quickest means of consolidating insulation. Insert the head of the vibrator and pull along slowly.
  - 9) Walk on the consolidated insulation envelope to achieve proper density, footprints of approximately 1” deep or less are expected. Insulation coverage shall be according to insulation manufacturer recommendations or as specified.
  - 10) Complete compaction of sand backfill behind forms. Place a layer of flattened empty bags on top of the insulation envelope. Walk on top of the bags and hand place 6” clean backfill on top of empty bags to protect against damage in case of storms. Complete backfilling to grade level as specified as soon as possible. Provide a minimum of 12” earth backfill.
  - 11) Obtain manufacturer’s and Architect/Engineer’s on-site reviews during the jointing and insulation process and before backfilling begins. **Obtain manufacturer’s written approval of the entire installation and submit same to Architect/Engineer.**
  - 12) A detectable “Caution-Buried Water Line” tape shall be placed 18” to 24” above each line.
- i. Expansion Compensation: Prefabricated expansion loops, ells and tees shall be furnished and installed where shown on plans, or where otherwise determined by the manufacturer’s delegated design.
  - j. Unless otherwise indicated or required by field conditions, piping shall be installed: level in crawlspace conditions (without slope); level or, if indicated by drawings, sloped in all below grade conditions to allow for removal of air in the piping.
    - 1) If this level condition is not achievable and air venting must be provided for below grade piping, provide air vent connections through conduits to be extended to air vents as indicated on plans or as required by conditions.
    - 2) Air vent nipples, piping, and piping accessories below and above grade shall be field insulated 304 stainless steel. Refer to Section 23 02 00 – Piping Systems Insulation.
  - k. Approved manufacturers for HDPE piping systems:
    - 1) Basis of Design: PERMAPIPE “Steel Polytherm” with expansion ells, tees and loops as specified.
6. Below Ground and Floor (Crawlspace) Heating and Chilled Water Piping

- a. General: Provide a complete factory pre-insulated piping system designed for below grade heating and chilled water distribution.
  - 1) Delegated Design: The system supplier/manufacturer shall be responsible for complete design of the pre-insulated piping system. Information contained in the drawings shall be used for reference, but shall not be relied upon without manufacturer's confirmation.
- b. Quality Control:
  - 1) Minimum experience: The system supplier shall have manufactured systems of the composition defined herein for at least ten years.
    - a) All straight sections, fittings, anchors, expansion ells, expansion loops, and other accessories shall be prefabricated to job dimensions and designed to minimize the number of field joints.
    - b) All field joints shall be straight sections of pipe.
  - 2) Analysis: Each system layout shall be analyzed by the piping system manufacturer to determine stresses on the carrier pipe and anticipated thermal movement of the service pipe. Heating water piping shall be designed for a minimum temperature change of 150°F. Chilled water piping shall be designed for a minimum temperature change of 60°F. The system design shall be in strict conformance with ANSI B31.1, latest edition.
  - 3) Installation/Inspection: Factory trained field supervision shall be provided for the critical periods of installation: unloading, field joint instruction, field joint inspection, and testing.
    - a) Below grade welded joints ultrasonic tests: provide for minimum of 50% of below-grade joints and 25% of above grade joints. Each failed inspection shall add two joints to the testing quantity, plus retest of failed joint.
  - 4) Field reports: **Manufacturer shall submit written field report** documenting system installed in approved and acceptable manner and documenting procedures and results of tests/inspections.
- c. **Submit factory-prepared shop drawings detailing fittings, jointing method, expansion compensation, anchors and thrust blocking, expansion pillows, installation methods, etc.**
  - 1) Shop drawings shall be prepared and submitted in 3D.
  - 2) Submit also NWD file (Navisworks) import of the 3D model.

- 3) Illustrate piping elevations and slopes with respect to finished grade elevations (below grade piping) and building finished floor elevations (below building/crawlspace piping).
- d. Service/Carrier pipe shall be black steel ASTM A53 standard weight seamless pipe with weld fittings. Fittings 1-1/4" and smaller shall have socket weld fittings. Provide dielectric flange kits at points of connection to copper, stainless steel, or other dissimilar metals.
  - 1) Straight pipe sections shall be pre-bent by the manufacturer prior to insulating/jacketing wherever required to accommodate the system layout (e.g., where slopes require bends greater than 90° elbow).
- e. Expansion ells, expansion loops, and anchors shall be designed and factory fabricated to prevent the ingress of moisture into the system.
- f. Pipe and fittings insulation and jacket: Basis of Design - urethane insulation with filament wound jacket.
  - 1) Service pipe insulation shall be spray applied nominal 2 lb/ft<sup>3</sup> density, 0.16 initial k-factor, polyurethane foam for straight sections and pre-formed polyurethane foam for all fittings. All polyurethane foam insulation shall be minimum 90% closed cell. Open cell foams shall not be allowed. To ensure no voids are present, all insulation shall be inspected by one of the following three methods: visually checked prior to application of the protective jacket, infrared inspection of the entire length, or x-ray inspection of the entire length. The insulation thickness shall not be less than indicated in these specifications.

Pipe Size (in)	Minimum Insulation Thickness (in)
1-6	Chilled Water - 2"
1-6	Heating Water - 2"

- 2) All straight sections of the insulated piping system shall have filament wound, polyester resin/fiberglass reinforcement composite directly applied on the insulating foam. All fittings of the insulated piping system shall be prefabricated to minimize field joints and jacketed in a chopped spray-up, polyester resin/fiberglass-reinforced composite, directly applied onto the insulating foam to a thickness related to the filament-wound jacket thickness.

The minimum thickness for FRP jacket shall be as follows:

Jacket Diameter	Minimum Thickness (in)
Up to 15 inches	0.125

- a) Suspended piping: Increase the minimum thickness as required to assure no damage to the jacket from rolling

pipe onto/over pipe rollers on 10 ft. centers during installation.

- g. Pipe and fittings insulation and jacket: voluntary alternate only – foamed in place urethane insulation between service pipe and thermoplastic casing.
  - 1) Delegated design, quality control, and shop drawings requirements of “5. a, b, and c” above apply.
  - 2) System shall equal that specified in “f” above, except the jacketing shall be a concentrically aligned PVC or high density rigid polyethylene piping material. Jacket wall thickness shall be not less than that for SDR-41 PVC.
- h. The internal pipe shall be hydrostatically tested to 150 psig or 1.5 times the operating pressure, whichever is greater.
- i. Field joints insulation: All field applied insulation shall be placed only in straight sections. Field insulation of fittings shall not be acceptable. After field joints in carrier pipe are made, provide protection for the bare exterior surfaces as follows (all insulation and coating materials for making the field joints shall be furnished by manufacturer of the preinsulated pipe):
  - 1) Clean rust, paint, chalk, or foreign material from surface to be coated by sandblasting or thoroughly wire brushing;
  - 2) Apply Rust-o-leum clean metal primer to clean surface (without drips or runs) to the entire exposed surface of steel. After primer is dry, apply Polyken 937 mastic coating to entire surface of pipe. Once set, apply Polyken 826 polyethylene pipewrap tape (minimum 12 mil) in spiral fashion with tension and overlap (minimum 50%).
  - 3) Wrap polyethylene tape with aluminum sheeting with adhesive backing equal to Alumiguard (manufactured by Polyguard) installed as per manufacturer’s directions.
  - 4) Apply Childers CP-22/23/24 to ends of any exposed insulation to create a vapor stop at the ends.
  - 5) Insulation shall then be poured in place into the field weld area encompassed by a suitable and durable (e.g., puncture resistant) pipe mold. The installer shall seal the field joint area with a heat shrinkable adhesive-backed wrap or with wrappings of glass reinforcement fully saturated with a catalyzed resin identical in properties to the factory-applied resin.
  - 6) Finish field joint with overlayment of Alumiguard or equal after the heat shrink wrap or the FRP lay-up has cured.
  - 7) Obtain manufacturer’s and Architect/Engineer’s on-site reviews during the joint insulation process and before backfilling begins.

**Obtain manufacturer's written approval of the entire installation and submit same to Architect/Engineer.**

- j. Expansion Compensation: Prefabricated expansion loops, ells and tees shall be furnished and installed where shown on plans, or where otherwise determined by the manufacturer's delegated design.
  - 1) Hydronic piping: Alternatively, where recommended by manufacturer, provide expansion loops, ells, and tees with field installed flexible expansion cushions equal to "Perma-Pipe Econo-Gard External Expansion Pads," or as otherwise recommended by the manufacturer.
- k. Unless otherwise indicated or required by field conditions, piping shall be installed: level in crawlspace conditions (without slope); level or, if indicated by drawings, sloped in all below grade conditions to allow for removal of air in the piping.
  - 1) If this level condition is not achievable and air venting must be provided for below grade piping, provide air vent connections through conduits to be extended to air vents as indicated on plans or as required by conditions.
  - 2) Air vent nipples, piping, and piping accessories below and above grade shall be field insulated 304 stainless steel. Refer to Section 23 02 00 – Piping Systems Insulation.
- l. Approved manufacturers for pre-insulated piping systems:
  - 1) Basis of Design: PERMAPIPE "Steel Polytherm" with expansion ells, tees and loops as specified.

## 2.02 VALVES

### A. General:

- 1. Single Manufacturer: Unless otherwise indicated by bases of design, provide valves of same manufacturer throughout where possible. Manufacturer's name and pressure rating shall be clearly marked on the outside of the valve body.
- 2. Confirm Appropriate Valves/Ratings: It shall be the Contractor's responsibility to verify prior to submittal or purchase that all valves to be used are appropriate for the piping systems, equipment, and pressures involved. Obtain clarification/direction from Architect/Engineer should any such questions arise from the Contractor, or from manufacturers of valves, piping systems, or equipment.
- 3. Neck Extensions: Provide valves with extended round stems/necks where valves are installed in piping to be insulated. Valves not so provided shall be replaced at Contractor's expense.

- a. Stem/neck extensions for chilled water, and any other systems subject to condensation, must permit operation of the valve without damage to or compromise of the insulation/vapor barrier system.
  4. Size Ranges: Size ranges indicated for valve selections are guidelines only. Contractor may substitute valve types specified for 2-1/2 inches and larger for 2 inch valve types if desired or required due to field conditions.
  5. Isolation Valves: Unless otherwise indicated, valves for shut-off or isolating service shall be gate, butterfly, or ball valves. Gate valves shall be limited to small valves used for pressure taps, air vents, blowdown valves, drain valves, and similar applications.
  6. Throttling Valves: Unless otherwise indicated, valves for throttling/balancing service shall be globe, ball, or butterfly valves.
  7. Chain Operators: For valves 3" and larger located ten feet (10') and higher (to pipe centerline) above floor, mezzanine, or service platform, install valve operator shaft in vertical up position and provide chain operators and related gear and wheel operator and other hardware/accessories.
  8. Acceptable manufacturers
    - a. Nibco
    - b. Crane
    - c. Stockham
    - d. Walworth
    - e. DeZurik
    - f. Mission
    - g. Milwaukee
    - h. Watts
    - i. Mueller
    - j. Kunkle (pressure relief, pressure/temperature relief)
    - k. Sporlan (refrigeration)
    - l. Equipment manufacturer (refrigeration)
- B. Gate Valves
1. Sizes 2 inches and below: Class 125 bronze, rising stem, screw-in bonnet, solid wedge, threaded. NIBCO T-111 or approved equal.



2. Sizes 2-1/2 inches and larger in non-potable systems: Class 125, iron body, bronze trim, OS&Y, bolted bonnet, solid wedge, flanged. NIBCO F-617-0 or approved equal. (Install with dielectric flange kit in copper piping systems.)
- C. Globe and Angle Valves
1. Sizes 2 inches and below: Class 125, bronze, screw-in bonnet, integral seat, renewable disc, threaded. NIBCO T-211 (globe), NIBCO T-311 (angle), or approved equal.
  2. Sizes 2-1/2 inches and larger in non-potable systems: Class 125, iron body, bronze trim, OS&Y, bolted bonnet, renewable seat and discs, flanged. NIBCO F-718-B (globe), F-818-B (angle), or approved equal. (Install with dielectric flange kit in copper piping systems.)
- D. Ball Valves (Above Grade)
1. Basis of Design/Basis of Cost Proposal: Bronze Body and stainless steel trim, sizes 1/4" to 2-1/2": Three piece bronze body, blowout proof stem. 316 stainless steel trim, full port, TFE seat rings, fluorocarbon rubber (Viton)-O-Rings, threaded, 600 PSI non-shock cold working pressure. For chilled water service, provide NIBCO T-595-Y-66-SS (to include SS nuts/bolts/handle) or approved equal. For all other services, provide NIBCO T-595-Y-66 or approved equal. See also "accessories" below.
  2. Voluntary Alternate Candidate: Bronze body and trim, sizes 1/4" to 2": Three piece bronze body, blowout proof stem, bronze trim, full port, TFE seat ring, fluorocarbon rubber (Viton)-O-rings, threaded. NIBCO T-595-Y or approved equal. See also "accessories" below.
  3. Accessories/features:
    - a. In chilled water and other systems subject to condensation, provide with "NS" Nibseal insulated and vapor barriered neck extensions which allow valve operation without damaging or breaking vapor seal/insulation system.
    - b. In insulated piping systems not subject to condensation, provide with "NS" Nibseal insulated and vapor barriered neck extensions which allow valve operation without damaging or breaking vapor seal/insulation system (limited to service temperatures of 250°F), or; "EL" extended lever option with round neck/lever extension to beyond the piping insulation.
    - c. In addition, provide "memory" stop feature with cast-in valve body stops, pre-tapped handle, screw, and memory lever/plate for ball valves at fan coils, air handlers, control valve bypass lines, and other areas where ball valves are subject to be used for balancing.
- E. Ball Valves for Below Grade Installation
1. One piece body with closed bottom design. Tee head integral to plug. F.I.P. threads both ends. 360-degree rotation. O-ring sealed design with top and port O-rings. Constructed of 85-5-5-5 ASTM B62 brass. Manufactured and tested to

ANSI/AWWA C800 standard. Mueller B-20283 with brass lever handle or approved equal. Sizes 3/4" to 2."

F. Butterfly Valves

1. Chilled Water Systems: Sizes 2-1/2 inches and above: lug type, ductile iron body, extended neck, molded-in EPDM liner, aluminum bronze disk, 416SS stem, brass bushings. Pressure rating 200 PSI (2"-12") and 150 PSI (14"-24") Basis of Design: NIBCO Series LD-2000.
  - a. Install with dielectric insulating flange kit in copper piping systems or where connecting to stainless steel components.
  - b. Exception to Basis of Design: 2-1/2" and larger isolation/flow-setting valves at chilled and heating water coils shall be butterfly valves where indicated by drawing details.
2. Heating Water Systems up to 200F: Sizes 2-1/2 inches and above: lug type, ductile iron body, extended neck, molded-in EPDM liner, aluminum bronze disk, 416 SS stem, brass bushings. Pressure rating 200 PSI (2"-12") and 150 PSI (14"-24") Basis of Design: NIBCO Series LD-2000.
  - a. Install with dielectric flange kit in copper piping system or where connecting to stainless steel components.
  - b. Exception to Basis of Design: 2-1/2" and larger isolation/flow-setting valves at chilled and heating water coils shall be butterfly valves where indicated by drawing details.
3. Lever/Wheel Operators: Provide valves 2-1/2" and smaller with lever operator. Provide valves 3" and larger with gear and wheel operator. (Coordinate also with controls for automatic valves provided with controls operator.)
  - a. Refer to 2.02.A for chain operator requirements.
4. Neck extensions shall be designed for and installed to accomplish vapor barrier condition where used in chilled water systems.

G. Check Valves

1. Sizes 2 inches and below: Class 125, bronze, horizontal swing, Y pattern, renewable disc, threaded. Basis of design NIBCO T-413.
2. Sizes 2-1/2 inches and larger:
  - a. Basis of Design/Basis of Cost Proposal: Class 125, iron body, bronze trim, horizontal swing, bolted bonnet, renewable seat and disc, flanged. Basis of Design: NIBCO F-918-B.
    - 1) Exception: Check valves in systems having parallel pumps or primary/secondary pumping shall be non-slam (silent) disc type with lug body, similar and equal to 'b' immediately below.

- b. Where indicated in exception of 'a' above, or where required due to field conditions and available space (and so accepted by Architect/Engineer): Class 125 twin disc lug style, non-slam, aluminum bronze disc, Buna-N seat. Install with dielectric flange kit in copper piping systems. Bases of Design: NIBCO W-920-W or Mission Duo-check.

#### H. Relief Valves

1. General: Provide approved pressure or pressure/temperature relief valves at all heating equipment and pertinent vessels, including but not limited to:
  - a. water heaters;
  - b. expansion/compression tanks;
  - c. others as indicated by drawings required by pertinent codes, or recommended by manufacturer.
2. Pressure/Temperature (P/T) relief valves: Basis of Design: ASME Rated and equal to Watts series 40, 140, N240, and 340 (dependent upon size required). Provide at all:
  - a. domestic water heaters;
3. Pressure relief valves for water service: Basis of Design: Adjustable type equal to Kunkle Figure 171 (1/2" through 2") or Figure 191-1 (2-1/2" through 6"). Provide at:
  - a. expansion/compression tanks, etc.
  - b. Alternatively, Contractor may, at its option, provide non-adjustable relief valves, provided the relief valve is replaced at Contractor's expense should adjustment become necessary.
4. Discharge Piping: Pipe all relief valves to suitable reception. Pipe relief valves serving systems potentially in excess of 100 degrees F. to outside the building and turn down to prevent injury from discharge, or to other locations if indicated by drawings. Verify location on site with Architect/Engineer. Obtain permission from Architect/Engineer prior to piping discharge of high temperature (>140F) relief inside building.

### 2.03 PIPING ACCESSORIES AND SPECIALTIES

#### A. Flow Measuring Stations (FMS)

1. Flow Measuring and Setting Valve Assemblies
  - a. Applications
    - 1) For heat transfer equipment served by piping up to 4", valved individual flow measurement assemblies on entering side (normal fully open) and flow setting valves on the leaving side (adjusted for flows).

- 2) For heat transfer equipment served by piping larger than 4": Use venturi FMS or magmeter FMS for pipe sizes above 4", and where otherwise indicated.

b. General

- 1) Flow devices shall be Venturi type.
- 2) Devices shall have a precision-machined throat and have a stated catalog accuracy of 3% of full scale at the particular flow range.
- 3) The gauge reading (flow signal) shall be at least two feet at the design flow with the valve in the wide-open position.
- 4) The valves shall have extended length differential readout ports fitted with check valve and color-coded protective caps.
- 5) Valve assemblies shall have an extended check and a memory stop to allow complete shut-off and return to set position without losing the set-point. Memory stop shall incorporate cast-in stops/wings in the valve body.
- 6) The permanent pressure loss added to the pump head shall not exceed two feet, per device, at the design GPM in the wide-open position.

c. Flow Measuring Valves

- 1) For sizes 2" and below: 600 psig at 250°F rated full port ball valve with bronze body, plated ball, Teflon seats and full-sized and heavy-duty steel handle with extended neck and vinyl grip. The venturi section of the valve shall be designed with the ball section and sized for maximum flow accuracy and pressure recovery over a wide range of flow measurement conditions. The valve accuracy shall be obtained with no provision for external clearances. The required clearances shall be contained entirely within the valve body. Valves shall also contain a ground-joint union especially designed for minimum turbulence and to allow for full service. Basis of Design: FDI Flowset Type "UA." Alternate acceptable manufacturer Pro Hydronics or equal.
  - a) Straight upstream/downstream diameters: though measurement accuracy of flow metering does not require straight upstream diameters in certain conditions (e.g., no pipe size changes between valve and fittings on either side), the installation guideline under this specification shall be to provide five (5) upstream and two (2) downstream pipe diameters at the valve.
- 2) For sizes 2-1/2" and above: flow measuring valve assemblies shall consist of a 240 psig at 250°F rated venturi section with 150-pound flanged steel connections and a cast iron full lug butterfly valve with EPDM seat, 416 ss stem, bronze sleeve bearing and

bronze disk on the downstream side. Basis of Design: FDI Flowset Type AF installed with flanges. Alternate acceptable manufacturer Pro Hydronics or equal.

- a) Straight upstream/downstream diameters: A minimum of six pipe diameters upstream and two pipe diameters downstream straight run shall be provided for valve assembly.
- 3) The flow measuring valves shall be used for shut-off, but shall not, under this specification, be used for balancing/throttling. Flow measuring valves shall be normally (wide) open.
- d. Flow Setting Valves
- 1) For sizes 2" and below: 600 psig at 250°F rated bronze body ball valve assembly with a plated ball and viton seats. This valve shall be equipped with a full-size handle with extended neck, vinyl grip, and external lockable memory stop for setting desired flow. The valve shall also contain a ground-joint union for service. Basis of Design: FDI Flowset Type UB. Alternate acceptable manufacturer Pro Hydronics or equal.
  - 2) For sizes 2-1/2" and above: Flow setting valve shall be flanged lug style butterfly valve in accordance with subsection 2.02 above (exception: provide with lever operator). Provide extended length dual core pressure/temperature ports with color-coded safety cap assemblies on retainers. Ports may be field installed or provided as part of an accessory flange kit. Basis of Design: Reference 2.02 above. Provide with FDI Flowset Model FA accessory flange. Alternate acceptable manufacturer Pro Hydronics.
- e. Other Accessories
- 1) Union connections: Provide union connections on both ends to facilitate piping system service and valves replacement.
  - 2) Tags: Manufacturer shall provide permanent equipment tag with each measuring valve indicating the equipment with which it is paired (e.g., terminal unit, AHU coil, etc.). For the particular size and model of valve, tag shall include a performance tag with either a mathematical formula relating gpm and venturi pressure tap readings or a calibration curve showing gpm vs. venturi pressure tap readings (separate equipment and performance tags are acceptable).
    - a) Tags shall be durable, produced to endure 20 years in an outdoor environment and remaining fully legible thereafter. Means of permanent attachment to valve handle (or piping) shall be provided (e.g., chain, cable, etc.).

- b) Intent of these requirements is to ensure the flow characteristics of the specific measuring valve are permanently attached and available for long-term use.
- 3) Molded insulation covers: where valves are used in chilled water service, provide pre-cut/pre-molded vapor insulation sleeves to clamshell or otherwise encompass the valve, allowing access to the test ports and handles and preventing condensation on valve ports. Where not provided by valve manufacturers, obtain pre-molded insulation cover from separate manufacturer of custom pre-molded insulation products. **Submit insulation cover with valves submittal.**
- 4) For all flanged piping connections installed on flow measurement/setting devices for chilled water service (or other condensing temperature piping systems), provide stainless steel nuts, washers, and bolts with anti-seize thread compound.
- f. Acceptable Manufacturers:
  - 1) Basis of Design: Flowset
  - 2) Alternate acceptable manufacturer: Pro Hydraulics
  - 3) Combination measurement and balancing not permitted: The use of a single assembly by any manufacturer to adjust the flow and measure the flow at the same valve/assembly shall not be allowed under this specification.
- 2. In-line indirect reading Venturi type flow meters:
  - a. Provide venturi-type flow measuring stations (FMS): in piping serving coils and similar transfer equipment where indicated by drawings and where pipe size exceeds 4"; and in piping serving central equipment and main supply/return piping (e.g., at pumps and at mains/branches where indicated by drawings).
  - b. Gerand Style VS, VW-F, (V-GE, grooved, where grooved pipe is allowed), similar by Preso, Flowset or approved equal. Accuracy  $\pm 1\%$  of actual flow.
  - c. For piping sizes up to 2-1/2", Series VS bronze with threaded (female) ends. Pressure/temperature ratings of 250 psig/250F. Install with full port union minimum of three pipe diameters downstream of venturi.
  - d. For piping sizes 3" and greater, Series VW-F (or V-GE where in grooved system) steel with flanged ends to match piping system/flange pressure ratings. Temperature rating of 250°F.
  - e. Wherever possible, size venturi "beta" factor to provide 20" to 50" W.C. differential pressure at design flow. In no case shall head loss through venturi exceed one-foot W.C.

- f. Provide with fittings kit (stainless steel nipples, ball valves, quick connect coupling, etc.) suitable for pressures and temperatures to be encountered. Provide with permanently attached and permanently reading tag showing specific model with its meter calibration flow/differential pressure. Said tag shall be durable, produced to last 20 years in an outdoor environment and remaining fully legible thereafter.
  - g. Maintain a minimum of six (6) pipe diameters upstream and three (3) pipe diameters downstream from any fitting, valve, instrument tap, etc.
  - h. Install with instrument taps between the horizontal and a 45 degree down position in horizontal piping installations. Avoid installing at top or bottom of horizontal pipes where air or debris, respectively, can cause incorrect readings.
  - i. Provide with integral analog/dial flow meter calibrated for the particular venturi. Locate meter as indicated on drawings, or confer with Architect/Engineer to verify meter location.
  - j. Provide valves (full port ball valves or butterfly valves wherever possible) to allow the venturi to be removed for service with shut down only to the particular equipment being served by the venturi (i.e., shutdown/disturbance to other parts of system shall not be required/allowed).
  - k. **Submit summary tabular data showing** equipment served, design flow, pipe size, venturi selection/"beta" factor, differential pressure curves vs. flow, permanent head loss (at design flow), fittings kits, flow meter, and pressure/temperature ratings. **Also submit complete data on models**, calibration curves, etc., referenced to the tabular summary. Venturis shall be factory calibrated for the nominal fluid temperatures in the system.
3. Electromagnetic Flow Meter (Magmeter)
- a. Provide line sized magmeter FMSs as indicated by drawings. Installation shall be complete with all accessories for a working assembly compatible with and connected to the Building Automation System.
    - 1) Institutional/commercial applications:
      - a) Basis of Design: Rosemont Series 8705 Magnetic Flow Meter Flow Tube with Rosemont 8712 E Remote Mount Magnetic Flow Meter Transmitter.
      - b) Other acceptable manufacturer: Yokogawa AXF Magnetic Flow Meter with AXFA11G Magnetic Remote Converter
    - 2) Coordinate also with Section 23 09 51 – Controls and Instrumentation, Part 2, and ensure products used in metering applications also comply with specifications therein for Flow Monitoring Stations – Water.

- b. Overview: Electromagnetic (mag) flowmeter shall provide non-intrusive flow measurement in conductive fluid or slurry. Meter shall be unaffected by density, temperature, pressure, or viscosity changes, and shall provide accurate and reliable long term metering. The state of art microprocessor signal converter produces flow accuracies of +/- 0.25%. Provide liner, electrode and flange materials as indicated below and as appropriate for the intended service.
- c. Operation: Flow meter shall use stainless steel flow tube lined with a nonconductive material. Two intrinsically safe DC powered electromagnetic coils are attached to the outside of the flow tube. The coils diametrically oppose each other. Two electrodes are located in the flow tube on an axis perpendicular to that of the coils. When the coils are energized, a magnetic field is created across the pipe diameter. As a conductive fluid flows through this magnetic field, a voltage is induced across the electrodes. Processed digitally by the amplifier, this induced voltage produces a very accurate signal.
- d. Materials and Features:
  - 1) Spool Housing: Welded carbon steel
  - 2) Pipe Spool: 316 stainless steel
  - 3) Flanges: Carbon steel
  - 4) Liner: PTFE or Halar for heating water applications; PTFE, Halar, or hard rubber for domestic water, and chilled water applications
  - 5) Grounding ring/electrode (where required for non-conductive piping systems or the particular application): 316 stainless steel
  - 6) Flow Range: 0.1 to 39.0 feet per second
  - 7) Flow Direction: unidirectional or bi-directional
  - 8) Accuracy: +/- 0.25% of actual for velocities of 0.1 to 40 feet per second.
  - 9) Amplifier: Unless otherwise indicated, remote amplifier/readout system for installation up to 100 feet from flow tube.
  - 10) BAS interface: Provide BAS interface and connection so that meter output is compatible with respective BAS manufacturer and system.
  - 11) BAS system analog inputs.
- e. Installation: Install in strict accordance with manufacturer's written instructions and other manufacturer recommendations which might apply to the respective application. Install in full flow conditions whether horizontal, or vertical, or sloped pipes. Do not install where pipes are subject to being partially filled (e.g., with air at the top).



4. In-line direct reading flow meter:
  - a. Provide for filter feeder assemblies and at other places indicated by drawings, including but not limited to: chilled and heating water system filter-feeders.
  - b. Size for design flow equaling approximately 75% of maximum range on flow meter.
  - c. Provide piping reducers as needed to accommodate flow meter/accuracy sizes and line pipe sizes. Install with upward flow and with nearby shut-off full port ball valves to isolate for maintenance.
  - d. Provide protective clamshell pipe shield with latching provisions to protect from physical damage. Internally insulate shield with 3/8" thick Armaflex II in chilled water systems. Leave uninsulated in heating water systems.
  - e. Basis of design: Hedland EZ-View Flow Meter with Radel® R plastic body; polysulfone piston and cone, T300-series stainless spring, Buna N flow indicator ring and pressure seals, C360 Brass or PVC fittings, Polypropylene limit indicators. Temperature Range 32°F to 250°F. Pressure rating 325 psi max. Accuracy 5% of full scale.
  - f. **Submit data showing gpm, service temperatures/pressures, and models along with flow ranges.**
  
- B. Unions
  1. Locations: Provide at piping connections on each side of all equipment, valves, where needed for convenient and easy removal of piping sections around equipment and valves, and at other points where shown on the Drawings.
  2. Unions in steel piping systems scoped in this Section shall be flanged or 150 pound malleable iron with ground bronze seat. Unions in copper piping systems shall be all bronze.
  3. Exceptions: Unions shall not be required on both sides of threaded isolation valves where a single union (or true union valve) permits convenient removal of the equipment or appurtenance the valve serves.
  4. Unions joining dissimilar metal piping systems (e.g., carbon steel and copper, carbon steel and stainless steel): Provide dielectric unions per "E" below.
  
- C. Flanges and Flange Gaskets
  1. Flanges in steel piping systems shall be steel weld neck, ASTM A105, ASME B16.5, 150 psi, flat or raised face as required (to match adjacent valve, equipment, etc.). Bolts shall be high strength steel ASTM A193, Class 2, Grade B8. Nuts shall be ASTM A194.
  2. Flanges in copper piping systems shall be Class 150 cast copper alloy companion flange with flat face. Bolts shall be high strength steel ASTM A193, Class 2, Grade

B8. Nuts shall be ASTM A194. Torque according to manufacturer's written instructions.

3. Flange gaskets shall be full faced, sealing gasket, 1/8" thick, with G-10 retainer and precision tapered groove for pressure energized EPDM quad-ring sealing element for controlled compression. Inside diameter of the retainer is to be 1/8" less than I.D. of flange and able to mate with mixture of flat face and/or raised face flanges.

D. Dielectric Connections:

1. Provide Dielectric isolation between dissimilar metal piping, including but not limited to: carbon steel and copper, carbon steel and stainless steel, galvanized steel and copper. (NOTE: Brass/bronze valves shall not be acceptable for dielectric isolation under this specification.)
  - a. Unions: Dielectric unions for piping shall be rated for temperature of 180 deg. F and pressure at 250 PSI. Basis of design: Watts Series LF3001A.
  - b. Nipples: Dielectric nipples for piping shall be rated for temperature of 220°F and pressure to 300 psig. Basis of Design: Elster Perfection Corp. Clearflow dielectric waterway.
  - c. Two-inch connections may be either dielectric union or isolating flange as required.
  - d. Two and one-half inch and larger connections shall incorporate isolating flange kits. Flanges in copper pipe system shall consist of Class 150 cast copper alloy companion flange with flat face (Nibco Fig. 771). Flanges for other piping system materials shall match the piping material of the system (i.e., black steel, galvanized steel, 316L stainless steel, etc.).
    - 1) Flange isolation kit shall consist of: Full faced isolating and sealing gasket, 1/8" thick, with G-10 retainer and precision tapered groove for pressure energized PTFE quad-ring sealing element for controlled compression. Retainer shall have a 550 volts/mil dielectric strength and minimum compressive strength of 50,000 psi. Inside diameter of the retainer is to be 1/8" less than I.D. of flange and able to mate with mixture of flat face and/or raised face flanges).
    - 2) Insulating sleeves: Full length G-10 insulating sleeve for each flange bolt (sleeve approximately 1/32" thick tube, 4000 volts/mil dielectric strength; water absorption 0.1% or less);
    - 3) Isolating washers: Two 1/8" thick, G-10 isolating washers for each bolt. Their compression strength shall be 50,000 psi; dielectric strength 550 volts/mil; water absorption 1.0% or less) and two 1/8" thick steel washers for each bolt (stainless or galvanized). Inside diameter of all washers shall fit over the isolating sleeve. Inside and outside diameter of steel and isolating washers shall be the same.

- 4) All materials shall be compatible for pipes containing water up to 280-degree °F and a minimum working pressure of 200 psi.
  - 5) Basis of Design: Pipeline Seal and Insulator, Inc. Linebacker flange isolation kit with Type "E" gasket.
- E. Escutcheon Plates: Provide chrome plated floor, ceiling and wall plates similar and equal to Crane No. 10B and C around all pipes passing through walls, ceilings, and floors in finished or outside areas.
- F. Thermowells
1. Provide thermowells where indicated on the drawings and where temperature measurement is needed for service or troubleshooting. Thermowells shall be matched with thermometers to be used as far as bore and depth. Thermowells shall be sized so that they will penetrate not less than 30 percent nor more than 50 percent of the pipe diameter in which it is installed. Locations for thermowells shall include, but not be limited to:
    - a. main supply and return piping;
    - b. heating and cooling coils, including run-around coils.
  2. Where possible, install thermowells in tee fittings where changes in flow directions occur.
  3. Optional T/P test ports: where allowed by drawings, Contractor may instead provide XL (3" extended length) brass pressure/temperature test ports with integral checks ("Pete's Plugs") for thermowells:
    - a. where required at heating/cooling coils due to small pipe size (1" or below).
    - b. Provide with dual seal core inserts of Nordel, rated 0F to 350F. Test port base/pipe connection size shall be 1/2", except that 1/4" may be substituted for pipe sizes 1" and below.
    - c. In all cases, ensure installation allows for easy insertion and removal of temperature and pressure probes/instrumentation.
- G. Thermometers
1. For thermowells: Unless otherwise indicated by drawings, provide piping thermometers in all thermowells:
    - a. Basis of Design/Basis of Cost Proposal: Digital Light Powered Variable Angle: Separable socket self-powered, 1% of reading accuracy, digital readout, variable angle, -40° to 300° F range, -30°F to 140°F ambient operation at 100% relative humidity, stem length and accessories to accommodate application. Weiss Digital Vari-Angle or equal, or;
    - b. Voluntary Alternate Candidate: Where available ambient light is not sufficient to activate light powered thermometers or as a cost reduction candidate: Liquid filled variable angle: separable socket, liquid (red) filled,

nine inch long, adjustable stem,  $\pm 1\%$  accuracy, similar and equal to Weiss "Vari-Angle." At Contractor's option, where thermowell is compatible, adjustable stem stainless steel bimetal thermometers with 5" dial, recalibrator, and  $\pm 1\%$  accuracy may be substituted; similar and equal to Weiss 5 VBM.

- c. Provide all thermometers with wells, stem lengths, and other accessories as required to accommodate the application.
2. For P/T Plugs: Except at heating/cooling coils and where otherwise not required by drawings, provide piping thermometers for all "Pete's Plugs":
    - a. stainless steel bimetal thermometers, 1 3/4" dial, 0.150" stem, red set pointer, accuracy  $\pm 1/2$  of 1% of reading throughout range, similar and equal to Weiss Model 134. **Verify compatibility with Pete's Plug prior to submittal.**
    - b. Furnish in lockable and nameplated "Maintenance Instruments" cabinets, one per mechanical room, furnished under this section. Cabinet shall be sized as required to accept all maintenance instruments, but not less than 12"W x 18"H x 6"D with two integral shelves. **Submit product and recommended location.**
  3. Easily readable installation: All thermometers shall be installed so that they can be easily and conveniently read from floor. Where bottom or back connected thermometers will satisfy this directive, they may be substituted for variable angle thermometers.
  4. Outdoor protective covers: Provide protective covers/sleeves for all thermometers installed outdoors: Internally insulated Schedule 40 PVC pipe with cap at top, sized to fit closely over thermometer and with bottom "saddle" cut to match contour of (insulated) piping; or as otherwise approved by Architect/Engineer.
  5. Scale range: Excepting Digital Light Powered thermometers, all thermometers shall be suitable for their respective service, and shall be selected for the lowest possible span. Unless otherwise noted, the schedule below shall be used as an approximate guideline, for non-digital thermometers.

Service	Liquid Filled Thermometer Range	Bimetal Range
Chilled Water	0-120F	30-130F
Heating Water	30-240F	0-220F

H. Air Vents

1. Air Vents: Provide air vents at all intermediate or high points subject to air traps in HVAC water piping systems (e.g., chilled and heating water) in mechanical equipment rooms and where piping is accessible above ceilings or is run outside.

2. Manual Air Vents: Manual air vents consisting of an isolation valve with discharge piped to nearest suitable receptor, (e.g., floor drains, service sinks, condensate drain, etc.) shall be installed where indicated by drawings.
3. Connections to Piping: All nipples, couplings, reducers, and piping accessories in black steel piping to extend piping from weld-o-lets or other taps to the air vent isolation valve shall be 304 stainless steel.
4. Locations: Review drawing schematics and/or obtain generic sketch from Architect/Engineer during construction, as required, to verify proper air vent locations.
5. Accessible Locations and Record Documentation: All air vents shall be installed so that they are safely accessible in the finished, occupied condition. **Record drawings/submittals** shall indicate location of all air vents above ceilings, in mechanical rooms, crawlspaces, below grade, etc. Provide access panels if/as required. Review all ceiling access panel locations with Architect/Engineer prior to installation.

I. Pressure Taps and Gauges

1. Taps: Provide gauge taps with isolation valves where indicated on the drawings and where pressure measurement is needed for balancing, service, or troubleshoot. Locations for pressure taps shall include, but not be limited to:
  - a. equipment (e.g., pumps, etc.);
  - b. heat exchange components (e.g., heating and cooling coils, etc.);
  - c. other equipment/locations as may be indicated by drawings or other specification sections.
2. Gauges: Provide pressure gauges where indicated on the drawings. Gauges shall be Bourdon tube type with copper alloy tube, brass tip and socket, 4 1/2" dial face, accuracy  $\pm 1\%$  of full scale, recalibrator feature, glass or polycarbonate lens.
  - a. Basis of Design: Marsh "Quality" Gauges.
3. Snubbers: Pressure taps at all pumps and other locations subject to pulsations shall be installed with integral snubbers at taps (or at gauges).
4. Connections to piping: All nipples, couplings, reducers, and piping accessories in black steel piping to extend piping weld-o-lets or other taps to the pressure tap isolation valve shall be 304 stainless steel.
5. Gauge Ranges: Range of pressure gauges shall be suitable for their respective service, and shall be selected for their lowest possible span.
6. Optional T/P Test Ports: where allowed by drawings, Contractor may instead provide "XL" (3" extended length) brass pressure/temperature test ports with integral checks ("Pete's Plugs") in place of pressure taps, at heating/cooling coils and where otherwise required by field conditions, provided adapters for pressure measurement (with snubbers) are supplied at each location (secure with brass

chain.) Provide with dual seal core inserts of Nordel, rated 0F to 350F. Test Port base/pipe connection size shall be  $\frac{1}{2}$ ", except that  $\frac{1}{4}$ " may be substituted for pipe sizes 1" and below.

Place adapters with snubbers in "Maintenance Instruments" cabinet described in "G" above.

J. Pipe Joint Sealant

1. Joint sealant shall be used for all threaded piping joints. It shall be Teflon tape or non-toxic thread compound suitable for the temperature and fluid service intended.

K. Pipe Penetration Sealing Materials: Non-Rated Penetrations (not requiring fire rating, smoke rating, fire/smoke rating, or smoke resistance):

1. Sealant for pipe penetrations shall be equal to Owens Corning Quietzone Acoustical Sealant. For roof applications, refer to other sections (architectural), and comply with requirements there-in. In event no other Divisions' sections address this condition, "MasterSeal NP-1" is acceptable.
2. Refer also to Part 3 for installation requirements for fire rated and corridor penetrations. Also refer to Part 3 for sleeve requirements.

L. Air/Dirt Separators

1. Provide air/dirt separator(s) as indicated by the drawings. Provide with integral particle capture assembly unless otherwise indicated.
  - a. Air/dirt separators shall be designed to eliminate entrained air and separate suspended particles. The air separator shell shall be of carbon steel and shall include a full diameter flanged removable head/end cover for access to the coalescing medium.
  - b. The coalescing medium shall be stainless steel. The separator shall include a bronze blowdown valve (min. 2"), bronze skim valve, bronze or cast iron air vent.
  - c. The separator shall be constructed in accordance with the latest revision of the ASME Boiler and Pressure Code and stamped for working pressure of 150 PSI working pressure at 250°F.
2. Provide with air vent assembly and full-size blowdown valve, with piping to nearest suitable receptor. Refer also to drawings.
3. Basis of Design: Spirovent VHN "Drain" with oversized blowdown.

M. Strainers

1. Provide strainers at suction side of all pumps
  - a. Exceptions:

- 1) Where strainers integral to air separators or suction diffusers/guides, where allowed).
  2. Provide line-sized strainers at inlet side(s) of all control valves and equipment (e.g., coils) and other places indicated by the drawings.
  3. Unless otherwise indicated, strainers for chilled and heating water service shall be:
    - a. Up through 2":
      - 1) Carbon steel piping systems: Line-sized, high tensile strength cast iron, wye type with #20 mesh stainless steel liner, screwed connections, similar and equal to Watts 77S (250 psig @ 406° F).
      - 2) Copper piping systems: Line-sized, lead-free copper silicone alloy, wye type with #20 mesh stainless steel screen, screwed connections, similar and equal to Watts LF777 (400 psig @ 210° F, 125 psig @ 350° F).
    - b. 2-1/2" through 12": Line-sized, high tensile strength cast iron, wye type strainer with flanged connections, similar and equal to Watts 77F-DI-125 (200 psig @ 210° F). Provide stainless steel screens with 1/8" perforations for sizes up to 8" and 3/16" perforations for sizes above 8". Provide all sizes with 20 mesh start-up liners.
    - c. 14" through 24": Line-sized, cast iron, wye type strainer with flanged connections, similar and equal to Keckley Style A (150 psig @ 150° F). Provide stainless steel screens with 3/16" perforations. Provide all sizes with 20 mesh start-up liners.
  4. Provide accessible blowdown ball or gate valve (as indicated on drawings) at each strainer with discharge piped through union(s) to nearest sanitary floor drain or other suitable receptor approved by Architect/Engineer (to outside the building where directed by the Architect/Engineer).
  5. All nipples, couplings, reducers, and piping accessories to extend the blowdown taps to the valves shall be 304 stainless steel.
- N. Drain Valves for Coils and Equipment
1. Provide drain valves for water coils, tanks, pumps (in piping) and similar equipment/ conditions to enable partial and controlled draining of systems for maintenance. At a minimum, valves shall be: 1/2" for pipe sizes up to 2"; 3/4" for pipe sizes 2-1/2" to 4"; 1" for pipe sizes 5" to 8"; 1-1/2" for pipe sizes above 8".
  2. All nipples, couplings, reducers, and piping accessories in steel piping systems to extend the taps to the valves shall be 304 stainless steel.
- O. Flexible Hoses
1. Pressure Hoses, braided stainless steel bellows type: Provide stainless steel braided hoses where indicated/allowed on drawings for connection of hydronic water piping to equipment.

- a. Size: Hoses shall be full line size, the larger of either piping or equipment connection.
- b. Design and ratings: Hoses shall be of close pitch annular design with 304 stainless steel corrugations (bellows) and with the number of interwoven braids (double at a minimum, or triple) in accordance with the temperature and pressure requirements of the application (at a minimum, 250 psig at 250°F).
- c. Ground connections: Ends shall be of joint types consistent with the equipment and piping configurations, allowing mechanical removal at both ends via threaded connections with a union, via flanged connections, or (where permitted) grooved connections (e.g., avoid welded, brazed, or solder connections).
  - 1) Dielectric protection: where connecting dissimilar metals (e.g., carbon steel and stainless steel), make connections per 2.03.D– Dielectric connections, above.
- d. Connections – steel piping/equipment: Connections to steel piping/equipment shall be male threaded or flanged steel, depending on size. Where flanged on both ends, provide floating flange at piping end.
  - 1) Ends shall be stainless steel material with dielectric protection.
- e. Connections – copper piping/equipment: Connections to copper piping/equipment shall be wrought copper male threads or heavy wall (schedule 80 equivalent) red brass with male threads.
  - 1) Ends shall be as noted immediately above or may be stainless steel without dielectric protection.
- f. Installation, alignment, and offset: Pipe and equipment connections shall be properly, fully, and truly aligned and fitted so that hoses do not offset or sag. Length of hose shall nominally be: 12” for pipe size to 1”; 18” for pipe sizes 1-1/4” to 2”; 24” for 2-1/2” to 4”. If field conditions or manufacturer’s recommendations warrant other lengths consideration, **request same from Architect/Engineer in submittal**.
  - 1) Offsets: unless otherwise indicated, length of hoses shall provide for a minimum of 1” intermittent (greater than 1” permanent) offset in any direction from the aligned final installation condition.
- g. Temporary bypass provisions: Where permitted for coils and similar conditions, arrange hose ends so that supply to return ends may be connected for coil bypass during flushing operations. Provide (temporary) couplings or unions to permit connection to supply and return end hoses.
- h. **Submittal information shall include:** diameters, lengths, connection types, bellows material, braid material, connection material, number of braids (single, double, triple), minimum bend radius, pressure rating at 250°F, offsets, and couplings/unions used for flushing operations.



- i. Acceptable Manufacturers:
    - 1) Basis of Design: Mason-Mercer 304 Stainless Steel Braided Hose, or Metraflex 304 Stainless Steel Braided Hose
  2. Pressure hoses – flushing and other temporary uses during construction: Provide conventional hard rubber wire reinforced suction hose rated for pressure and temperature conditions of the application. Use ends, couplings, adapters, and quick-connects (e.g., camlock) to accommodate field piping.
    - a. For maximum pressures to 150 psig at 75°F, Firequip Tank-Flex, Anchor Rubber Products series TC or T-202, or similar.
    - b. For maximum pressures at 70°F, Anchor Rubber Company Tigerflex H/J/K Series PVC Suction Hose: up to 3” – 60 psig; 4” – 50 psig; 6” – 40 psig.
  3. Blowdown Hoses:
    - a. Application: Typically, above ceiling or otherwise elevated locations (i.e., where hard-piped blowdowns conflict with service/access or where otherwise indicated on drawings) to serve hydronic quick-connections to strainer blowdown valves. Other applications as needed and acceptable to the Engineer.
    - b. EPDM construction, rated from -40 °F to 190°F service, 200 psig service, 1/4” to 2” diameter, red color, eco-brass male/female hose connections, length as required.
    - c. Confer with Engineer for locations where, due to proximity, hoses can serve multiple blowdowns
    - d. Basis of Design: Flexicraft RM2 multipurpose hose, or equal.
- P. Quick Connections
1. Hydronic Systems: Quick connect couplers requiring no tools, style according to size and connections.
- Q. Flexible Connectors:
1. Hydronic Systems: Double sphere, Mason Safeflex SFDEJ, rated for 250°F at 215 psig.
  2. Atmospheric Steam (to 5 psig): Double sphere, Mason Safeflex SFDEJ, rated for 250F @ 5 psig, approved for clean steam produced with pure water (reverse osmosis, RO).
  3. Provide with control rods to limit expansion/contraction to manufacturer's recommendations.

## 2.04 EXPANSION, CONTRACTION, AND OTHER MOVEMENT COMPENSATION

- A. General: Provide compensation for movement for all piping systems, including, but not limited to: heating water, chilled water, and domestic water. Such compensation shall be by means of suitable expansion loops or offsets.
1. Alternatively, factory in-line "expansion joints" or braided stainless steel flexible hoses per 2.03.O.1 manufactured for the system(s) involved may be used where indicated by the drawings or required by field conditions and acceptable to the Engineer.
  2. Where indicated on drawings, provide in-line "expansion joints" equal to Hyspan Series 3500 with drain port.
  3. Where indicated by the drawings, provide pressure hoses in accordance with 2.03.O.2. above.
- B. Intervals: At a minimum, such expansion compensation shall be provided at the following conditions:
1. Piping services with design temperatures less than 100°F (e.g., chilled water, domestic cold water): 100-foot intervals
  2. Piping services with design temperatures above 100°F and less than 250°F (e.g., heating water, domestic hot water): 75-foot intervals
  3. At all building expansion joints
  4. Where indicated by drawings
  5. **Provide submittal for any proposed in-line expansion joints and all flexible pressure hoses.**
  6. Refer also to Part 3 below.

## 2.05 HANGERS, SUPPORTS AND ANCHORS

- A. Hangers and Supports - General:
1. Interior supports/hangers: Hangers, supports, and anchors shall be of iron or steel consisting of angles, channels, "Unistrut", "I" beams, tubing (rectangular and/or round), rods, rings or clamps attached to the building structure utilizing metal clamps and inserts manufactured for that purpose. Attachments to structure shall be made to provide uniform loading (i.e. avoiding large point loading).  
  
All supports shall be hot dipped galvanized, zinc plated, or epoxy coated.
  2. Exterior Supports/Hangers/Steel (including roofs and crawlspaces):
    - a. Where steel, hanger, or stanchion supports are installed outside, the steel, hanger rods, nuts, washers, and hangers shall be hot dipped galvanized.
    - b. Any miscellaneous exposed steel outside shall be painted with a minimum of one coat of industrial rust-inhibiting primer (minimum 92% zinc content).

- c. Apply two coats of cold galvanizing applied to field joints, cuts, etc.
  3. See Drawings and other specifications sections for special details and/or additional information. Coordinate with General Contractor/Construction Manager for joists and other members reinforcement that may be needed prior to installation of systems.
  4. Wire or perforated tape/strap shall not be used in the hanger system.
  5. Where supports are in direct contact with copper pipe, the supports shall be epoxy coated "Copper-Gard" or shall have thermoplastic elastomer cushions. Copper clad steel supports, hangers, brackets, etc. in contact with copper pipe are not acceptable.
- B. Equipment, Tanks, Pipes, Ducts, and Similar System Components
  1. Steel Building Structures:
    - a. General: Where supporting equipment, tanks, etc. from steel building structures, support such using minimum of 2" x 2" x 3/8" angle steel spanning a minimum of three (3) joists or purlins (or two beams) to distribute load, thereby avoiding concentrated loads. Small ductwork and piping shall be similarly supported except that spanning two joists/purlins may be acceptable for single runs of ductwork/piping if approved by the Architect/Structural Engineer. Span additional members and/or increase angle, channel or wide flange steel forms sizes as needed for the particular conditions/weights involved.
    - b. Specific conditions: See Drawings and other specifications sections for special details and/or additional information. Coordinate with General Contractor/Construction Manager and Architect/Structural Engineer for joists and other members reinforcement that may be needed prior to installation of systems.
    - c. Special conditions: Obtain on-site approval of the special conditions/approach from Architect/Engineer prior to supporting equipment, duct, and piping.
  2. Supports from new concrete members: Supports shall be via single inserts or "Unistrut" Channel inserts embedded into the concrete: for all pipe runs 6" and larger; for all multiple pipe runs; and for all duct runs with any duct 18" and larger in any dimension.
    - a. Unless field conditions do not permit, place inserts in beams or joists, avoiding inserts in "pans" where only slab occurs. Unistrut channel inserts shall be used to span beams or joists.
    - b. Drilled anchors shall be in accordance with the particular loads (including dynamic/vibration loads), and be in accordance with requirements of the Structural Engineer.
    - c. **Submit insert and drilled anchor products and intended applications.**

d. Exploded anchors shall not be acceptable in any case.

C. Piping Systems Anchors

1. For piping systems anchors, provide connections to, extensions to, braces to, and/or spans to suitable structural members for the particular anchoring conditions/needs. Coordinate closely with General Construction trades and Architect/Engineer. Where welding to building structural members is required, said welding shall be performed by Welders licensed for that application and supervised by the general contractor/construction manager.
2. **Submit shop drawings, product data, field sketches, and/or other information for Architect/Engineer review.**

D. Roof supports guidelines: Unless otherwise indicated by drawings, piping/conduits supports on roofs shall provide for minimum of: 18" clearance between underside of finished piping and roof where four or more pipes are routed together; 12" clearance between underside of finished piping and roof where two or three pipes are routed together; 6" clearance between underside of finished piping and roof where single pipe is routed above.

1. Exceptions: 18" and 12" clearances described above do not apply to condensate/drainage piping where such clearances cannot be maintained and still achieve drainage.

E. Adjustable chair supports: Outside (including on roofs) and for piping 4" and larger, provide adjustable chair roller type supports unless otherwise specified or indicated.

F. Adjustable spring type hangers/isolators. Provide where indicated by drawings and where described below. Select/adjust springs to permit plus or minus 2 inches deflection from installed condition. Where piping systems are sloped, maintain the slope throughout the deflection range.

1. At the three piping supports closest to each pump (suction and discharge)
2. At the four piping supports where piping enters building from below grade conditions, and
3. Where piping offsets vertically from one floor level to another.
4. Basis of Design: Mason Type HES or equal.

G. Hanger and Anchor Steel: The Contractor shall furnish and install all necessary steel framing required to support hangers and to construct/brace anchors. Trapeze hanger members shall be selected for a maximum deflection of 0.05" from the unloaded condition to the maximum operating load condition.

H. Hanger Rod Diameter and Spacing: Refer to Part 3 - Execution, below.

2.06 IDENTIFICATION

A. Provide laminated three-layer plastic with engraved black letters on light contrasting background color for all major pieces of equipment, control cabinets, terminal boxes,

thermostats, fire/fire-smoke dampers, etc. Nameplates installed outdoors shall be suitable for that service.

- B. Valve Tags: Provide brass or aluminum tags with stamped numbers (valve numbers) and letters (valve function). Tag size to be minimum 1-1/2 inch diameter with smooth edges. Submit. **Submitted Record Drawings shall show locations, numbers, and function of all valves.** Refer also to Part 3 for valve function abbreviations to be included in valve tags. Provide valve tags for:

1. All valves over 1/2" in size.
2. All control valves, balancing valves, shut-off valves, and similar items of any size.

C. Pipe Markers

1. Plastic Tape Pipe Markers: Flexible vinyl film tape with pressure sensitive adhesive backing and printed markings. Length and letter size to conform to stencils alternate below. Marking to convey fluid and direction of flow. Approved manufacturers: W.H. Brady Company, 3M, Seton, or equal approved by Architect/Engineer.
2. Only stenciled/painted markers shall be allowed outdoors unless the plastic markers are demonstrated to be durably suitable for that service (adhesion, fading, cracking, etc.). Where plastic markers are accepted for outside service, provide clear protective coating recommended by manufacturer.
3. Stenciled/Painted Pipe Markers: Use gloss enamel paint with clean-cut symbols.

D. Identification Size:

Outside Dimension of Insulation/Pipe and Ductwork/Equipment	Length of Color Field	Size of Letters
3/4" - 1-1/4"	8"	1/2"
1-1/2" - 2"	8"	3/4"
2-1/2" - 6"	12"	1-1/4"
8" - 10"	24"	2-1/2"
Over 10"	32"	3-1/2"
Ductwork and Equipment	--	1-1/2"

- E. Underground Plastic Pipe Markers (Water, Hydronic HVAC Systems, Sanitary, Storm, and All Plastic/FRP Piping): Provide bright colored continuously printed plastic ribbon tape with tracer wire for metal detection. Ribbon shall be not less than six (6) inches wide by minimum four (4) mil thick and shall be manufactured for direct burial service.
- F. Streamers: Provide to assist in locating above ceiling and otherwise elevated components subject to service/maintenance needs. Refer also to 3.08 below for examples of locations/components.
1. Provide 2" wide nylon colored ribbon streamers as indicated in Part 3. Color shall be red for heating systems, blue for cooling systems, red-white for domestic hot

water, blue-white for domestic cold water. Other consistent color codings are also acceptable.

2. Length of streamers shall be as required to drop to a height of 9' AFF. Trim bottom as required for higher ceilings.
3. Coordinate with ductwork trades to provide different color codes for piping and air systems.

## 2.07 VIBRATION ISOLATION

- A. Comprehensive requirement: Provide for vibration isolation for all rotating or reciprocating pieces of equipment, and all other equipment/piping subject to initiating or transmitting vibration. Vibration isolation shall be as indicated by the drawings, as specified in other sections of these specifications, and/or as recommended by the manufacturer of the particular equipment.
  1. Exception: Where manufacturer recommends installation without external vibration isolation features.
- B. Example locations: Vibration isolation shall include, but not necessarily be limited to:
  1. equipment inertia bases or isolators to prevent transmission of vibration or noise to the structure;
  2. duct isolation/flex connections to prevent transmission of vibration or noise to duct systems;
  3. axial/seismic restraints to contain range of equipment movement;
  4. and piping isolators/flex connectors to prevent transmission of vibration or noise to piping systems.
- C. Refer also to Section 23 00 10 - General Requirements for Mechanical Work.

## 2.08 ACCESS PANELS

- A. Products
  1. Access panels shall be as specified in Architectural Divisions. Access panels provided under this Division shall equal those provided under Architectural Divisions. Where access panel(s) are not specified in Architectural Divisions, access panels shall meet specifications herein.
  2. Unless otherwise indicated by Architectural specifications (refer to '1' above), panels in ceilings shall be of flanged steel construction, with continuous hinge, and quarter turn screw locks, installed flush with adjacent surfaces and painted to match. Unless otherwise indicated, panel shall be sized and located for easy access to and replacement of equipment, but not less than 24" x 24".
  3. Unless otherwise indicated by Architectural specifications (refer to '1' above), panels in walls and partitions shall be of flanged satin finish stainless steel construction, with continuous hinge, and quarter turn screw locks, installed flush

with adjacent surfaces. Unless otherwise indicated, size of access panel shall be suitable for access to AND replacement of equipment, but not less than 12" x 12".

4. Where access panels are provided in fire rated walls, partitions, floors, or ceilings, they shall be listed and approved for the equivalent fire protection rating. (Refer also to Architectural drawings for locations of such rated members.)
5. Painting: Paint steel access panels and cure in open position so frame and panel are not "stuck" together. Obtain color selection from Architect to match surrounding finish.

B. Locations of Access Panels Provided Under Division 23

1. Refer also to Architectural drawings for access panels provided by other Divisions, and coordinate bidding and installation accordingly. Access panels not indicated in Architectural drawings shall be provided under this section.
2. At a minimum, provide access panels where required by codes and for maintenance or service. Access panels shall be provided for the following elements where they are "behind" inaccessible construction (e.g., above gypsum, plaster, or similar ceilings; behind gypsum, plaster, CMU, or similar walls/partitions):
  - a. fire and smoke dampers;
  - b. smoke and heat detectors;
  - c. manual or automatic dampers;
  - d. valves;
  - e. controls equipment, devices, and instrumentation;
  - f. equipment; automatic or manual air vents;
  - g. and other items requiring access for service or inspection.
3. Also provide access panels with enclosed interiors (access boxes) where needed or where indicated by the drawings.

2.09 EQUIPMENT PADS/SUPPORTS

A. Equipment Pads

1. Unless otherwise indicated, housekeeping and other equipment pads and supports shall be provided under this section.
  - a. Interior Pads:
    - 1) Material: Interior pads shall be constructed of reinforced 3,000 psi concrete having the following reinforcing steel: No. 4 rebar around perimeter and at pad diagonals, and 4" x 4" 6 gauge welded wire

framework for entire pad. Grout/seal all interior pads prior to setting equipment. For pad thickness, see below.

- 2) Minimum thickness: for equipment without drain piping – 3-1/2”.
  - 3) Minimum thickness: for equipment with condensate or other drain piping – increase pad height as required (minimum 5-1/2” thick) for proper installation of drain trap and/or sloped piping.
  - 4) For extensions to existing housekeeping pads, match existing pad height unless noted otherwise on drawings.
2. Chamfer edges of pads and fill all voids with grout to a smooth finish.
  3. Increase the above minimum requirements as needed for the particular size, weight, installation requirements (including depths of condensate drain traps), etc., of the equipment. Refer also to drawings and particular equipment specifications sections.
  4. Coordinate bidding/proposal and execution with Prime Contractor for pads/supports provided by other Divisions/trades.

B. Equipment Supports

1. Where required by drawings or field conditions, provide welded steel supports to elevate or otherwise support equipment: air handlers, pumps, etc. Such supports shall be shop, field, or manufacturer fabricated from steel pipe, angle, channels, tubing, beams, grating, or other appropriate members as required by the characteristics of the equipment and installation. Equipment supports constructed of wood shall not be allowed.
2. Where required by drawings or field conditions, provide welded steel supports to support equipment from structure overhead. Provide angles or other structural members spanning two or more joists or beams to sufficiently distribute the weight of the equipment. Coordinate with the Architect/Engineer and General Contractor/Construction Manager as needed.
3. Paint all such supports with minimum of one coat of industrial rust-inhibiting primer and two coats of industrial (oil based) enamel. Color to be similar to or matching equipment being supported. For outside equipment, supports shall be of hot dipped galvanized steel, primed and coated with matching color, using exterior materials suitable for the galvanized substrate.
4. Use galvanized materials with two coats of cold galvanizing applied to field joints where outside or where subject to moisture/high humidity (e.g., cooling towers) and where otherwise indicated by drawings or these specifications. Where material is to be painted due to architectural or other considerations (e.g., on roof), provide galvanized treatment/ primer to accept finish coats.
5. Refer also to drawings for specific conditions and intent.

C. Supports for Rooftop Equipment, Piping, Ductwork, and Conduit



1. Where drawings illustrate particular conditions, construct in accordance with the intent of the drawings. Where specific illustrations do not describe a particular condition, comply with the following.
2. Equipment
  - a. Provide equipment pedestals consisting of an insulated minimum 18 gauge metal full perimeter curb with: an insulated 1-1/4" treated plywood top, and a minimum 18 gauge stainless steel cap for small equipment such as condensing units and utility fans. Pedestals shall be minimum 14" high (above finished roof level) and shall be internally insulated.
  - b. Provide equipment supports consisting of a minimum 18 gauge metal shell and base plate with treated wood nailer and minimum 18 gauge stainless steel counter flashing for large equipment such as condensing units over 15 tons, for rooftop ductwork, and for rooftop piping where indicated on plans.
  - c. Metal cap components shall be Type 304 stainless (or similar) steel to provide a weldable substrate for field or shop inert gas welding as may be required. Exception: Metal components may instead be galvanized steel where welds are not indicated by drawings or field conditions. Obtain confirmation/clarification from Architect/Engineer, prior to submittals.
3. Roof Penetrations: Provide curbed roof penetrations consisting of a minimum of 14 gauge stainless steel full perimeter curb with 14 gauge galvanized steel cover to accept quantity of pipes (and conduits) entering the penetration assembly horizontally. Fully insulate roof penetration curb with closed cell insulation. Finished installation shall be weather tight and insulated/vapor barriered to prevent condensation at all conditions to be experienced.
4. Coordinate with other trades/divisions to size penetrations for shared use where applicable
5. Basis of Design: Pedestals, supports, and roof penetrations shall be as manufactured by Thycurb, Pate, or approved equal. Verify exact model/style and coordinate with roofing or general contractor for roof tie-in.

## PART 3 - EXECUTION

### 3.01 INSTALLATION OF PIPING SYSTEMS

- A. General requirements of all piping systems.
  1. Codes/Standards: Piping systems shall be fabricated and installed in accordance with their pertinent code requirements and with applicable elements of ASME B31.1, B31.3, and B31.9.
  2. Manufacturers' Instructions: Install all systems, accessories, specialties, and appurtenances in accordance with respective manufacturer's written installation instructions. Verify such instructions are consistent with the Contract Documents,

and obtain clarification from Architect/Engineer prior to proceeding should conflicts between the instructions and documents occur.

3. Sizes/Locations/Slopes: Piping sizes, approximate locations, and slopes shall be:
  - a. as required by codes, applicable standards, or best construction practices for the particular work;
  - b. as shown on the Drawings;
  - c. or as required by Specification.
4. Ream Ends/Remove Burrs/Clean Piping: Ream pipe and tube ends to the nominal inside diameter after cutting. Remove burrs from threads in threaded piping. Clean inner walls of piping of burrs, cutting oil, grindings, cuttings, etc.
5. Keep Systems/Materials Clean: Piping systems shall be kept clean during all phases of the work. Once fabrication has started on any length of pipe, keep open ends plugged or capped to prevent the entry of dirt and other foreign material.
6. Expansion Compensation:
  - a. Provide suitable expansion compensation (loops, offsets, flexible connections, or in-line expansion joints where allowed):
    - 1) At all building expansion joints;
    - 2) Where straight piping runs exceed 100 feet for systems operating at or below nominally 100°F ambient temperatures;
    - 3) At 75 feet intervals for systems operating above 100°F temperatures (heating water, domestic hot water);
    - 4) At 50 feet intervals for systems operating above 250°F;
    - 5) And at other places shown on drawings.
  - b. Anchor piping as required to control movement as intended by expansion compensation. Provide accompanying pipe guides. Coordinate with General Contractor. Refer also to Part 2 above.
  - c. Cold Springing:
    - 1) Cold spring hot piping (above 100°F) to provide piping under operating temperatures to be properly set and with reduced expansion/compression stresses.
    - 2) Cold springing shall not be used to reduce the length of expansion/contraction elements (e.g., offsets, loops). Provide full compensation elements, and cold spring to achieve approximately one-half the expansion/contraction, thereby reducing stresses on the operating condition. Coordinate with Architect/Engineer as required.

7. Dielectric Protection:
  - a. Piping Systems: Provide dielectric protection at dissimilar metals piping connections in accordance with part 2 above.
  - b. Hanger Systems: Electrically isolate piping from hanger materials to prevent contact of dissimilar metals (e.g., copper pipe and steel hangers). Use multiple wraps of PVC tape (color coded where required for particular piping system) or other similar technique/material approved by the Architect/Engineer.
8. Removal/Service of equipment, valves, devices, and appurtenances:
  - a. Unions/Flanges and Valves: Coordinate positioning of unions/flanges and valves so that both piping system elements perform their intended functions during equipment shutdown/removal. For example, position unions where they permit removal of the component they serve without disassembly of other piping (beyond the unions) serving the component. Similarly, position valves where they shut off service to the affected component during its removal and reinstallation and leave clear the space needed for service and removal.
  - b. Piping disassembly: Provide for physical space to accomplish convenient disassembly of piping portions, including tool clearance. Use of close or butt nipples is not permitted under these specifications.
  - c. Blowdown valves/piping (e.g., serving strainers, air/dirt separators, etc.): Install valve in convenient location for open/close operations. Install piping to sanitary receptor with unions that permit easy dis-assembly for access to strainer screen.
9. Nuts, Bolts, and Washers: For all chilled water service piping, provide stainless steel nuts, bolts, and washers for connection/etc. of valves and other piping accessories. Install with anti-seize compound.
10. Anti-Seize Provisions: Provide anti-seize compound equal to "Never-Seez" on threads of all chilled water and heating water system components, to include nuts, bolts, etc. Where components are supplied with nuts/bots factory installed (e.g., valves), remove nuts/bolts, apply anti-seize compound, and reinstall consistent with manufacturer's torque requirements.
11. Ventilation: Provide mechanical ventilation as required to ensure fumes are properly removed from all jointing activities (e.g., welding, soldering, solvent cementing, etc.), including those which may collect in confined areas such as crawlspaces, tunnels, or mechanical rooms. Provide diligent fire protection, prevention, and safety measures for these and similar operations.
12. Controls and TAB Coordination/Support: Provide full coordination and cooperation with controls/instrumentation and TAB (test, adjust, and balance) trades. Install wells, ports, valves, fittings, etc. as required and as requested by those trades. Provide craftsmen to support those trades at all times that work by those trades is occurring.

13. Stainless Steel Specialties: All nipples, couplings, reducers, and piping accessories in steel piping systems to extend from the taps, beyond the insulation, and to the nearest valve shall be 304 stainless steel, including all similar conditions provided by or for controls.
  14. Movement at Penetrations: In floor, roof, wall, partition and any structural penetrations, center pipe in sleeves/penetrations and make other allowances for movement as required by the particular conditions. Provide anchors and expansion compensation/vibration isolation as may be required for penetrations where movement would damage piping, roofs, walls, or partitions. Confer with Architect/Engineer as required.
  15. Blowdown, Vent, and Drain Piping: Provide accessible ball isolation valve at each strainer, air vent, and piping or equipment drain. Route discharge pipe, through union(s), to nearest suitable receptor (e.g., floor drain). Route pipe to not create maintenance or pathway obstruction.
    - a. When maintenance or pathway obstruction cannot be avoided, provide stepover/crossover similar or equal to EGA Minico, aluminum construction, height as required. Coordinate pipe routing and stepover location with pertinent access items as to not interfere.
  16. Electrical Coordination/Support: Coordinate with electrical trades to avoid routing of piping above electrical rooms and within code required clearances for electrical equipment. Adjust schematic routing shown on drawings as required to achieve this coordination.
- B. General Requirements for Piping/Systems Jointed by Welding
1. Currently Certified Welders: Welded piping systems shall be fabricated only by welders certified for the piping/welding systems involved. **Submit names of certified welders with certification papers, and restrict all welding procedures to these individual craftsmen.**
  2. Bevel Welds: All welded piping shall use factory or field beveling at circumferential joints. Flanges shall be weld neck type. Slip-on flanges, screwed flanges may be applied only with written approval of the Architect/Engineer. Avoid fillet or butt weld conditions in piping systems.
  3. Split Rings/Backer Rings: Fabricate building systems (e.g., chilled water, heating water) using split welding rings with root spacing nubs to assure proper alignment, complete weld penetration, and prevention of weld splatter reaching the interior of the pipe. Use rings designed for smooth inner bore flow conditions. Basis of Design: Imperial. Apply to:
    - a. All pipes 4" and larger; and
    - b. All joints between strainers and control valves of coils, etc. (to assist in pipe being free of material that could damage/affect coil, heat exchanger, or control valves).

- c. Exception to backer rings: Shop made joints using metal inert gas (MIG)/gas metal arc welding (GMAW), provided inside bore of pipe remains slag/spatter free.
4. Compatible Flanges: Companion flanges at equipment or valves shall match flange construction of equipment or valve. Raised faces and flat faces shall not be joined together.
5. Gaskets: Gaskets, bolting, and torque shall be applied in accordance with the recommendations of the gasket manufacturer and bolting standards of ASME B31.1. Strains shall be evenly applied without overstressing of bolts. Gaskets shall cover entire area of mating faces of flanges.
6. Restricted Use of Weld-o-lets (bosses): All flow branches in welded piping systems shall have take-offs constructed from tee or lateral fittings. Shaped nipples, "thread-o-let," "weld-o-let," or boss fittings shall not be acceptable under this specification for Base Proposal.
  - a. Exception: No flow branches. Thread-o-let, weld-o-let, or similar boss fittings shall be acceptable where the branch will not normally be experiencing flow. Examples include instrumentation taps, controls taps, make-up water taps, air vent taps, piping drain taps.
  - b. Exception: Flow branches when all the following conditions prevail:
    - 1) Connection size is a minimum of two pipe sizes larger than branch pipe size and a minimum of one pipe size smaller than main. (e.g., 4" weld-o-let may be used on 6" piping to serve a 2-1/2" branch. For purposes of this exception, 5" pipe size is not to be considered.) Reduce to branch pipe size by separate fitting.
    - 2) Holes in main piping shall be made using rotating hole cutting machinery (e.g., hole saw) to provide a smooth, uniform hole with minimal cuttings in the pipe.
    - 3) Remove by swabbing and/or vacuum cuttings deposited in pipes.
7. Owner's Testing: The Owner reserves the right to engage Owner's Authorized Inspector to conduct non-destructive examinations on any or all welded joints to verify compliance with ASME B31.1, as applicable. Contractor shall repair/remedy all deficient joints, which shall be subject to re-testing thereafter.
8. Passivation: All stainless steel piping/systems with welded joints shall have welds cleaned, passivated (with citric acid treatment), rinsed and neutralized if/as necessary, and tested per ASTM A967. The following procedure and products shall be used as the basis of design:
  - a. Cleaning
    - 1) Mix 5 parts Stellar Solutions KleerKleen 4000 with 100 parts distilled water by volume.

- 2) Apply KleerKleen 4000 liberally to the weld with a clean stainless steel brush, sponge, or rag.
  - 3) Rinse thoroughly with distilled water.
  - b. Descaling
    - 1) Apply Stellar Solutions Weld Wizard 9310 liberally to the weld with a clean stainless steel brush, sponge, or rag and allow to sit for a minimum of 30 minutes. (Note: Weld Wizard 9310 must remain moist during treatment. Periodically mist/spray surface lightly with water to prohibit drying.)
    - 2) Rinse thoroughly with distilled water.
  - c. Passivation
    - 3) Apply Stellar Solutions CitriSurf 2210 liberally to weld with a clean stainless steel brush or roller and allow to sit for a minimum of 20 minutes. (Note: CitriSurf 2210 must remain moist during treatment. Periodically mist/spray surface lightly with water to prohibit drying.)
    - 4) Rinse thoroughly with distilled water and dry with hot air blower (heat gun).
  - d. Testing: Conduct copper sulfate test using Stellar Solutions Copper Sulfate Passivation Test Kit. Repeat "Passivation" process in 'c' above if test fails.
  - e. Refer to Material Safety Data Sheets before using the above products.
- C. General Requirements for Below Grade and Crawlspace Piping Systems
1. Schedule and obtain Architect/Engineer's, Owner's, and/or building inspector's on-site review of below-grade piping systems and tests prior to backfill.
  2. Where piping systems are installed in crawlspaces, hang all piping from structure (floor) above. Coordinate with General Contractor for installation of hangers.
  3. Where piping transitions from being supported (hung) by structure above to being supported (e.g., buried) below grade, do so only with horizontal piping and/or flexible joints sufficient to absorb relative movement between structure and soil.
    - a. Provide an expansion loop, offset, or swing joint to achieve this requirement. Loop shall be capable of providing a minimum of 4" of movement. Metraflex Metraloop or equal.
    - b. Clarify details with Architect/Engineer, as required.
  4. Where piping systems in the conditions of "3." above use welded, soldered, brazed, flanged, "Victaulic," or solvent cemented joints.

- a. Use flexible couplings immediately after last hanger in crawlspace. Flexible coupling shall be stainless steel bellows/braid assembly, "Hyspan" series 4500, "Metraflex," or equal approved by Architect/Engineer. Install exactly aligned in piping system, and provide coupling(s) length sufficient for 2 inches of movement/misalignment in either direction. Submit complete data on product and selection/length for each application.
  - b. Alternatively, where allowed by Architect/Engineer, install adjustable spring type piping hangers where piping transitions from hanger support to soil support. Unless otherwise indicated by drawing, a minimum of four (4) hangers (along length of pipe) shall be of this type. Mason PC3ON, Mason type HES, or equal, with minimum of 5" rated deflection. Select for "free hanging" deflection of 3" to allow support with plus or minus 2" deflection (up or down). After installation is complete, release the pre-compression plate.
5. Piping below slabs and other structural elements shall not be installed in trenches cut for foundation beams, footings, columns, or other structural components. Coordinate any sleeving or coring of concrete beams or joists with Architect/Engineer prior to performing the work.
  6. Plan and construct work to ensure properly made joints and alignment of piping systems. Support piping runs at ground level, roll piping during welding procedures, over excavate trenches in width and depth at piping joints, and/or create other conditions to allow proper jointing, testing, observation, and placement of buried pipes.
- D. General Requirements for Plastic Piping Systems
1. Fabricate and install all plastic piping systems (e.g., PVC, CPVC, FRP, PVDF, polypropylene, polyethylene, polybutylene) in strict accordance with highest industry standards and manufacturer's written instructions.
  2. Provide supports at close intervals in accordance with applicable parts of this section and pertinent code provisions.
- E. General Requirements for Drainage Piping Systems
1. Early Planning: BEFORE installation of condensate or other graded piping systems, verify elevations to ensure that installation can be accomplished and without conflicts with other systems (ductwork, lights, structural [foundation, floors, roof], ceiling heights, etc.)
  2. Drainage Coordination: For condensate piping, verify installation prior to hanging/locating air handling equipment. Coordinate also with Electrical trades as required to avoid conflicts with light fixtures, etc.
  3. Overflow Piping: Provide for overflow condensate piping (or high-level condensate switch) for all above ceiling or suspended air handling units as required.

### 3.02 GENERAL REQUIREMENTS FOR VALVES

- A. General: Install valves in accessible conditions, as shown in the drawings, in locations required by Codes, in locations required for balancing and maintenance, and where required to accommodate construction phasing. These locations shall include, but not be limited to branch taps, HVAC equipment, coils, pumps, and vertical risers.
- B. Readily Accessible Operation: Install in vertical or in horizontal and locate such that they are readily accessible. Position valve handles for easiest access and operation consistent with surrounding systems and conditions.
- C. Valves required but not shown: Valves, accessories, and equipment shall be installed as shown on the Drawings and in other locations as required by Codes AND as may be needed for phasing and for future maintenance or service. At a minimum, accessible valves shall be provided to isolate all equipment, control valves, risers, and major branches.
  - 1. Verify all phasing valves at start of construction and coordinate with Architect/Engineer as required.
- D. Butterfly Valve Disc Orientation: Where butterfly valves are installed immediately adjacent to tees or elbows, install valve so that its disk in the full open position aligns with axis of the piping main (e.g., the flow direction).
  - 1. Exception: Where doing so would prevent installation of chain operator where specified.
- E. Flanges: Match flange ratings/patterns with those of respective valves.
- F. Chain Operators: For valves 3" and larger located ten feet (10') and higher (to centerline) above floor, mezzanine, or service platform, provide chain operators and related hardware/accessories. Plan valve location and orientation to permit clear operation of chain mechanism. Select/adjust chain fall for bottom at approximately 5'-0" above floor.
  - 1. Provide wall mount bracket or similar provision so that chain does not present a safety issue or an impediment to maintenance activities.
- G. Flow metering valves:
  - 1. Install with minimum of 5 straight upstream pipe diameters and 2 straight downstream diameters, unless manufacturer's installation instructions recommend more pipe diameters.
  - 2. Use valves with double-ended union connections where not specified with a flanged connection.

### 3.03 CLEANING AND FLUSHING

- A. General: All piping shall be thoroughly and completely cleaned and flushed to protect entire piping system from operation with potentially damaging contaminants (e.g., slag, spatter, oil grindings, cuttings, construction debris, etc.). Cleaning and flushing shall be accomplished under the supervision of the chemical water treatment (sub) Contractor to assure all preparations for the chemical water treatment are properly accomplished.



1. Cleaning and flushing shall be completed before connections to heat exchange, balancing, control, or other components that may be damaged or have performance reduced by contaminants within the system.
  2. Where new sections of piping are to be connected to existing systems, perform all cleaning and flushing prior to connections to existing systems so as to assure no contamination of existing system results from the new sections.
- B. Minimum requirements: At a minimum, the on-site cleaning and flushing requirements shall include:
1. Circulate Cleaners: Provide means of circulating cleaners, including temporary means as may be required to accommodate construction phasing and renovations. Cleaning and flushing shall remove any/all dust, dirt, slag, grindings, particles, etc.
  2. Clean Strainers and Filters: As a part of the flushing/cleaning procedures, frequently remove and clean strainers and screens and filter/feeder bags and cartridges, including at the conclusion of the cleaning/flushing process.
    - a. Remove smaller mesh start-up screens only at completion of cleaning/flushing.
    - b. Note: Pump strainers are the primary intention of the removal and cleaning strainers, such as strainers protecting coils, equipment, control valves, and similar are to be isolated and bypassed during cleaning and flushing.
  3. Maintain Equipment Protection: Strainers/screens shall at all times protect the system/equipment they are intended to serve (e.g., control valves and other control equipment; coils; chillers; boilers; heat exchangers; pumps; pressure reducing valves, and other similar or related materials). Traps shall be removed from the line during flushing.
  4. Repeat: Include repeated cleanup and flushings as required for phasing.
- C. Refer also to Section 23 07 50 - Chemical Water Treatment for related information.

### 3.04 FIRE RATED PENETRATIONS

- A. General: Where pipes, conduit, ducts, etc. pass through floors, walls, partitions ceilings, or roofs having a required fire and/or smoke resistive rating, such penetrations shall be constructed to provide the required fire and/or smoke resistive rating. Use approved/listed penetration details incorporating sleeves unless such details are not available with sleeves (or not applicable to the particular condition). For penetrations on one side of wall (i.e., piping going into a wall and dropping in wall) provide through-penetration firestop system that does not require a sleeve at the penetration.
- B. Drawings Details as General Guidance: Where products or methods of complying with UL Listed Separation Details are indicated on drawings or herein, those shall be seen as minimum requirements and are offered as guidance to the Contractor. This guidance is not intended to indicate means or methods of complying with Code requirements for maintaining Code required separations.

- C. Approved Assemblies Required: In all cases, such penetrations shall be listed and approved assemblies and shall be made in accordance with the latest published edition of U.L. Fire Resistance Directory. All floor penetrations shall have a Class 1 W rating or a sleeve that extends to above the floor.
- D. Proposed Details: **The Contractor shall submit the proposed penetration detail from the Fire Resistance Directory for the Architect/Engineer's review.** In addition, the Contractor shall be responsible for securing approval of such proposed methods from all authorities having jurisdiction. Note that the particular details of the listed penetration may require a deviation from the other specifications regarding insulation type or sleeve material.
- E. Materials and Methods: Fire-stopping materials and methods shall be equal to those listed in the latest published edition of U.L. Fire Resistance Directory for specific types of penetrations shown on plans.
  - 1. Materials shall be similar and equal to Specified Technologies Incorporated "SpecSeal-Series" or "Pensil-Series" fire stop system yielding a permanently resilient/flexible condition which allows minor movement in piping systems without compromise to the fire resistance and damage to the partition/floor, etc.: sealant; wrap strip; collar; putty; non-combustible ceramic or mineral wool; and steel sleeves, etc.
  - 2. The correct combination of these elements shall be used as required to create an appropriate U.L. penetration system, appropriate for conditions encountered shall be utilized (confirm with Architect/Engineer).
  - 3. Also provide: fire rated gypsum and/or Pabco "Super FireTemp" board; steel channels and angles; and other members required for the particular fire resistance and penetration method involved.

### 3.05 SLEEVES AND BLOCKOUTS

- A. All Penetrations: Furnish and install sleeves at all pipe penetrations of beams, joists, walls, partitions, floors, and roofs.
  - 1. Water-stop Rings: Sleeves in cast concrete masonry members shall include water-stop ring.
  - 2. Copper Pipe Isolation: Sleeve all penetrations of copper pipe through concrete floors/walls/members such that the concrete is not in contact with the copper pipe. Where copper piping is to be run in/through concrete, completely isolate the copper material from the concrete using PVC sleeve designed for this purpose, or other suitable method approved by the Architect/Engineer.
  - 3. Fire/Smoke Penetrations: Where penetrations are through fire and/or smoke rated elements, construct in accordance with the approved U.L. penetration detail. Refer to 23 01 00-3.04 above.
  - 4. Embedded in Structure Prohibited: In no case shall piping be embedded in concrete structure unless approval is first obtained from the local building official and the Architect/Engineer.

5. Center Pipe: Center pipes in sleeves/block-outs/penetrations and make other allowances for movement as may be required by the particular conditions.
  6. Exception: Sleeves are not required at core-drilled (floor, roof, wall) penetrations provided requirements of "D" below are met.
- B. Non-Fire Rated: Sleeves through non-rated (fire and/or smoke) concrete floors shall be Schedule 10 or 40 galvanized pipe (or black steel primed and painted prior to setting sleeve), each with water stop ring around circumference in the middle of the concrete thickness. Sleeves through non-rated (fire and/or smoke) masonry, plaster, gypsum, CMU, etc. partitions shall be constructed of 18 gauge galvanized sheet metal.
- C. Pipe sleeves through floors above the first level shall extend a minimum of one inch (1") above the finished floor.
- D. When floor penetrations through floors above the first floor are made by core drilling, provide UL Listed Through-Penetration Firestop System with a "W Rating" of "Class 1".
- E. Minimum Sizes: Sleeves above the first floor and in interior partitions/walls shall be sized to provide a minimum of 1/2 inch space between the centered pipe and sleeve. Sleeves in the first floor and all exterior walls shall be sized for a minimum of 1" space between the pipe and the sleeve. Where insulated piping is indicated, the minimum clearance shall be provided between the insulation jacket and the sleeve (except as required for applicable fireproofing or to accommodate specific field conditions that the Architect/Engineer has reviewed with the Contractor).

Prior to setting sleeves, coordinate with General Contractor to confirm sleeve will fit within the partition/wall cavity, including applicable construction tolerances. Contact Architect/Engineer upon discovery of any conflicts.

- F. Vertical Pipe Penetration Supports:
1. Riser Clamps: Where riser clamps are used to support vertical pipes, provide around the sleeve a schedule 40 black steel pipe ring 1/2" higher than the sleeve. Ring size to be minimum of one pipe size larger than outside (insulated) diameter; or minimum of two pipe sizes larger for uninsulated piping systems, up to a 1/2" clear annular clearance between the pipe and the sleeve. Where wall or partition thickness prevents the outside ring from being used (due to ring size exceeding wall or partition thickness), use Unistrut sections outboard of the sleeve to support the riser clamps.
  2. Hangers: Steel pipe ring and/or unistrut sections may be deleted where conditions are suitable for pipe to be supported from hangers in lieu of riser clamps. Hangers are preferable in insulated piping systems, especially those subject to condensation.
- G. Typical Lengths: Pipe sleeves through partitions shall extend 1" beyond both sides of partitions. Exception: if in exposed condition in finished area, sleeve shall be flush with partition.
- H. Sleeves at foundation perimeters and other below grade/below slab conditions (e.g., for refrigerant piping, water piping, etc.) that rise into perimeter walls, or just inside perimeter walls, shall be long sweep rigid galvanized steel (RGS) electrical conduit or other sleeving

techniques indicated by drawings. Unless otherwise indicated, provide individual sleeve for each pipe. Insulated piping may use foamed in place (between the pipe and the sleeve) insulation. Where piping is copper, wrap/tape it prior to installing in sleeve and insulating. Coordinate with General Contractor to ensure sleeves are placed at locations and in a manner satisfactory to the Architect/Engineer.

- I. Exterior Walls: Where pipes pass through exterior walls above grade, the annular space between the pipe and sleeves shall be thoroughly caulked with light colored GE "GESIL-N" silicone sealant to provide water tight or airtight closure. "Link Seal" also acceptable as sealing provision. Provide escutcheon/other trim acceptable to Architect where penetration is exposed outdoors.

Refer also to drawings for conditions and intent.

- J. Coordinate sleeves and blockouts through beams, grade beams, wall footings, and similar conditions with General Contractor and secure approvals from Architect/Engineer.
- K. Other Conditions: Use other sleeves and seals where indicated by the drawings or job conditions.

### 3.06 EXCAVATION AND BACKFILL

- A. General: Perform all work with the highest regard to safety and in accordance with U.S. 29 CFR 1926 "Safety and Health Regulations for Construction." Special attention shall be directed to Subpart P – Excavations. Refer also to 23 00 10.1.12 – Safety.

1. Safety Precautions and Programs

- a. In excavations that are four (4) feet or more in depth, means of egress shall be provided by stairway, ladder, ramp or other safe means so as to require no more than twenty-five (25) feet of lateral travel for employees/workers.
- b. In addition, on projects in which trench excavation will have a depth of five feet or more, the Contractor, and all of its subcontractors, shall comply with all requirements of 29 C.F.R. 1926 Subpart P 652 "Safety and Health Regulations for Construction – Excavations" and all Appendices related thereto.
- c. **Before commencing any trench excavation that will be five (5) feet deep or deeper, provide Owner, through submittal to the Architect/Engineer, with detailed plans and specifications regarding the safety systems to be utilized.** Said plans and specifications shall include a certification from a registered professional engineer indicating full compliance with the 29 CFR 1926 Subpart P -- Excavations.
- d. Contractor shall ascertain, prior to proposal, whether or not such conditions prevail and services are needed and shall include cost of same in proposal.

2. All shoring and bracing shall be designed so that it is effective to the bottom of the excavation. Sheet piling, sheet piling, bracing, shoring, trench boxes, and other methods of protection, including sloping, shall be based upon the condition and

nature of the materials to be retained, and by loads (including surcharge) imparted to the sides of excavation by equipment and stored materials.

3. Store excavated or other materials a minimum of two feet (2') from the edge of any excavation. Retain such materials to prevent their falling or sliding into the excavation, and to prevent excessive pressure on the sides of the excavation.
  4. Maintain sides and slopes of excavations in a safe condition by scaling, benching or barricading.
  5. Take other precautions via shoring and bracing to prevent slides or cave-ins. Take special precautions when trenches are located adjacent to backfilled excavations, or subjected to vibrations from railroads, highway traffic, operation of machines, etc.
  6. Soils Classification: The general stable/active soils classification for purposes of this specification shall be as indicated below. Classifications relate to soils surrounding the particular pipe segment (e.g., select fill by other trades, native soil): three feet below bottom of pipe; one foot from each side of pipe (both directions); and three feet above top of pipe. Coordinate to confirm with Architect/Geotechnical Engineer/Structural Engineer as required. Confirm soil conditions with Architect/Engineer prior to trenching. In general, structures using suspended slabs, carton forms, post-tensioned slabs, etc. will be considered as an active soil condition.
    - a. Stable Soils: Those tested to have a PVR (Potential Vertical Rise) of 1" or less.
    - b. Active Soils: Those tested to have a PVR of greater than 1".
    - c. Project Basis of Construction: Active soils
- B. Utility and building services coordination: Verify locations of all existing utilities and building services in the area prior to start of excavation (gas, electrical, water, sanitary, storm, telephone, cable TV, optical cable, etc.) Coordinate with utility companies as required.
- Excavation within four feet (4') of existing utilities or other below grade systems shall be done by hand digging only.
- C. Protection of Trees: Avoid trenching, excavation, or placement of heavy equipment within drip lines of any trees. Adjust routings shown on drawings, as required, to achieve this directive. Verify on site.
- Failure to comply with this directive shall subject contractor to damages for like replacement or potential future replacement of affected trees.
- D. Where drawings or conditions require concrete or other materials to be placed against undisturbed earth surfaces, any loosened or disturbed materials shall be removed from such surfaces.
- E. Trenching

1. General: Trenches shall be large enough to permit handling of pipe and accessories and jointing methods of the particular systems (e.g., welding, bell and hub, solvent cementing, mechanical joints, thrust restraints, etc.).
  - a. For cast iron pipe installation, trench bottom width shall exceed bell or coupling diameters by at least twelve inches (12").
2. Active Soils: Trenches in active soils shall be excavated a minimum of three feet (3') below the bottom of the pipe to provide for a stable select fill bedding course.

F. Preparation of Trench Bottom

1. Load bearing base bedding course: Trenches shall be dry when the trench bottom is prepared. The trench shall be course bedded to within twelve inches (12") of the finished flow line grade of the pipe bottom with compacted select structural load-bearing bedding as specified in other Divisions; or, if none is specified in other Divisions, as indicated by "default" below.
  - a. Default load bearing bedding: ½" minus select fill material, compacted as specified below, unless greater compaction is required to be consistent with foundation materials and compaction.
  - b. Minimum depth of load-bearing base bedding course:
    - 1) Active soils: Minimum of 3 feet below the bottom of the pipe, with the lower 2 feet being load-bearing bedding as specified above (the upper 12" shall comprise the final bedding course).
2. Final Bedding Course: A final bedding course as specified below shall then be placed over the load-bearing bedding. A continuous trough with compacted bedding course shall be prepared to receive the bottom quadrant of the pipe barrel. Remove loose or disturbed material and bring the trench bottom up to grade with final bedding material as follows:
  - c. Active Soils
    - 1) Final bedding course shall be a minimum of 12" thick.
    - 2) Where either metallic or plastic/FRP piping is used, sand (only), compacted.
3. Prepare the trench bottom carefully so that when placed in its final position, the pipe will be true to line and grade and uniformly supported.
4. Provide a bentonite plug in the trench at the building perimeter where site drainage or other conditions could permit water intrusion into the trench and under the building. Refer also to drawings.

G. Compaction

1. Unless greater compaction is required by '2' below, accomplish same with vibratory or rammer type compactor, minimum of three full-width passes per 6" of

uniformly spread uncompacted materials to a compaction density of not less than 95%.

2. Compaction below building or equipment slabs, roads, flatwork, or other construction elements shall be performed to the structural requirements of compaction for those elements should the compaction density exceed 95%. Coordinate with general construction trades and other Division's specifications.
3. If moisture content of material is not sufficient to obtain required density, water shall be applied and moved with the material prior to backfilling.

#### H. Laying Pipe

1. All pipe shall be clean at the time it is placed in the line. Open ends of pipe sections already in place shall be tightly plugged to prevent the entrance of trench water, mud, dirt, etc.
2. Keep trench bottom free of frost, frozen earth, or standing water at the time of pipe laying and jointing, and all times prior to completion of below-grade piping system insulation.

#### I. Jointing and Inspecting Pipe

1. Joint pipe and secure inspections as follows:
  - a. For hub and spigot joints, inspection by authority having jurisdiction and/or Owner's representative, including witnessing of Contractor's pressure/leak tests.
  - b. For solvent cemented pipe, inspection by Owner's representative and/or Architect/Engineer, including witnessing of Contractor's pressure/leak tests.
  - c. For welded joints, inspection by Contractor's welding inspector, followed by inspection and testing by Owner's certified inspector.

#### J. Backfilling

1. Clean trenches and backfill material of any organic material, roots, trash, lumber, other debris and frozen material prior to backfilling. Backfill material shall contain no organic material, roots, trash, lumber, other debris or frozen material.
2. Backfill material under slabs inside building shall match adjacent materials and be of density acceptable to the Architect/Engineer.
3. Backfilling by means of sluicing or flooding with water is not permitted. Backfill shall not be placed on frozen ground.
4. Partially backfill immediately after the pipe is laid (unless other methods for preventing pipe movement are provided). Leave joints exposed for inspections and hydrostatic testing.

- a. Water shall not be permitted to rise in unbackfilled trenches after pipe has been placed.
5. Whenever timber or other sheeting is driven to a depth below the elevation of the top of the pipe, that portion of the sheeting below a point four feet above the elevation of the top of the pipe shall not be disturbed or removed.
6. Pipe layer backfill (bedding material under the bottom quadrant of the pipe, around sides, and up to a point one foot (1') above the top of the pipe) shall be compacted to 95%:
  - a. Active Soils:
    - 1) Metallic piping: compacted sand, coarse sand, or select material containing rocks no larger than 1/4 inch in greatest dimension;
    - 2) Plastic piping or plastic/FRP jacketed piping: compacted sand only
7. Backfill to grade (above pipe layer)
  - a. Active Soils, Non-Load-Bearing Conditions: Compacted non-load-bearing backfill material placed above the pipe layer backfill shall contain no rocks larger than four inches (4") in any dimension. Top the upper 9" with approved landscaping soil. The material shall be left mounded approximately one inch for each foot of backfill depth, to a maximum of three inches higher than the surrounding terrain.
  - b. Active Soils, Load-Bearing Conditions: Compacted load-bearing backfill placed above the pipe layer backfill shall be select material containing no rocks larger than two inches (2") in any dimension. Where beneath slabs or other structural elements, backfill shall match fill or foundation material specified for slab.
  - c. Active Soils, Backfill to Grade Compaction: If moisture content of material is not sufficient to obtain required density, water shall be applied to and mixed with the soil prior to backfilling.
8. All backfill material shall be placed uniformly and compacted in six inch (6") layers to the requirements of "G" above. Backfill shall be brought up evenly on both sides of the pipe simultaneously to avoid damage or displacement from unbalanced loading.
  - a. Exception: Landscaping soil compaction not required.
9. Joints shall not be covered with backfill until inspections, and pressure and leak testing are completed, **and all related reports have been submitted:**
  - a. Weld inspections as specified,
  - b. Leak tests/pressure tests, and



- c. All field insulation joints have been completed, with spot reviews by the Architect/Engineer.

3.07 HANGERS AND SUPPORTS

- A. Individual Hangers: Individual hangers shall be of the adjustable type and sized to be installed on the outside of any insulation; clevis style or style appropriate for the application and acceptable to Architect/Engineer.
- B. Hanger Rods: Steel hanger rod diameter and spacing for horizontal piping supports (including those for rooftop piping) shall, at a minimum, be according to the following schedule.

Maximum Support Spacing (ft)				
Pipe Size (in)	Min. Rod Dia (in)	Steel Pipe	Copper Pipe	Plastic Pipe (e.g. PVC, CPVC, PVDF)
1/2	3/8	5	5	4*
3/4 - 1-1/4	3/8	8	6	4*
1-1/2	3/8	10	6	4
2	3/8	10	8	4
2-1/2 - 3	1/2	10	10	4
4 - 6	5/8	10	10	4
8 - 12	7/8	14	--	4
14 - 20	1	14	--	4

- 1. \*Polyethylene piping 1" and smaller shall be supported every two feet.
- 2. NOTE: Shortest spacing will govern for trapezes, etc.
- 3. Cast iron soil pipe 6" and smaller shall be supported at each joint, within 18" of joint. Cast iron soil pipe 8" and larger shall be supported on both sides of each joint when horizontal run exceeds five (5) feet.
- 4. Where piping runs in multiple and at the same level, trapeze hangers (or roof curbs/rails) shall be installed.
- C. Vertical Piping: Vertical piping shall be supported and braced to keep the pipe in alignment and carry the weight of the pipe and contents. Where indicated for particular conditions, follow the intent(s) expressed in the drawings, or as may be necessary to adapt to field conditions. Consider the following applications where appropriate.
  - 1. Support chilled/heating water and other insulated piping risers four stories or less at top and bottom using specified spring type hangers, with hanger supports having adequate bearing on structural members as approved by the Architect/Engineer.
  - 2. Support non-insulated risers at each floor with riser clamps having adequate bearing on the rings (or unistrut sections) around sleeves or other suitable structural elements approved by Architect/Engineer.
  - 3. For copper tubing, provide additional vertical supports such that maximum distance between supports is not more than ten (10) feet.

4. Coordinate closely with the Architect/Engineer and insulation trades for riser insulation specialties associated with piping systems subject to condensation.
- D. Insulated Piping: Insulated piping shall be supported with inserts of the same thickness as the insulation, or with other approved methods. Refer also to Piping Systems Insulation, Section 23 02 00.
- E. Dielectric Protection: Electrically isolate dissimilar piping/hanger materials in accordance with 3.01 above.
- F. Fire-proofing Coordination: Where structural members serving hangers and supports are fireproofed by other trades/divisions (e.g., sprayed on, membrane wrap, etc.), coordinate with applicable trades to, as much as possible, install hangers prior to sprayed-on application so fireproofing repairs can therefore be minimized.
- G. Refer also to Part 3 - 3.01 above for additional requirements.

### 3.08 IDENTIFICATION

- A. Above Ground Piping: After insulating and/or painting, provide identification of above ground piping systems in non-finished areas via pressure sensitive bands (or optional stenciled/painted lettering where in compliance with "5" below).
  1. Locations: Provide markers in readily visible locations not greater than approximately 30 feet (30') apart, and wherever a pipe penetrates a partition or wall. Identify each pipe at least once in every room or confined area, and at every valve and tee or branch connection other than direct equipment connections.
  2. Application: Tapes shall be applied circumferentially around the pipe with ends overlapped. Apply after painting where piping systems are to be painted. Should identification tape be applied longitudinally, each end of each tape shall be strapped down using plain tape of the same color and completely circumscribing the pipe. Surface preparation and application of tape shall be in accordance with the instructions of the tape manufacturer.

Where tapes are accepted for use outdoors (see Part 2), tape on pipe located out of doors, in crawlspaces, or in attics shall be protected by a coat of clear varnish or other suitable protective coating recommended by the manufacturer.
  3. Systems: Pipe markers shall be applied to the following piping systems:
    - a. heating water supply and return;
    - b. chilled water supply and return;
    - c. primary and secondary (overflow) condensate;
    - d. domestic cold water;
    - e. domestic hot water supply and return;
  4. Provide permanent placard at each heating water and chilled water, and pipe entering/leaving mechanical room areas, indicating service and equipment served.

5. Stenciled/painted lettering: Stenciled/painted lettering, including flow direction arrows, shall be subject to:
  - a. Multiple color requirements as set forth in 3.09 below;
  - b. Minimum lettering/numbering sizes as set forth by ANSI/ASME A13.1;
  - c. Applied with full alignment with the piping barrel, and without "overspray" onto the pipe or beyond the letters.
  
- B. Below Grade Piping:
  1. Provide underground plastic pipe markers with tracer wire for direct burial service as specified in Part 2 above. Install marker ribbon approximately six inches (6") below finished grade and also atop the piping prior to backfilling (wrapped around the pipe where specified for plastic gas piping systems).
  2. Markers shall be provided for piping systems as follows: domestic water, sanitary, storm, chilled water, and heating water.
  3. Also provide surface markers at all changes in directions. Markers shall be cast-in-place concrete with stainless steel or bronze nameplates embedded, or other materials appropriate for outdoor service, and shall be manufactured or constructed for that purpose. Markers to indicate utility below. **Provide submittal/shop drawing.**

Coordinate with serving utility(ies) to provide surface markers for utility piping installed by others.
  
- C. Equipment: Identify air handling units, terminal boxes, thermostats, fans, pumps, heat transfer equipment, water treatment devices, control cabinets, major control equipment, filters, etc. with nameplates applied with corrosive-resistant fasteners or suitable adhesive recommended by manufacturers.
  
- D. Valves: Identify control valves, balancing valves, and valves in main and branch lines with tags installed with non-corrosive chain/cable. Provide valve chart and schedule in aluminum frame with clear plastic shield. Install chart at location as directed. **Indicate valve locations and numbers on Record Drawings.**

Tags shall include valve descriptions illustrating isolation (ISO), balance (BAL), control (CTL), bypass (BYP), and crossover (CRS). For isolation, bypass, and crossover valves, include normal position as normally open (NO), normally closed (NC).
  
- E. Streamers: Where piping system components require access for TAB, commissioning, service, and maintenance, and such components are elevated above ceilings or elevated and obscured by surroundings, install streamers to assist in locating the components.
  1. Typical components to be identified with streamers: control valves; balance valves; air vent valves (auto air vents and manual air returns); strainers; branch, riser, or isolation valves; flow measuring valves/ components; etc.

2. Proximity: Where multiple components are in the immediate proximity of one another (generally within 3 feet), and where all are visible and accessible from the same (vertical) path, a single streamer can be used to identify locations of all.
3. Coordinate also with Section 23 08 90 – Air Distribution, for streamers applied to systems therein.

### 3.09 PAINTING

#### A. Interior Scope:

1. Non-galvanized, uninsulated exposed (in mechanical rooms, in finished areas) steel piping, supports, hangers, anchors, and accessories:
  - a. clean rust, oil, foreign materials;
  - b. prime with lead-free industrial rust inhibiting primer;
  - c. finish with minimum of one coat of industrial machinery enamel. Use additional coats as required to achieve complete and uniform coverage.

#### B. Exterior Scope: (including crawlspaces and other spaces outside the conditioned envelope).

1. Non-galvanized, uninsulated steel piping, supports, and accessories: clean rust, oil, foreign materials; prime with lead-free industrial rust inhibiting primer; finish with minimum of two coats of industrial oil-based machinery enamel. Use additional coats as required to achieve complete and uniform coverage.

#### C. Where required for slip resistance, provide angular aluminum oxide included in field intermediate coat. Where required, increase aluminum oxide content or include in multiple layers if/as required to achieve slip-resistant finish acceptable to Owner/Engineer

#### D. Compatibility with substrate:

1. **Prior to submittals**, verify with substrate manufacturers (e.g., insulation, jackets, mastics, adhesives, sealants, etc.) that specified or proposed/submitted painting are compatible with substrates and will not harden, soften, crack, peel, or otherwise deteriorate substrate materials.

#### E. Colors

1. Pipes shall be color-coded according to the Owner's standards and preferences.
  - a. In addition to those requirements, for fluids operating at 2-temperatures (low/high), the supply temperature fluid shall be a darker shade of color, and the return temperature system shall be lighter color.
  - b. If the Owner does not have a standard or a preference, use the colors as presented in Part 4 below.
2. Labels (background/text) shall be colored and sized in accordance with ANSI/ASME A13.1

- 1) System colors exception: Where applicable, match architectural finishes/colors in finished/occupied spaces in the building.
- 2) System colors coordination: Where applicable, match or coordinate colors prescribed by other parts of these specifications (e.g., piping insulation systems, plumbing systems, fire protection systems, etc.)

1. **Provide submittal to verify all system colors, and label background/text colors** with the Architect/Engineer prior to painting.

F. Jackets

1. Interior: Where a metallic jacketing or Venture clad product is specified elsewhere (e.g., piping insulation), the painting specified herein in unfinished/unoccupied areas may be omitted.
2. Exterior: Where a metallic jacketing is specified elsewhere (e.g., piping insulation), retain the painting specified.
3. Refer also to other related sections

3.10 ACCESS PANELS

Install access panels to comply with Code and for access. Refer also to Part 2 above for more specific requirements. Paint and cure in open position to prevent panel and frame from sticking together.

3.11 VIBRATION ISOLATION

Provide vibration isolation as needed and as described in Part 2 above. Refer also to Section 23 00 10 - General Requirements for Mechanical Work.

3.12 CONTRACTOR'S TESTING/COMMISSIONING

- A. General: The following tests, all other tests required by codes, regulations, and manufacturers' instructions governing the work, and other tests required by other sections of these specifications shall be made in the presence of the Owner's Representative(s) and/or local Building Official and to their complete satisfaction. Leaks and defective material shall be repaired and/or replaced as required, and tests repeated until systems are found to be tight.
- B. Pressure/Pumped Systems:
  1. After fabrication (and after Owner's weld joint inspections as may apply), and before insulating, backfilling, or otherwise covering joints, perform 6 hour, 150 psig (or 120 percent of systems operating pressure, whichever is greater) test on all pressure/pumped piping systems.
  2. Piping systems intended to convey water or other liquid shall be hydrostatically tested. Piping systems intended to convey pressurized gases shall be tested with compressed air or dry nitrogen.

3. Tests shall result in zero pressure drop (corrected to temperature) over the test cycle. Inspect all joints for leakage.
  4. NOTE: Do not subject equipment to tests beyond its rated pressure.
- C. Welded joints inspections and testing
1. Contractors shall procure services of a Lead Inspector.
    - a. Testing and inspections required herein and those required by ASME B31.1 and other applicable standards shall be planned, scheduled, organized, scoped, coordinated, and supervised by the Contractor's Lead Inspector.
    - b. Lead Inspector shall be independent of the subcontractor/trades performing the work, the manufacturer of the equipment, and the suppliers of the equipment.
    - c. Where Lead Inspector is appropriately certified, experienced and qualified, Lead Inspector may also conduct the respective inspections.
    - d. Lead Inspector shall coordinate and schedule inspections by applicable governmental authorities (e.g., TDLR – Texas Department of Licensing and Registration, Tx HHSC – Texas Health and Human Services Commission, TFC – Texas Facilities Commission, local inspection authorities, etc.) and by Owner representatives.
    - e. Lead Inspector shall coordinate, supervise, and direct Support Inspectors and Technical Specialists.
  2. Contractor shall provide support inspectors and technical specialists:
    - a. Contractor shall provide under this Section inspectors and other technical specialists as required to ensure a high grade of quality control of the work of this Section. Such inspectors and specialists shall be expertly qualified for the respective roles they perform, and may be: employees of the Contractor or respective subcontractor; technical representatives of the equipment manufacturer(s), approved for their respective role by the manufacturer(s); and/or independent inspectors/specialists hired by the Contractor (subcontractor) or manufacturer.
    - b. In addition to other roles occasioned by the work or required under this Section, Contractor's Support Inspectors and Technical Specialists shall: prepare for testing; inspect conditions to confirm they are ready for testing; conduct all pre-testing needed or appropriate to ensure readiness for Lead Inspector's or Owner's testing and commissioning verifications; and support as needed supplemental testing and commissioning verifications performed by Owner's Authorized Representative(s).
    - c. Manufacturer's inspector(s)/representative(s) shall be present at, and shall perform or otherwise actively assist/participate in, inspections and tests of this Section.

3. Contractor, through Contractor's Lead Inspector, shall be responsible for scheduling, coordinating and fully orchestrating inspections and tests so that: work completeness is appropriate for each stage of inspection/testing; appropriate/required attendees have confirmed attendance; and all other related parties (invited attendees) have been notified. In general, inspections and tests shall be confirmed approximately two weeks in advance, but in no case less than one week (unless by prior agreement amongst all required attendees).
  - a. Schedule all testing, start-ups, and Contractors commissioning activities well in advance of the need and advise Owner Representative(s) and Architect/Engineer in writing of the scheduled activities, including participation of each. Advise the Owner Authorized Representative(s), and Architect/Engineer immediately upon any proposed recommended changes in schedule.
  - b. Immediately upon completion of each testing, start-up or commissioning activity, **prepare and submit report detailing the testing, its scope, its performers, other participants, witnesses, and test results.** For results, clearly indicate test conditions and test criteria, not limiting the technical data to "pass/fail" entries in reports.
4. Except as indicated within this Section, testing, inspections, and commissioning shall be the responsibility of the Contractor's Lead Inspector, and such procedures shall be subject to being observed or witnessed by the Owner's Authorized Representative(s).
5. **Testing/Commissioning Organization Submittal:**
  - a. **Prior to fabrication of piping systems or placement of equipment, submit organizational diagram** of Contractor's testing/commissioning team for Section 23 01 00. Include: all testing/commissioning activities; generic parties responsible for leading each (e.g. subcontractor "x", manufacturer "y", independent party "z", Owner's Authorized Representative(s), etc.); parties conducting, participating in, or observing each; special certifications or qualifications required of each; required vs. invited participants; and names of individuals serving the respective roles (to the extent names are known at the time of submittal).
  - b. Prior to scheduling respective tests, secure the names, qualifications, and roles of the participating parties, including those to be provided by the Owner (Owner's Authorized Representatives). **Update submittal with this information by or before the respective testing/commissioning activity.**
6. Owner shall provide its authorized representative(s):
  - a. Owner's Authorized Representatives are separate from and independent of Contractor's Lead Inspector and Contractor's Support Inspectors and Technical Specialists. Owner's Authorized Representatives may observe, witness, or participate in inspections and tests conducted by Contractor or manufacturer.





Owner's Inspector concludes differently than the Contractors' Inspector, the two shall confer to confirm respective conclusions/positions. If concurrence is not reached, the decision of the Owner's Inspector shall govern the work required.

- D. Valves: Verify that valve construction is suitable for test pressures and notify Architect/Engineer of any concerns prior to testing. While under pressure tests, inspect all valves for leakage at joints, packing, stems, etc. Adjust all valves, flow controls, and other controls to function properly.
- E. **Reports: Within one (1) week after each test is performed, submit written report of test dates, procedures, testing mechanics, and results.** Indicate leaks and repair action as appropriate. Include certification by signatures of testing mechanics, trade superintendent, and Owner's representative or other witnesses.

3.13 VERIFICATIONS OF CONTRACTOR'S TESTING

- A. Contractor's testing shall be subject to partial or complete verifications with Owner's representative(s) or, including but not limited to the Architect/Engineer.
- B. Schedule, organize, and assist testing verifications as required. Refer also to Section 20 08 00 and perform work as described therein.

PART 4

**Mechanical/Fire Suppression/Plumbing Piping System Abbreviations, Systems Colors and Letter/Label Coloring**

Pipe Contents	Label Abbreviation	System Color	Label Colors (Background/Text)
Chilled Water Return	CHR	Light Gray	Green/White
Chilled Water Supply	CHS	Light Gray	Green/White
Condensate Drain	COND	Light Gray	Green/White
Deionized Water Supply	Deion Sup	N/A	Green/White
Deionized Water Return	Deion Ret	N/A	Green/White
Domestic Cold Water	DCW	Light Gray	Green/White
Domestic Hot Water Return	DHWR	Light Gray	Green/White
Domestic Hot Water Supply	DHW	Light Gray	Green/White
Fire Suppression Water	FIRE	Red	Red/White
Grease Waste (Kitchen)	GW	N/A	Black/White
Heating Water Return	HWR	Light Gray	Green/White
Heating Water Supply	HWS	Light Gray	Green/White
Natural Gas	N GAS	Safety Yellow	Yellow/Black
Pumped Condensate Return	PCR	Light Gray	Blue/White
Sanitary Vent	V	N/A	Green/White
Sanitary Waste	SAN	N/A	Green/White
Storm Drain	STORM	Light Gray	Green/White
Softener Water	SOFT W	Light Gray	Green/White

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West Campus Dining Facility

23 01 00-64  
BASIC MATERIALS AND METHODS FOR MECHANICAL WORK

END OF SECTION

## SECTION 23 01 60 - PUMPS

The General Conditions, any Supplementary General Conditions, and Division 1 - General Requirements are hereby made a part of this Section as fully as if repeated herein.

### PART 1 - GENERAL

#### 1.01 SCOPE

- A. Provide pumps as indicated by the drawings and as described herein. This section includes all pumps except where integral with a manufactured piece of equipment.

#### 1.02 RELATED WORK

- A. Section 23 00 10 - General Requirements for Mechanical Work
- B. Section 23 01 00 - Basic Materials and Methods for Mechanical Work
- C. Section 23 02 00 - Piping Systems Insulation
- D. Section 23 09 51 - Controls and Instrumentation
- E. Section 23 09 70 - Division 23 Testing, Adjusting, and Balancing

#### 1.03 SUBMITTALS

- A. **Provide submittals under provisions of Section 23 00 10 - General Requirements for Mechanical Work.**
- B. **Submit product data, including:**
  - 1. **Certified performance curves and rated capacities of selected model**
  - 2. **Dimensions and weights (shipping, installed, and operating)**
  - 3. **Furnished specialties and accessories**
  - 4. **Indicate pump's operating point on curves.**
  - 5. **Illustrate NPSH Curves for condenser water and similar pumps.**
  - 6. **Suction Diffusers: Should suction diffusers/guides be indicated by the drawings, submit letter by manufacturer on manufacturer's letterhead guaranteeing pump performance in accordance with the published pump curves of the proposed installation.**
- C. **Submit manufacturer's installation instructions and operations and maintenance data. Include:**
  - 1. **Installation instructions, assembly views, lubrication instructions, and replacement parts lists**

- D. **Provide specification copy mark-ups as required by Section 23 00 10.**

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Provide and install centrifugal water pumps for water service as scheduled. Pumps shall be statically and dynamically balanced and shall be constructed to permit complete servicing without breaking piping or motor connections.
- B. Pumps shall meet or exceed scheduled conditions, including flow, head, shut-off head, and efficiencies. Pumps shall operate at low noise levels not exceeding Hydraulic Institute and OSHA guidelines.
- C. Ensure pump pressure ratings are at least equal to system's maximum operating pressure at point where installed but not less than specified.
- D. Select pump/motor combinations for non-overloading operation throughout the pump operating range.
- E. Motors
1. Three phase motors shall be NEMA Premium efficiency, high power factor motors, equal to Baldor Super Efficient Premium E. All three phase motors shall be "drive rated" in accordance with the latest applicable IEEE bulletins/standards to ensure they are fully compatible with use with variable frequency drive speed controllers from at least 10 to 90 Hz. This requirement shall apply regardless of whether or not motors are served by variable frequency drives in design documents, so that future devices may be added without concern for motor change. **Submittal shall include motor manufacturer's warranty literature specifically addressing this subject, and shall include statement of compliance.**
  2. Single phase fractional horsepower motors shall be high-efficiency permanent split capacitor (PSC) motors.
  3. Unless otherwise indicated, provide open drip proof motors for inside installations and TEFC motors for outside installations.
  4. All motors shall have minimum of 1.15 service factor. All motors to operate in 208V or 240V systems shall be dual voltage rated for operation at either voltage.
  5. All motors shall have bearings rated for L-10 200,000-hour minimum life.
  6. Provide all three phase motors with shaft grounding rings equal to Aegis SGR. Mounting shall be in accordance with motor manufacturer's recommendations. **Indicate mounting method in submittals.**
  7. Provide multi-speed motors where indicated by scheduled equipment.
- F. Pump connections 2-1/2" or larger shall be flanged. Connections 2" or smaller may be screwed with unions provided.

- G. Heating water pumps shall be suitable for handling water at 230 degrees F.
- H. Provide base mounted pumps five horsepower (5 hp) or greater on factory inertia bases (with bases on housekeeping pads) with laterally stabilized unhoused spring type vibration isolators provided by the factory and intended for the specific application.
  - 1. Exception: Pumps below 5 hp may be provided without inertia bases and with vibration isolators as recommended by manufacturer or ASHRAE.
  - 2. **Submit all details of bases and vibration isolators for Architect/Engineer's review and acceptance.**
- I. Where requested by Architect/Engineer, provide for easily removable, shop fabricated insulated housing/shroud for reducing noise from 3500 rpm (nominal) pumps. Housing shall attenuate noise without restricting air movement or causing motor temperatures to rise. Verify details with Architect/Engineer.
- J. Manufacturer shall provide certified equipment start-up and an in the field certified training session.
  - 1. Pump start-up shall include determining pump alignment, lubrication, voltage, amperage readings, and rotation.
  - 2. Verify and document all proper electrical connections, pump's balance, discharge and suction gauge readings, and adjustment of head.
  - 3. **Submit a copy of the start-up report to both the contractor and to the Architect/Engineer.**
  - 4. Contractor shall include the report in Records for the Owner.

## 2.02 BASE MOUNTED PUMPS (HORIZONTAL SPLIT CASE OR END SUCTION)

- A. Acceptable Manufacturers
  - 1. Basis of Design: Aurora
  - 2. Other acceptable manufacturers
    - a. Bell & Gossett
    - b. Allis Chalmers
    - c. Paco
    - d. Taco
    - e. Weinman
    - f. Peerless
    - g. Armstrong

- h. Others where scheduled or specified
- B. General: The pumps shall be long coupled, base mounted, single stage, end suction, vertical split case design, in cast iron stainless steel fitted, specifically designed for quiet operation.
  - 1. Pumps shall be rated and suited for operation at the following conditions:
    - a. 225°F at 175 PSIG working pressure
    - b. 250°F at 250 PSIG working pressure
  - 2. Working pressures shall not be de-rated at temperatures up to 250°F.
  - 3. Pumps shall be composed of separable components: a motor, bearing assembly, shaft coupling, and pump end (wet end).
    - a. Motor: Refer to 2.01 above.
    - b. Shafts Coupling: the motor shaft shall be connected to the pump shaft via a replaceable flexible coupling.
      - 1) Exception: Close coupled pumps where so scheduled
  - 4. Pump shall be designed to allow for true back pull-out allowing access to the pump's working components, without disturbing motor or piping, for ease of maintenance.
  - 5. Each pump shall be hydrostatically tested 1.5 times the maximum rated working pressure and name-plated before shipment. **Submit report evidencing same at time of shipment.**
- C. Casing: Close grain cast iron design for heating systems with bronze wear ring and integrally cast pedestal volute support.
  - 1. Rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges.
  - 2. Volute shall include gauge ports at nozzles, and vent and drain ports.
- D. Impeller: Fully enclosed, keyed to shaft, trimmed for specific design conditions.
  - 1. Hydrostatically and dynamically balanced to ANSI/HI 9.6.4-2009, balance grade G6.3, or most recent equivalent standard.
  - 2. Impeller materials shall be:
    - a. bronze, or
    - b. stainless steel
- E. Shaft: High-grade alloy steel with:

1. gasketed bronze shaft sleeve
  2. stainless steel shaft sleeve for all iron pumps
- F. A bearing assembly shall support the shaft via two heavy-duty lubricated ball bearings.
1. Bearing assembly shall be replaceable without disturbing the system piping and shall have foot support at the coupling end.
  2. Pump bearings shall be lubricated without removal of the bearings from the bearing assembly.
  3. Thermal expansion of the shaft toward the impeller shall be prevented via an inboard thrust bearing.
  4. The bearing assembly shall have a solid SAE1144 steel shaft. A stainless steel shaft sleeve shall be employed to completely cover the wetted area under the seal.
  5. Bearings – L-10 200,000-hour minimum life with:
    - a. Permanently sealed requiring no external lubrication; or,
    - b. Oil lubricated roller or ball bearings with oil reservoirs; or
    - c. Grease lubricated roller or ball bearings with accessible grease fittings (mount).
    - d. Provide oil seal and integral dirt and water seal at each end of reservoir.

Note: Vertical shaft mounts shall have lower bearings designed so that condensate on pump casing or pump shaft does not drain onto bearing assembly, whether pump is operating or not. **Submit specific details and explanation thereof for this requirement.**

- G. Drive: A center drop-out type coupling, inverter duty rated, capable of absorbing torsional vibration, shall be employed between the pump and motor.
1. Pumps shall be provided with a suitable coupling sleeve. Coupling shall allow for removal of pump's wetted end without disturbing pump volute or movement of the pump's motor and electrical.
  2. Connections: Unless otherwise recommended by the manufacturer, coupling sleeve shall be constructed of a neoprene material to maximize performance life.
  3. An ANSI and OSHA rated coupling guard shall shield the coupling during operation. Coupling guard shall be dual rated ANSI B15.1 and OSHA 1910.219 compliant coupling guard and contain viewing windows for inspection of the coupling. No more than .25 inches of either rotating assembly shall be visible beyond the coupling guard.
- H. Seals: Pump shall be equipped with an internally-flushed (leakless) mechanical seal assembly installed in an enlarged tapered seal chamber. Application of an internally flushed mechanical seal shall be adequate for seal flushing without requiring external flushing lines.

1. Standard assembly shall have Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
2. For all heating water and other higher temperature applications, provide leakless mechanical seal of:
  - a. Viton/Ni Resist approved for 230°F continuous service
  - b. EPR/Carbon-Tungsten Carbide seal with 250° F maximum operating temperature, or
  - c. EPR/Silicon Carbide-Silicon Carbide seal with 225°F maximum operating temperature.
- I. Baseplate: Base plate shall be of high-grade heat treated structural steel or fabricated steel channel configuration fully enclosed at sides and ends, with securely welded cross members and fully open grouting area (for field grouting).
  1. The minimum base plate stiffness shall conform to ANSI/HI 1.3.8.2.1-2009 for grouted Horizontal Baseplate Design standards.
  2. Provide integral drain rim grout base and casing foot. Drain rim shall extend the entire length of the pump, encompassing the casing to at least the flange face of suction connection (and discharge connection for split case pumps).
  3. Provide with drain piped to floor drain.
- J. Alignment: Pump and motors shall be factory aligned, and shall be realigned after installation by the manufacturer's representative.
- K. Machined Fit Parts: Pump shall be of a maintainable design and, for ease of maintenance, shall use machine fit parts and not press fit components.
- L. Vibration: The pump(s) vibration limits shall conform to Hydraulic Institute ANSI/HI 9.6.4-2009 for recommended acceptable unfiltered field vibration limits (as measured per ANSI/HI 9.6.4-2009 Figure 9.6.4.2.3.1) for pumps with rolling contact bearings.
- M. Motor: Refer to 2.01 above.

## PART 3 - EXECUTION

### 3.01 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the site in such a manner as to protect the materials from shipping and handling damage. Provide materials on factory provided shipping skids and lifting lugs if required for handling. Materials susceptible to damage by the elements shall be packaged in such a manner that they could withstand short-term exposure to the elements during transportation.



- B. Store materials in clean, dry place and protect from weather, construction traffic, and construction dust/debris. Handle carefully to avoid damage.
- C. Use all means necessary to protect equipment before, during, and after installation.
- D. All scratched, dented, and otherwise damaged units shall be repaired or replaced as directed by the Architect/Engineer.

### 3.02 INSTALLATION

- A. General: Pump assemblies shall be installed in accordance with manufacturer's installation instruction and with provisions indicated herein and in the drawings.
- B. Housekeeping pads and inertia bases: Provide housekeeping pads for all base mounted pumps. Integrate with inertia bases where required.
- C. Grout pump bases: Unless manufacturer specifically **submits** that grouted bases are not required, and Engineer accepts the omission, grout all base mounted pump frames/bases.
- D. Suction piping: At a minimum, provide on suction side:
  - 1. Line-sized shut-off valve, wye type strainer (with blowdown to floor drain), reducer as required (reducing elbow or eccentric reducer for horizontal pumps), flexible connector, and a minimum of six piping diameters straight inlet to pump.
  - 2. Refer also to drawings.
  - 3. Suction diffuser/guide with integral strainer in lieu of wye type strainer is allowed only where indicated by drawings or where required by field conditions. (Submit and verify with Architect/Engineer prior to purchase and installation, as suction diffusers are not desired unless shown on drawings.)
- E. Discharge Piping: At a minimum, provide on discharge side:
  - 1. Reducer, flexible connector, line sized soft seated (non-slam, silent) check valve; venturi flow measurement where indicated by other requirements of the Construction Documents; and discharge balancing/shut-off valve.
  - 2. Refer also to drawings.
- F. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge pipes.
- G. Ensure pumps operate at specified or intended system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- H. Align pump/motor shafts. Qualified millwright shall check, align, and certify base mounted pumps prior to start-up. **Submit signed report from millwright documenting same**, including millwright's qualifications summary.
- I. Drainage provisions: Provide drainage and drainage piping to floor drains., consistent with the service.

1. Provide for seal drainage (or stuffing box, if applicable)
  2. Provide for condensate drainage on chilled water pump.
  3. For close coupled chilled water pumps, provide insulation as required to prevent condensate on motor/coupling elements. Verify details with Architect/Engineer, as required.
- J. Provide pressure taps with gauge cocks at strainer inlet, at pump suction, and at pump discharge. Pipe to common pressure gauge/control assembly board with snubbers. Refer also to drawings for details, where provided.

### 3.03 CONTRACTOR'S COMMISSIONING

- A. **Manufacturer's Startup:** Provide start-up by qualified and approved technical specialist representing the manufacturer of the products involved.
1. Verify all installation conditions are consistent with manufacturer's standards and the requirements of the construction documents.
  2. Confirm all conditions for operation are proper, including all pump accessories and approved installation practices.
  3. Refer also to Parts 2 and 3 herein.
- B. **Submit report** detailing the start-up procedures, including confirmation of proper lubrication, alignment, motor wiring connections, valves, strainers, reducers, gauges, and related accessories/peripherals.

### 3.04 VERIFICATION OF CONTRACTOR'S TESTING

- A. Contractor's testing shall be subject to partial or complete verifications with Owner's representative(s) or, including but not limited to the Architect/Engineer.
- B. Schedule, organize, and assist testing verifications as required. Refer also to Section 20 08 00 and perform work as described therein.

END OF SECTION