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E&C Engineers & Consultants Inc.
Texas Firm Registration No: F-003068
SECTION 23 00 00  
BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Basic Mechanical Requirements specifically applicable to Division 23 Sections, in addition to Division 01 - General Requirements.

1.02 RELATED DOCUMENTS:

A. THE UNIFORM GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, and DIVISION 01 of the Specifications apply to the work specified in this Section.

B. All work covered by this Section of these Specifications shall be accomplished in accordance with all applicable provisions of the Contract Documents and any addenda or directives which may be issued herewith, or otherwise.

1.03 GENERAL:

A. The Contractor shall execute all work hereinafter specified or indicated on accompanying Drawings. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the Drawings.

B. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation.

C. The Mechanical, Electrical, and associated Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

D. When the mechanical and electrical Drawings do not give exact details as to the elevation of pipe, conduit and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping, exposed conduit and the duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.

1.04 DEFINITIONS: (Note: These definitions are included here to clarify the direction and intention of this specification. The list given here is not by any means complete. For further clarification as required, contractor shall contact the designated Owner’s representative.)

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A. 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.

B. General Requirements: The provisions of requirements of other Division 01 sections apply to entire work of contract and, where so indicated, to other elements which are included in project. Basic contract definitions are included in the General Conditions.

C. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the Specifications, and to 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.

D. 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's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

E. 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.

F. Approve: Where used in conjunction with Architect's/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's/Engineer's responsibilities and duties as specified in General and 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's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

G. 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."

H. Furnish:

1. The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations."

2. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."

I. 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 operation."
J. Provide: The term "provide" means "to furnish and install, complete and ready for intended use."

1.05 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS:

A. General: Refer to DIVISION 01 for construction phasing and time increments.

B. Fees and Costs: Refer to Division 01 for payment requirements of fees and utility costs.

C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to City controlled services. If inspections by City personnel are specifically required by this document, refer to Division 01 for responsibility.

D. Compliance: The Contractor shall comply in every respect with all requirements of National Fire Protection Association, local Fire Department regulations and utility company requirements. In no case does this relieve the Contractor of the responsibility of complying with these Specifications and Drawings where specified conditions are of higher quality than the requirements of the above-specified authorities. Where requirements of the Specifications and Drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.

1.06 CONTRACT DOCUMENTS:

A. All dimensional information related to new structures shall be taken from the appropriate Drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

B. The interrelation of the Specifications, the Drawings, and the schedules are as follows: The Specifications determine the nature and setting of the several materials, the Drawings establish the quantities, dimensions and details, and the schedules give the performance characteristics. If the Contractor requires additional clarification, he shall request it in writing, following the contractually prescribed information flow requirements.

C. Should the Drawings or Specifications conflict within themselves, or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.10 FUTURE WORK

A. Provide for future work as noted below.

B. Areas of the project are designed for future build-out.

C. Piping, conduit, etc. that is installed in the shell & core shall be installed as noted on the drawings with the understanding that there will be build-out in these areas and routing shall be done in a manner to provide adequate clearance for those future utilities.

1.11 SUBMITTALS

A. Refer to Uniform General Conditions Article 8.

B. Proposed Products List: Include Products specified in the following Sections:

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1. Section 23 05 13 – Motors.
2. Section 23 05 48 – Vibration Isolation.
3. Section 23 05 53 – Mechanical Identification.
4. Section 23 05 93 – TAB – TAB Agent Requirements.
5. Section 23 05 93.A – TAB – Contractor Requirements.
6. Section 23 06 22 – Hydronic Specialties.
7. Section 23 07 16 – Equipment Insulation
8. Section 23 07 19 – Piping Insulation
9. Section 23 20 00 – HVAC Pumps
10. Section 23 20 00.A - Piping, Valves and Fittings
11. Section 23 21 00 – Hydronic Piping
12. Section 23 22 00 – Steam and Steam Condensate Piping
13. Section 23 22 00.A – Steam and Steam Condensate Specialties
14. Section 23 57 00 – Heat Exchangers

C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.

D. Mark dimensions and values in units to match those specified.

E. Submit Fabrication Drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space, (2) where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment, (3) where called for elsewhere in these Specifications; and (4) where specifically requested by the Architect/Engineer. Fabrication Drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

F. All required Fabrication Drawings, except as noted otherwise, shall be prepared at a scale of not less than 1/4" = 1'-0". Fabrication Drawings for ductwork, air handling units, and sections in Mechanical Rooms shall be drawn at a minimum scale of 3/8" = 1'-0". Submit three blueline prints of each Fabrication Drawing to the Architect/Engineer for review. Reproduction and submittal of the Construction Documents is not acceptable. The Architect/Engineer will review the drawing and return one print with comments.

1.12 SUBSTITUTION OF MATERIALS AND設備:

A. Refer to General Conditions for substitution of materials and equipment.

B. General: Within thirty days after the date of contract award or work order, whichever is later, and before purchasing or starting installation of materials or equipment, the Contractor shall
submit for review, a complete list of suppliers, contractors and manufacturers for all materials and equipment which will be submitted for incorporation into the project. The list shall be arranged in accordance with the organization of the Specifications. This initial list shall include the manufacturer's name and type or catalog number as required to identify the quality of material or equipment proposed. This list will be reviewed by the Engineer and the Owner and will be returned to the Contractor with comments as to which items are acceptable without further submittal data and which items will require detailed submittal data for further review and subsequent approval. The initial list shall be submitted as herein specified. Materials and equipment requiring detailed submittal data shall be submitted with sufficient data to indicate that all requirements of these Specifications have been met and samples shall be furnished when requested. All manufacturer's data used as part of the submittal shall have all inapplicable features crossed out or deleted in a manner that will clearly indicate exactly what is to be furnished.

C. It is not the intent of the Drawings and/or Specifications to limit products to any particular manufacturer nor to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products. When a manufacturer's name appears in these Specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

D. The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable. The burden of proof of equality rests with the Contractor. The decision of the designer is final.

E. When requested by the Architect/Engineer, the Contractor shall provide a sample of the proposed substitute item. In some cases, samples of both the specified item and the proposed item shall be provided for comparison purposes.

F. Timeliness: The burden of timeliness in the complete cycle of submittal data, shop Drawings, and sample processing is on the Contractor. The Contractor shall allow a minimum of six (6) weeks time frame for review of each submission by the office of the design discipline involved after receipt of such submissions by that design discipline. The Contractor is responsible for allowing sufficient time in the construction schedule to cover the aforesaid cycles of data processing, including time for all resubmittal cycles on unacceptable materials, equipment, etc. covered by the data submitted. Construction delays and/or lack of timeliness in the above regard are the responsibility of the Contractor and will not be considered in any request for scheduled construction time extensions and/or additional costs to the Owner.

G. All equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.

H. Acceptance of materials and equipment will be based on manufacturer's published data and will be tentative subject to the submission of complete shop Drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.

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I. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked and found to be correct with respect to dimensions and available space and that the equipment complies with all requirements of the Specifications.

J. Physical Size of Equipment: Space is critical; therefore, equipment of larger sizes than shown, even though of specified manufacturer, will not be acceptable unless it can be demonstrated that ample space exists for proper installation, operation, and maintenance.

K. Materials and Equipment Lists: Eight (8) copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer. The lists shall be accompanied by eight (8) sets of pictorial and descriptive data derived from the manufacturers’ catalogs, sales literature, or incorporated in the Shop Drawings.

L. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.13 MATERIALS AND WORKMANSHIP:

A. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use, and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.

B. The responsibility for the furnishing of the proper equipment and/or material and seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor who shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

1.14 FLAME SPREAD PROPERTIES OF MATERIALS:

A. Materials and adhesives incorporated in this project to be installed within return air plenums shall conform to NFPA Standard 255, "Method of Test of Surface Burning Characteristics of Building Materials" and NFPA 90. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

1.15 REGULATORY REQUIREMENTS

A. The "Authority Having Jurisdiction" over the project described by these documents is the Owner, as an Agency of the State of Texas. As such, it is required that the installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards, which are made a part of these Specifications. All referenced codes and standards shall be those current at the date of issue of the design documents.

B. National Fire Protection Association Standards (NFPA):

1. NFPA No. 13, Sprinkler System, Installation
2. NFPA No. 14, Standpipes and Hose Systems
3. NFPA No. 20, Centrifugal Fire Pumps
4. NFPA No. 37, Stationary Combustion Engines & Gas Turbines
5. NFPA No. 45, Fire Protection for Laboratories Using Chemicals
7. NFPA No. 54, Gas Appliances, Piping, National Fuel Gas Code
8. NFPA No. 70, National Electrical Code
9. NFPA No. 72D, Proprietary Signaling Systems
10. NFPA No. 78, Lightning Protection Code
11. NFPA No. 90A, Air Conditioning Systems
12. NFPA No. 91, Blower & Exhaust Systems
13. NFPA No. 99, Health Care Facilities
14 NFPA No. 101, Life Safety Code
15. NFPA No. 200, Series, Building Construction
16. NFPA No. 255, Method of Test of Surface Burning Characteristics of Building Materials
27. NFPA No. 258, Standard Research Test Method for Determining Smoke Generation of Solid Materials

C. American National Standards Institute (ANSI):
   1. A40.8, National Plumbing Code
   2. B31.1, Power Piping

D. American Gas Association Publications (AGA): Directory of Approved Gas Appliances and Tested Accessories

E. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes

F. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these Specifications.

G. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA): All current editions of applicable manuals and standards (See Sections 23 31 00.UT and 23 33 00.UT).
H. Air Moving and Conditioning Association (AMCA): All current editions of applicable manuals and standards.


J. American Water Works Association (AWWA): All current editions of applicable manuals and standards.

K. National Electrical Manufacturers’ Association (NEMA): All current editions of applicable manuals and standards.

L. City of Houston, Fire Department as may be applicable to construction on this site.

M. International Building Code, (Includes the International Mechanical and International Plumbing Codes)

N. Texas Occupational Safety Act: All applicable safety standards

O. Occupational Safety and Health Act (OSHA)

P. ADA and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards and the requirements of the American Disabilities Act.

Q. Texas State Fire Marshal Rules


T. Refer to Specification Sections hereinafter bound for additional Codes and Standards.

U. All materials and workmanship shall comply with all applicable state and national codes, Specifications, and industry standards. In all cases where Underwriters’ Laboratories, Inc. has established standards for a particular type material, such material shall comply with these standards. Evidence of compliance shall be the UL “label” or “listing” under Re-Examination Service.

V. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 01 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

1.16 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS:

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A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.

B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

C. Conformance with Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters' Laboratories, Inc., or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this Section of the Specifications conform to such requirements. The label of the Underwriters Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

D. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection.

E. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

F. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.

G. Verification of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

H. All mechanical and Plumbing equipment that is to be controlled or monitored by the building automation system shall be BACnet compatible.

1.17 WALL, FLOOR AND CEILING PLATES:

A. See Section 23 05 29.

1.18 SLEEVES, INSERTS, AND FASTENINGS:

A. See Section 23 05 29.
1.19 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Architect/Engineer before proceeding.

1.20 MANUFACTURER'S RECOMMENDATIONS

A. The manufacturer’s published directions shall be followed in the delivery, storage, protection, installation, piping, and wiring of all equipment and material. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturers’ directions, and shall obtain the Architect/Engineer’s instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturers’ directions or such instructions from the Architect/Engineer, he shall bear all costs arising in connection with the deficiencies.

1.21 SPACE AND EQUIPMENT ARRANGEMENT:

A. The size of mechanical and electrical equipment indicated on the Drawings is based on the dimensions of a particular manufacturer and a particular model. While other manufacturers and models may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space with all adequate clearances. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

1.22 LARGE APPARATUS:

A. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

1.23 PROTECTION:

A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.
B. Take particular care not to damage the building structure in performing work. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workmen or their tools and equipment during the construction of the building.

C. Equipment and materials shall be protected from rust both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these Specifications.

1.24 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS:

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades (including Controls and Testing and Balancing), subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.25 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT:

A. The Contractor shall note that the electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings, and should any mechanical equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

B. The Electrical Trades shall provide all interconnecting wiring for the installation of all power. The Electrical Trades shall provide all disconnect switches as required for proper operation, as indicated on the Drawings or required by applicable code. All combination starters, individual starters, and other motor starting apparatus not specifically scheduled or specified as provided by the equipment manufacturer under the scope of Division 23, shall be provided under the scope of Division 26.

C. The Mechanical Trades shall provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams shall be submitted to the Architect/Engineer for review within thirty (30) days after the submittals for equipment have been reviewed. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control Drawings, not a series of manufacturer's individual diagrams. After these diagrams have been reviewed by the Architect/Engineer, copies shall be transmitted to the Electrical Trades by the Contractor. They shall be followed in detail.

1.26 SUPERVISION:

A. Each Contractor and subcontractor shall keep a competent superintendent or foreman on the job at all times. (Refer to the Uniform General Conditions for additional information concerning supervision.)

B. It shall be the responsibility of each superintendent to study all Drawings and familiarize himself with the work to be done by other trades. He shall coordinate his work with other trades and before material is fabricated or installed, make sure that his work will not cause an interference with another trade. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved. Where interferences cannot be resolved without major changes to the Drawings, the matter shall be referred to the A/E for ruling.

1.27 SITE OBSERVATION:

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

1.28 PRECEDENCE OF MATERIALS

A. The specifications determine the nature and setting of materials and equipment. The drawings establish quantities, dimensions and details.

B. The installation precedence of materials shall be as follows. Note that if an interference is encountered, this shall guide the contractor in the determination of which trade shall be given the "Right-of-Way".

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<thead>
<tr>
<th>Building lines</th>
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<td>Structural Members</td>
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<td>Soil and Drain Piping</td>
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<td>Natural Gas Piping</td>
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<td>Domestic Water (Cold and Hot)</td>
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<td>Refrigerant Piping</td>
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<td>Electrical Conduit</td>
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1.29 CONNECTIONS FOR OTHERS:

A. The Mechanical Contractor shall rough in for and make all gas, water, steam, sewer, etc. connections to all fixtures, equipment, machinery, etc., provided by others in accordance with detailed roughing-in Drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

B. After the equipment is set in place, this Contractor shall make all final connections and shall provide all required pipe, fittings, valves, traps, etc.

C. Provide all air gap fittings required, using materials hereinbefore specified. In each service line connected to an item of equipment or piece of machinery, provide a shutoff valve. On each drain not provided with a trap, provide a suitable trap.

D. All pipe fittings, valves, traps, etc., exposed in finished areas and connected to chrome plated lines provided by others shall be chrome plated to match.

E. Provide all sheet metal ductwork, transition pieces, etc., required for a complete installation of vent hoods, fume hoods, etc., provided by others.

1.30 INSTALLATION METHODS:

A. Where to Conceal: All pipes, conduits, etc., shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.
B. Where to Expose: In mechanical rooms, janitor's closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.

C. Support: All piping, ducts and conduits shall be adequately and properly supported from the building structure by means of hanger rods or clamps to walls as herein specified.

D. Maintaining Clearance: Where limited space is available above the ceilings below concrete beams or other deep projections, pipe and conduit shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above-floor clearance. Sleeves shall be as herein specified. Approval shall be obtained from the Architect/Engineer for each penetration.

E. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping, ducts and conduits run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. Conduits in furred ceilings and in other concealed spaces shall be neatly grouped and racked indicating good workmanship. All conduit and pipe openings shall be kept closed until the systems are closed with final connections.

1. All piping not directly buried in the ground shall be considered as "interior piping".

2. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the construction inspector so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall give as much advance notice as possible no less than 10 working days.

3. All above-ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid, such as air inlets or outlets and lighting fixtures, shall be complete and installed in accordance with contract requirements, including power to lighting fixtures, fans, and other powered items. Adequate lighting shall be provided to permit thorough inspection of all above-ceiling items. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Architect/Engineer, Physical Plant, Resident Construction Manager's Construction Inspector(s), the Resident Construction Manager and Office of Facilities Planning and Construction (OFPC). Areas to be included and time of inspection shall be coordinated with the Construction Inspector.

4. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems. The ceiling supports (tee bar or lath) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.

5. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.

1.31 RECORDS FOR OWNER:

E&C Engineers & Consultants
E&C No. 3484.00
A. The Contractor shall maintain a set of “blueline” prints in the Field Office for the sole purpose of recording “installed” conditions. Daily note all changes made in these Drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.

B. At Contract completion the Contractor shall provide a set of reproducible revised drawings per Division 01. The contractor shall transfer the information from the “blueline” prints maintained as described above, and turn over this neatly marked set of reproducible Drawings representing the "as installed" work to the Architect/Engineers for verification and subsequent transmittal to the Owner. The Contractor shall refer to Division 01 of these Specifications, and to the Uniform General Conditions, for additional information. These Drawings shall include as a minimum:

1. Addendum written drawing changes.
2. Addendum supplementary drawings.
3. Accurate, dimensioned locations of all underground utilities, services and systems.
4. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.
5. Change Order written drawing changes.

C. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in duplicate, prepared in a neat brochure or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.

1. All warranties and guarantees and manufacturers' directions on equipment and material covered by the Contract.
2. Two sets of operating instructions for heating and cooling and other mechanical and electrical systems. Operating instructions shall also include recommended preventative maintenance and seasonal changeover procedures.
3. Valve tag charts and diagrams specified herein.
4. Approved wiring diagrams and control diagrams representing "as installed" conditions.
5. Copies of approved Shop Drawings.
6. Any and all other data and/or drawings required as submittals during construction.
7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.

F. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer.

1.32 ROOF PENETRATIONS AND FLASHING:

E&C Engineers & Consultants
E&C No. 3484.00
A. Pipe, conduit and duct sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided and installed by a qualified contractor for all roof penetrations. This shall be the responsibility of the General Contractor.

1.33 EXCAVATION, TRENCHING AND BACKFILL:

A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):

1. The Mechanical and Electrical subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the Drawings and/or required for the installation of piping, conduit, utility systems, etc. All exterior lines shall be installed with a minimum cover of 24", unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe. For sewers, the maximum width of trench specified applies to the width at and below the level may be made as wide as necessary for sheeting and bracing, and the proper installation of the work.

2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used. Bell holes for lead pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room for caulking. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. In general, grading for electrical ductbanks and conduits shall be from building to manhole, and from a high point between manholes to each manhole. Special pipe beds shall be provided as specified hereinafter.

3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by men especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 6" below the trench depths specified. The overdepth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to
a depth and for the trench lengths required, and then backfilled to trench bottom
grade, as hereinafter specified, with sand.

4. All grading in the vicinity of excavation shall be controlled to prevent surface ground
water from flowing into the excavations. Any water accumulated in the excavations
shall be removed by pumping or other acceptable method. During excavation,
material suitable for backfilling shall be stacked in an orderly manner a sufficient
distance back from edges of trenches to avoid overloading and prevent slides or
cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job
site as directed by the Construction Inspector.

5. All shoring and sheeting required to perform and protect the excavations and to
safeguard employees and/or adjacent structures shall be provided.

6. Excavate as required under the building in order that all piping, ductwork, etc., shall
clear the ground a minimum of 12" for a distance of 24" on either side. Edges of such
excavations shall slope at an angle of not over 45 degrees with the horizontal unless
otherwise approved by the Construction Inspector. The bottom of such excavation
shall be graded to drain in a manner acceptable to the Construction Inspector.

7. Trenches for cast iron drain, storm water and sewer lines inside the building shall be
properly excavated, following, in general, the procedures set out for exterior lines.
Where floors are to be poured over these lines, they shall be backfilled, tamped and
settled with water. Where no flooring is to cover the lines, they shall be backfilled to
form a level grade.

8. All surplus materials removed in these trenching operations becomes the property of
the contractor, and shall be disposed of at the expense of the contractor, at a legal
disposal site, off of the campus.

B. Backfilling:

1. Trenches shall not be backfilled until all required tests are performed and until the
piping, utilities systems, etc., as installed are certified by the Owner's inspector to
conform to the requirements specified hereinafter. The trenches shall be carefully
backfilled with sand to a depth of 12 inches above the top of the pipe. The next layer
and subsequent layers of backfill may be excavated materials approved for backfilling,
consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved
materials free from large clods of earth or stones larger than 1 1/2" in diameter,
flooded until the pipe has cover of not less than one foot. The remainder of the backfill
material shall then be thrown into the trenches, moistened, and tamped or flooded in
one foot layers. Blasted rock, broken concrete or pavement, and large boulders shall
not be used as backfill material. Any trenches improperly backfilled, or where
settlement occurs, shall be reopened to the depth required for proper compaction,
then refilled and mounded over, and smoothed off.

2. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or
shall be other such materials more suitable for the application. Installation and
compaction shall be as required for compatibility with adjacent materials.

C. Opening and Reclosing Pavement and Lawns: Where excavation requires the opening of
existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut
as required to install new lines and to make new connections to existing lines. The sizes of
the cut shall be held to a minimum, consistent with the work to be accomplished. After the
installation of the new work is completed and the excavation has been backfilled and
flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.

D. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 ft. to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction Inspector will give immediate instructions for the disposition of same. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

1.34 ACCESS DOORS:

A. General: This Contractor shall provide wall or ceiling access doors for unrestricted access to all concealed items of mechanical equipment or devices.

B. Doors: Access doors mounted in painted surfaces shall be of Milcor (Inland-Ryerson Construction Products Company) manufacture, Style K for plastered surfaces and Style M or DW for non-plastered surfaces. The Style K doors shall be set so that the finished surface of the door is even with the finished surface of the adjacent finishes. Access doors mounted on tile surfaces shall be of similar construction as noted above, except they shall be of stainless steel materials. Access doors shall be a minimum of 12" x 12" in size.

1.35 OPERATION PRIOR TO COMPLETION:

A. When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Construction Inspector's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.

B. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

1.36 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT:

A. Before the work is accepted, an authorized representative of the manufacturer of the installed materials and/or equipment shall personally inspect the installation and operation of his materials and/or equipment to determine that it is properly installed and in proper operating order. The qualifications of the representative shall be appropriate to the technical requirements of the installation. The qualifications of the representative shall be submitted to the owner for approval. The decision of the owner concerning the appropriateness of the representative shall be final. Testing and checking shall be accomplished during the course of the work where required by work being concealed, and at the completion of the work otherwise. In addition, the Contractor shall submit to the Architect/Engineer a signed statement from each representative certifying as follows: "I certify that the materials and/or equipment listed below have been personally inspected by the undersigned authorized
manufacturer's representative and is properly installed and operating in accordance with the
manufacturer's recommendations".

B. Check inspections shall include plumbing equipment, heating, air conditioning, insulation, venting equipment, controls, mechanical equipment and such other items hereinafter specified or specifically designated by the Architect/Engineer.

1.37 TESTS:

A. The Contractor shall make, at no additional cost to the Owner, any tests deemed necessary by the inspection departments having jurisdiction, and in the National Fire Protection Association, ASTM, etc. Standards listed. The Contractor shall provide all equipment, materials, and labor for making such tests. Reasonable amounts of fuel and electrical energy costs for system tests will be paid by the Owner. Fuel and electrical energy costs for system adjustment and tests which follow beneficial occupancy by the Owner will be borne by the Owner.

B. Additional tests specified hereinafter under the various Specification Sections shall be made.

C. The Construction Inspector shall be notified in writing at least 10 working days prior to each test and other Specification requirements requiring action on the part of the Construction Inspector. All equipment shall be placed in operation and tested for proper automatic control requirements before the balancing agency starts their work.

D. Maintain Log of Tests as hereinafter specified.

E. See Specifications hereinafter for additional tests and requirements.

1.38 LOG OF TESTS:

A. All tests shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel, description, and extent of system tested, test conditions, test results, specified results, and other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance". All Test Log entries shall be legibly signed by the Project Contractor or his authorized job superintendent.

1.39 COOPERATION AND CLEANUP:

A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition. At the end of each day's work, each trade shall properly store all of his tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.

1.40 CLEANING AND PAINTING:

A. All equipment furnished and installed in exposed areas under Divisions 23 and 26 of these Specifications shall be cleaned, prepared, and painted according to the specification for the equipment.

B. All purchased equipment furnished by the mechanical and electrical subcontractors shall be delivered to the job with a suitable factory protective finish with the colors hereinafter specified. The following materials shall not be painted: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.
C. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal work shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.

D. Color of finish painting noted shall be painted using Pratt and Lambert, Inc.'s "Effector" enamel, or approved equal. Two coats shall be applied with a light tint first coat and deep color for final coat. Colors shall be as follows:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>COLOR</th>
<th>&quot;P and L&quot; PAINT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Couplings and Fuel Gas Piping</td>
<td>Safety Yellow</td>
<td>Y361M (Daisy Yellow)</td>
</tr>
<tr>
<td>Fire Protection Equipment and Piping</td>
<td>Safety Red</td>
<td>R131R (Vibrant Red)</td>
</tr>
</tbody>
</table>

Note that the paint specified above is included for purposes of establishing a quality which shall be used on this project. The proposed paint shall be submitted, and alternatives will be considered using the submittal procedures specified in this document.

E. Jacketing on insulation shall not be painted.

F. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible due to the painting operation.

G. Scope of painting for Division 23 and 26 work in areas other than those defined as "exposed" is as follows:

1. All canvas finishes including those underfloor and in concealed spaces shall be painted with one sizing coat if not already sized, containing mildew resistant additive and Arabol adhesive prior to any other specified finish paint.

2. All fuel piping (natural gas, LPG, etc.) and all fire protection piping shall be painted whether concealed or exposed, in all areas of the project without exception. Fuel piping shall be painted safety yellow, and fire protection piping shall be painted safety red. These "safety" colors shall be as defined by OSHA. Primer and first color coat may be omitted on piping above ceilings.

3. If insulated, the piping shall be primed, only, prior to insulation, and the insulation jacketing shall be painted as specified for piping. The requirements of this paragraph are "primary" and have priority over any conflicting specification or instruction, should a conflict in the Construction Documents exist.

H. The surfaces to be finish painted shall first be prepared as follows:

1. On canvas finishes pretreat as specified above. Insulated surfaces having vapor barrier jacket exposed to view shall first be painted with one (1) coat of sealer.

2. Galvanized and black steel surfaces shall first be painted with one (1) coat of P&L galvanized metal primer. Primer may be eliminated on concealed fire and gas piping.

3. Aluminum surfaces shall first be painted with one (1) coat of P&L zinc chromate primer. (See Section 1.51.5)
4. Cast iron pipe shall first be primed with a "nonbleed" primer.

5. The underside of all cast iron sinks not recessed in a cabinet are included as items to be painted in exposed areas.

I. Where factory applied finishes are damaged in transit, storage or installation, or before final acceptance, they shall be restored to factory fresh condition by competent refinishers using the spray process.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 PIPE PRESSURE TESTS:

A. The following lines shall be tested 1.5 times working pressure or at least at the following stated pressure for the length of time noted:

<table>
<thead>
<tr>
<th>Service</th>
<th>Testing Medium</th>
<th>Pressure (PSIG)</th>
<th>Testing Time in Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water</td>
<td>Water</td>
<td>150</td>
<td>24</td>
</tr>
<tr>
<td>Steam M.P. &amp; L.P.</td>
<td>Water</td>
<td>150</td>
<td>24</td>
</tr>
<tr>
<td>Steam Condensate M.P.</td>
<td>Water</td>
<td>150</td>
<td>24</td>
</tr>
<tr>
<td>Steam H.P.</td>
<td>Water</td>
<td>300</td>
<td>24</td>
</tr>
<tr>
<td>Steam Condensate H.P.</td>
<td>Water</td>
<td>300</td>
<td>24</td>
</tr>
<tr>
<td>Pumped Condensate Return</td>
<td>Water</td>
<td>150</td>
<td>24</td>
</tr>
<tr>
<td>Domestic Hot &amp; Cold Water</td>
<td>Water</td>
<td>150</td>
<td>24</td>
</tr>
<tr>
<td>Sanitary &amp; Storm Piping</td>
<td>Water</td>
<td>Fill to top</td>
<td>24</td>
</tr>
<tr>
<td>Compressed Air</td>
<td>Air</td>
<td>150</td>
<td>24</td>
</tr>
<tr>
<td>Compressed Gases</td>
<td>Nitrogen</td>
<td>150</td>
<td>24</td>
</tr>
<tr>
<td>Medical Vacuum</td>
<td>Nitrogen</td>
<td>150</td>
<td>24</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Air</td>
<td>100</td>
<td>24</td>
</tr>
<tr>
<td>Fire Protection Systems</td>
<td>Water</td>
<td>150</td>
<td>24</td>
</tr>
</tbody>
</table>

B. Where leaks occur, the pipe shall be repaired and the tests repeated. No leaks shall be corrected by peening. Defective piping and joints shall be removed and replaced.

3.02 TRAINING REQUIREMENTS

E&C Engineers & Consultants
E&C No. 3484.00
### Hours of Training Required

<table>
<thead>
<tr>
<th>Task</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motors</td>
<td>0</td>
</tr>
<tr>
<td>Plumbing Specialties</td>
<td>2</td>
</tr>
<tr>
<td>Plumbing Fixtures and Trim</td>
<td>0</td>
</tr>
<tr>
<td>Hydronic Specialties</td>
<td>0</td>
</tr>
<tr>
<td>Steam and Steam Condensate Specialties</td>
<td>4</td>
</tr>
<tr>
<td>HVAC Pumps</td>
<td>0</td>
</tr>
<tr>
<td>Fan Coil Units</td>
<td>2</td>
</tr>
<tr>
<td>Electronic Variable Speed Drives</td>
<td>4</td>
</tr>
<tr>
<td>Pneumatic Controls</td>
<td>8</td>
</tr>
<tr>
<td>DDC Building Controls</td>
<td>8</td>
</tr>
<tr>
<td>Sequence of Operation</td>
<td>8</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1  GENERAL

1.00  The following sections are to be included as if written herein:
   A.  Section 23 00 00 – Basic Mechanical Requirements
   B.  Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C.  Section 23 05 53 – Mechanical Identification

1.01  SECTION INCLUDES
   A.  Single phase electric motors.
   B.  Three phase electric motors.
   C.  The Contractor shall provide all motors required for equipment supplied under this Division of
       the work.

1.02  RELATED WORK
   A.  Section 23 73 23 - Air Handling Unit with Coils: Fan motors

1.03  REFERENCES
   A.  AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   B.  AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
   C.  ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
   D.  ANSI/NEMA MG 1 - Motors and Generators.

1.04  SUBMITTALS
   A.  Submit product data under provisions of Section 23 00 00.
   B.  Submit test results verifying nominal efficiency and power factor for motors 1 horsepower and
       larger.
   C.  Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.05  OPERATION AND MAINTENANCE DATA
   A.  Submit operation and maintenance data under provisions of Section 23 00 00.
   B.  Include assembly drawings, bearing data including replacement sizes, and lubrication
       instructions.

1.06  QUALIFICATIONS
A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience. Marathon motors shall not be accepted.

1.07 REGULATORY REQUIREMENTS
A. Conform to ANSI/NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site under provisions of Section 23 00 00.
B. Store and protect products under provisions of Section 23 00 00.
C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.09 WARRANTY
A. Provide five year manufacturer's warranty under provisions of Section 23 00 00.
B. Warranty: Include coverage for motors 1 horsepower and larger.

PART 2 PRODUCTS
2.01 GENERAL CONSTRUCTION AND REQUIREMENTS
A. Electrical Service: Refer to Drawing Schedules for required electrical characteristics.
B. All Motors: Design for continuous operation in 40 degrees C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.
C. Totally Enclosed Motors: Design for a service factor of 1.00 and an 80 degrees C maximum temperature rise in the same conditions.
D. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.
E. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency.
F. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.
G. Motors shall be built in accordance with the latest ANSI, IEEE, and NEMA Standards, and shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled, and of approved manufacture as described herein, or of the same manufacture as the equipment which they serve. All motors provided by the Contractor shall be of the same manufacture unless they are an integral part of the piece of equipment to which they are attached. Nameplate rating of motors shall match the characteristics scheduled.
H. All motors shall be designed for NEMA Design B starting torque unless the driven machine requires high starting torque and shall be selected for quiet operation, free from magnetic hum.

I. In addition, all motors shall be provided with adequately sized electrical connection box with threaded hub for attachment of flexible conduit, unless bus duct connection is indicated. Where motors are connected to driven equipment by the use of a V-belt drive, they shall be furnished with adjustable rails.

J. Dynamic Balance shall be no greater than the vibration limits of the driven equipment as defined in Section 23 34 16 for fans and Section 23 20 00 for pumps.

K. All motors shall be provided with all copper windings, terminal wiring, and copper or bronze lugs. AL/CU rated connectors are not allowed.

L. All motors installed with direct-drive equipment shall be selected for rpm to match the rpm of the unit being served.

2.02 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

F. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors with drip-proof enclosures except as hereinafter specified. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.03 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

E. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.
2.04 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.
B. Starting Current: Less than five times full load current.
C. Pull-up Torque: Up to 350 percent of full load torque.
D. Breakdown Torque: Approximately 250 percent of full load torque.
E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
F. Enclosures shall be of the open drip-proof type with a service factor of 1.15 and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.
G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
H. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.05 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Enclosures shall be of the open drip-proof type with a service factor of 1.15 and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.
B. In general, all motors 3/4 horsepower and larger, unless smaller motors are indicated to be supplied as 3-phase, shall be 3-phase and shall be squirrel cage high efficiency induction type with standard NEMA frame sizes.
C. Motors 1 HP and larger shall have integral frames.
D. Starting Torque: Between one and one and one-half times full load torque.
E. Starting Current: Six times full load current.
F. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.
H. Insulation System: NEMA Class B or better.
I. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data. Test and balance motors to limits defined in 2.01J.
J. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of...
cast iron or aluminum with steel inserts.

K. Bearings: Ball or roller type, double shielded with continuous grease relief to accommodate excessive pressure caused by thermal expansion or over lubrication. All motor bearings shall be factory prepacked with a nondetergent lubricant, and shall be provided with lubrication fitting arranged to provide easy access when installed on the driven apparatus except as noted hereinafter. Permanently lubricated factory-sealed motors may be provided in fractional HP sizes only where they are an integral part of a piece of approved apparatus. All bearings shall be designed for B-10, 200,000 hour minimum life hours of continuous service. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

L. Sound Power Levels: Refer to ANSI/NEMA MG 1.

M. Part Winding Start Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

N. Weatherproof Epoxy Sealed Motors (Where Indicated): Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel. Bearings shall be double shielded with waterproof non-washing grease.

O. Nominal Efficiency: Meet or exceed values per 23 05 13-3.03 at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

P. Nominal Service Factor: Meet or exceed values per 23 05 13-3.02 at full load and rated voltage when tested in accordance with ANSI/IEEE 112.

Q. Motors 1 HP and larger shall be provided with a copper frame grounding lug of hydraulic compression design, for installation by the electrical subcontractor.

R. Motors 10 hp and larger shall be inverter duty rated and shall be provided with shaft grounding device.
D. Pushbuttons with or without pilot lights, hand-off-automatic switches and other scheduled apparatus shall be standard duty type mounted in NEMA enclosures or in cover of starter as specified or scheduled, and shall be furnished by the trade furnishing the starter except as specifically indicated elsewhere.

E. Hand-Off-Automatic switches for equipment which could damage itself if left in the "hand" position (such as sump pumps), shall be spring return to "off" from the "hand" position.

PART 3 EXECUTION

3.01 APPLICATION

A. Motors drawing less than 250 Watts and intended for intermittent service may be germane to equipment manufacturer and need not conform to these specifications.

B. Motors shall be open drip-proof type, except where specifically noted otherwise.

C. Motors shall be energy efficient type.

D. Single phase motors for shaft mounted fans or blowers shall be permanent split capacitor type.

E. Single phase motors for fans and pumps shall be capacitor start, capacitor run type.

F. Motors located in exterior locations shall be totally enclosed weatherproof epoxy-sealed type.

3.02 NEMA OPEN MOTOR SERVICE FACTORS

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3.03 Motor Efficiencies – Nominal, full load, three phase
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END OF SECTION
SECTION 23 05 48
VIBRATION ISOLATION

PART 1  GENERAL

1.00  The following sections are to be included as if written herein:

A.  23 00 00 -- Basic Mechanical Requirements
B.  23 05 29 -- Sleeves, Flashings, Supports and Anchors
C.  23 05 53 -- Mechanical Identification

1.01  WORK INCLUDED

A.  Inertia bases.
B.  Vibration isolation.

1.02  SCOPE OF WORK:

A.  Furnish and install all labor, materials, equipment tools and service and perform all operations required in connection with or properly incidental to the construction of complete system of vibration and noise control, as indicated on the Drawings, reasonably implied therefrom or as specified herein, unless specifically excluded.

1.03  REFERENCES

A.  ASHRAE - Guide to Average Noise Criteria Curves.

1.04  QUALITY ASSURANCE

A.  Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.

1.05  SUBMITTALS

A.  Submit shop drawings and product data under provisions of Section 23 00 00.
B.  Indicate inertia bases on shop drawings.
C.  Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.
D.  Submit manufacturer's installation instructions under provisions of Section 23 00 00.

1.06  CERTIFICATES

A.  Submit a certificate from the manufacturer that isolators are properly installed and properly adjusted to meet or exceed specified requirements.

1.07  INTENT OF RESPONSIBILITY:

A.  It is the intent of this specification to provide for vibration isolation supports for all equipment, piping, and ductwork as set out below. The transmission of perceptible vibration, structural borne noise, or objectionable air borne noise to occupied areas by equipment installed under
this contract will not be permitted. The Contractor shall be held responsible for installing the vibration isolators as specified herein or shown on the drawings or otherwise required to prevent the transmission of vibration which would create objectionable noise levels in occupied areas. The isolation supplier must be a firm capable of dealing effectively with vibration and noise characteristics effects and criteria; and one which can provide facilities and capabilities for measuring and evaluating the aforementioned disturbances.

B. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or supplier who will be responsible for adequate coordination of all phases of this work. Inertia bases shall be included as part of mechanical work. Pads under electrical gear shall be included as part of electrical work. The concrete work shall meet the requirements specified in the General Contract Specifications.

C. The Contractor shall furnish complete submittal data, including Shop Drawings, which shall indicate the size, type, and deflection of each isolator; and the supported weight, disturbing frequency, and efficiency of each isolator proposed; and any other information as may be required for the Architects and Engineers to check the isolator selection for compliance with the specification. All steel bases and concrete inertia bases shall be completely detailed, and shall show completely any reinforcing steel that may be required to provide a rigid base for the isolated equipment. Further, the submittal data shall indicate, clearly, outlined procedures for installing and adjusting the isolators and bases mentioned above.

D. The vibration isolation manufacturer, or his qualified representative, shall be responsible for providing such supervision as may be required to assure correct and complete installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation and before acceptance by the Owner, the isolation manufacturer or his qualified representative, in company with the Architect or his designated representative, shall make a final inspection and submit his report to the Architects and Engineers, in writing, certifying the correctness of the installation and compliance with approved submittal data. Any discrepancies or maladjustments found shall be so noted in the report. Should any noise or vibration be objectionable to the Owner, Architect or Engineer, a field instrumentation test and measurement must be made to determine the source, cause, and path of any such disturbance. Any variation or noncompliance with these specification requirements is to be corrected by the installing contractor in an approved manner.

E. Vibration isolation devices shall be as manufactured by Mason, Amber/Booth Company, Consolidated Kinetics, Korfund Dynamics Corporation, or approved equal.

PART 2 PRODUCTS

2.01 GENERAL DESIGN FEATURES:

A. All vibration isolators and bases furnished by the Contractor shall be designed for and treated for resistance to corrosion.

B. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc-electroplated or cad-plated. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.

C. All isolators exposed to the weather shall have steel parts PVC coated, hot-dip galvanized or zinc-electroplated plus coating of Neoprene or Bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel.

D. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these specifications, but in no case shall be less than one inch. The springs shall be capable of 30% over-travel before becoming solid.
E. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2" under the isolated structure, and designed so that the isolators can be installed and removed when the operating clearance is 2" or less. When used with spring isolators having a deflection of 2-1/2" or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.

F. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1" to 2".

G. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.

H. Isolators for equipment installed out-of-doors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind load of 55 PSF (pounds per square foot) applied to any exposed surface of the equipment without failure.

2.02 ISOLATOR TYPES: Isolator types and required deflections are specified under "Schedule of Isolated Equipment", paragraph 3.02. The isolators shall comply with the following descriptions for each type required on the project:

A. Type 1 - An adjustable, free-standing, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring(s) shall be rigidly attached to the mounting baseplate and to the spring compression plate. The isolator shall be designed for a minimum Kx/Ky (horizontal to vertical spring rate) of 1.0. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the baseplate. Baseplates shall be sized to limit pad loading to 100 psi.

B. Type 2 - An aluminum-housed, or cast iron housed, adjustable, spring mounting having telescoping top and bottom sections separated by resilient inserts of Neoprene or other suitable material to limit horizontal motion. The inserts shall be permanently lubricated to minimize vertical friction. Sheet or cast iron housings may be used if they are hot-dip galvanized after fabrication. A Neoprene pad having a minimum thickness of 1/4" shall be bonded to the baseplate.

C. Type 3 - An elastomeric mounting having steel base plate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric materials. The elastomer may be Neoprene or high synthetic rubber with anti-ozone and anti-oxidant additives. Mountings shall be designed for approximately 1/4" deflection and loaded so that deflection does not exceed 15% of the free height of the mounting.

D. Type 5 - A spring hanger consisting of a rectangular steel box, coil springs, spring cups, Neoprene impregnated fabric washer, steel washer, and Neoprene insert designed to prevent metal to metal contact between the hanger rod and bottom of the hanger box. The hanger box shall be capable of supporting a load of 200% of rated load without noticeable deformation or failure.

E. Type 6 - A spring hanger, as described in Type 5, with the addition of an elastomeric element at the top of the box for acoustic isolation. The design shall be such to prevent metal to metal contact between the hanger rod and the top of the hanger box. The elastomeric element shall meet the design requirements for Type 3 mountings.

F. Type 7 - An elastomeric hanger, consisting of a rectangular steel box and an elastomeric isolation element, which shall be of Neoprene or high quality synthetic rubber with anti-ozone and anti-oxidant additive. The elements shall be so designed for approximately 1/4" deflection
and loaded so that deflection does not exceed 15% of the free height of the element. The design shall be such as to prevent metal-to-metal contact between the hanger rod and the steel box.

G. Type 8 - 1/4" thick closed cell Neoprene ASTM Grade S.E.C. 44 in sheets cut to fit penetrations, as required.

2.03 BASE TYPES: Base types and required deflections are specified under "Schedule of Isolated Equipment", paragraph 7.8, or are indicated on the Drawings. The bases shall comply with the following descriptions for each type required on the project.

A. Type B-1 - A structural steel fan and motor base with motor side rails and holes drilled to receive the fan and motor. The steel members shall be adequately sized to prevent distortion and misalignment of the drive, and specifically shall be sized to limit deflection of the beam on the drive side to 0.05" due to starting torque. Snubbers to prevent excessive motion on starting or stopping shall be furnished, if required; however, the snubbers shall not be engaged under steady running conditions.

B. Type B-2 - A concrete inertia base, consisting of a perimeter steel pouring forming, reinforcing bars welded in place, bolting templates, anchor bolts, and height-saving brackets for side mounting of the isolators. The perimeter steel members shall be structural channels having a minimum depth of 1/12 of the longest span, but not less than 6" deep. The inertia base for pumps shall be at least equal in weight to the pump with its driving motor and be sized for a minimum overlap of 4" around the base of the equipment. Concrete inertia bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split-case pumps. The bases shall be T-shaped where necessary to conserve space.

PART 3 EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS:

A. Install vibration isolators for motor driven equipment.

B. Set steel bases for one inch clearance between housekeeping pad and base. Set concrete inertia bases for 2 inch clearance. Adjust equipment level.

C. Provide spring isolators on piping connected to isolated equipment as follows: Up to 4 inch diameter, first three points of support; 5 to 8 inch diameter, first four points of support; 10 inch diameter and over, first six points of support. Static deflection of first point shall be twice deflection of isolated equipment.

D. Pumps:

1. Each centrifugal pump and its driving motor shall be mounted on a common inertia base and the base, in turn, to be mounted on the scheduled vibration isolator type to prevent the transmission of vibration and noise to the building structure.

2. In general, all inertia bases shall be formed and poured in place onto a hard, flat surface from which the base can be separated when cured. The base shall be shimmed, using flat material, to the intended final height prior to equipment mounting and piping connection.

3. After the piping connections are made and the system filled with water and ready to put into service, the isolator adjustment bolts shall be extended until the shim blocks can be removed. The isolators may then be backed down slightly to restore the intended height.
The locknuts should then be tightened on the isolators. Jack bolts shall be trimmed to a length which will allow no more than 1 inch of additional height adjustment. After final adjustment, the inertia base shall not support any piping load.

E. Piping:

1. Floor mounted supports shall have the same type of isolator or media as is used for the nearest isolated equipment connected to the piping.

2. The pipe hanger system shall have provisions for all piping to be shimmed or blocked in place until all connections are made and the system filled with water; then, the isolators adjusted to support the weights, and the shim blocks removed.

3. The first three support points from a piece of isolated equipment shall be of the positioning type and provide not less than the static deflection of the equipment isolators.

4. All springs supporting piping shall be capable of an additional 1/2" deflection prior to complete compression and springs supporting vertical risers shall have provisions for limit stops.

F. Resilient Sleeves:

1. Resilient sleeves shall be provided at all points where equipment room walls, floors, or ceilings are penetrated by ducts, piping, or refrigerant line, etc.

G. Fans and Air Handling Units:

1. Such units shall have electrical flexible connections not less than 36" long and the flexible duct connections with a free length of not less than 8".

3.02 SCHEDULE OF ISOLATED EQUIPMENT:

A. Tabulated below is a schedule of equipment on this project requiring vibration isolation and base isolators of the types listed above. Any equipment, system, construction or condition that may be altered, added, or changed; or that is not specifically considered herein or on the plans shall be treated in a manner that is set out for similar equipment system or construction in order to comply with the above requirements heretofore cited.
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<th>ISOLATOR</th>
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END OF SECTION

- o o o -
PART 1 GENERAL

1.00 The following sections are to be included as if written herein:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors

1.01 SECTION INCLUDES
   A. Nameplates.
   B. Tags.
   C. Stencils.
   D. Pipe Markers.

1.02 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION
   A. NONE

1.03 RELATED SECTIONS
   A. Section 23 00 00 - Basic Mechanical Requirements.

1.04 REFERENCES

1.05 SUBMITTALS
   A. Submit under provisions of Section 23 00 00.
   B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
   C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
   D. Product Data: Provide manufacturers catalog literature for each product required.
   E. Samples: Submit two of each type of label, tag, etc., of the approximate size specified or implied in the specification.
   F. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.06 PROJECT RECORD DOCUMENTS
   A. Submit under provisions of Section 23 00 00.
   B. Record actual locations of tagged valves.

PART 2 PRODUCTS
2.01 NAMEPLATES

A. Manufacturers:
   1. Seaton.
   2. Other acceptable manufacturers offering equivalent products.
      a. Brady
      b. Bunting
      c. EMED

B. Description: Laminated three-layer plastic with engraved letters on contrasting background as hereinafter specified.

2.02 TAGS

A. Manufacturers:
   1. Seaton
   2. Other acceptable manufacturers offering equivalent products.
      a. W.H. Brady
      b. Bunting

A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

B. Chart: Typewritten letter size list in anodized aluminum frame.

2.03 PIPE MARKERS

A. Manufacturers:
   1. Seton
   2. Other acceptable manufacturers offering equivalent products.
      a. W.H. Brady
      b. Bunting
      c. EMED

B. Color: Conform to ASME A13.1.

C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

E. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

2.04 CEILING TACKS

E&C Engineers & Consultants
E&C No. 3484.00
A. Manufacturers:

1. Seton
2. Other acceptable manufacturers offering equivalent products.
   a. W.H. Brady
   b. Bunting
   c. EMED

B. Description: Steel with 3/4 inch (20 mm) diameter color coded head.

C. Color code as follows:

1. Yellow - HVAC equipment
2. Red - Fire dampers/smoke dampers
3. Green - Plumbing valves
4. Blue - Heating/cooling valves

2.05 General: The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fans, pumps, etc., shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same number as shown on the Drawings. For example, pumps will be identified as 3A, 3B, 3C, etc.; exhaust fans will be E-1, E-2, etc.; supply fans will be S-1, S-2, etc.

2.06 Mechanical: All items of mechanical equipment shall be identified by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16" thick, 3-ply, with black surfaces and white core. Engraving shall be condensed Gothic, at least 1/2" high, appropriately spaced. Nomenclature on the label shall include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled shall include but not be limited to the following:

- Pumps
- Exhaust Fans
- Fan and Coil Units
- Zoning Boxes/Valves
- Fire/Smoke dampers
- Air Conditioning Control
- Miscellaneous - similar
- Panels and Switches
- and/or related items

2.07 Piping: Pipe markers and arrow markers also shall be provided on but not limited to the piping of the following systems:

- Primary Chilled Water Supply
- Pumped Steam Condensate
- Natural Gas
- Primary Chilled Water Return
- High Pressure Steam Condensate
- Oxygen
- Instrument (Pneumatic) Air
- RO Water
- Atmospheric Relief
- Clean Steam
- Plumbing Piping
2.08 Electrical: Nameplates shall be 2 or 3 ply laminated plastic, a minimum of 3/32" thick, such that letters will be white on black background. Letters shall be similar to Roman Gothic of a size that is legible and appropriate to the application. Attachment of nameplates shall be by screws. Rivets or adhesives are not acceptable.

A. Electrical equipment to be identified includes: All switchgear, distribution panels, transformers, motor control centers, panelboards, disconnect switches, starters, contactors and time switches.

B. Nameplates on distribution panels, motor control centers and panelboards shall give voltage characteristics.

Example:

\[
\text{PANEL LA} \\
120/208V, 3 PH, 4 W \\
\text{served from ___}.
\]

C. Individual circuit breakers in distribution panels, individual units in motor control centers, disconnecting means, and motor starters, shall have nameplates showing the load served.

D. Branch circuit panelboards shall have neatly typed circuit directories behind clean plastic. Identify circuits by room numbers. Room numbers shall be those finally selected by the Owner; not necessarily those given on contract Drawings. If a circuit serves more than one room, list each room. Spares and spaces shall be indicated with erasable pencil; not typed.

2.09 The Contractor shall prepare and install, in a suitable glazed frame, typewritten valve charts giving the number, location and function of each line valve installed under this Contract. Each valve shall be numbered on these charts in accordance with the system of which it is a part of its location. For example, valves in different systems would be designated as follows:

- HPS-1-3 High Pressure Steam 1st Level - Valve No. 3
- CHS-2-4 Chilled Water Supply 2nd Level - Valve No. 4

2.10 Valve Tags:

A. The Contractor shall provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above. These tags are to be affixed to all valves except simple service and drain valves located within 10’ and within sight of the device or equipment served. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged. These tags shall be 1/8” thick brass discs, 1 1/2” in diameter. Each tag shall be attached to its valve with copper clad annealed iron wire or other approved material.

B. Valves at water headers and steam PRV stations, valves associated with condensate, gas, water meters, and other valves as specified shall also be tagged with standardized color coded plastic tags. These tags shall be 2 1/2" wide by 1 1/2" high with these color codings:
Red = normally closed; Green = normally open; Blue = open in winter, closed in summer; and
Yellow = closed in winter, open in summer. Tags should be engraved on both sides.

2.11 In addition, pipe runs throughout the building including those above lift out ceilings, under
floor, and those exposed to view when access doors or access panels are opened shall be
identified by means of Seton Setmark or Brady Mechanical Pipe Markers. Concealed areas,
for purposes of this identification section, are those areas which cannot be seen except by
demolition of the building elements. In addition to the pipe markers, arrow markers shall be
used to indicate direction of flow. The following specific instructions shall apply to the
application of these markers:

A. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where
several valves exist on one header, it is necessary to mark only the header.

B. Provide an arrow marker with each pipe marker pointing away from the pipe marker to
indicate direction of flow.

C. Provide a double ended arrow marker when flow can be in either or both directions.

D. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where line
goes through a wall or service column.

E. Provide pipe markers and arrow markers at intervals not exceeding 50 feet.

F. Markers shall be located on the two lower quarters of the pipe where view is unobstructed.

G. Use Seton Setmark Type SNA or Brady snap-on type identification for all piping systems,
3/4" thru 6". For piping systems larger than 6", use Seton or Brady strap on markers.

H. Pipe Markers shall conform to ANSI A 13.1-1981 "Scheme for the Identification of Piping
Systems". Arrow markers must have same ANSI background colors as their companion pipe
markers, or be incorporated into the pipe identification marker.

I. Locate markers so as to be visible from floor.

2.12 Specials: Refer to special requirements noted in the various sections hereinafter bound.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 91 00 for stencil painting.

3.02 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with
sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 09 91 00.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's
instructions.

F. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

G. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify thermostats relating to terminal boxes or valves with nameplates.

J. Identify valves in main and branch piping with tags.

K. Identify air terminal units and radiator valves with numbered tags.

L. Tag automatic controls, instruments, and relays. Key to control schematic.

M. Provide ceiling tacks to locate valves, dampers or other concealed equipment above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION
SECTION 23 05 93
SYSTEM TESTING, ADJUSTING AND BALANCING

PART 1  GENERAL

1.00 The following sections are to be included as if written herein:

A. 23 00 00 -- Basic Mechanical Requirements
B. 23 05 29 -- Sleeves, Flashings, Supports and Anchors
C. 23 05 53 -- Mechanical Identification

1.01 SUMMARY

A. Testing, adjusting and balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by an impartial technically qualified TAB firm selected and employed by the Owner, separate and apart from the construction contract.

B. The firm shall be capable of performing the services specified at the location of the facility described within the time specified, of preparing and submitting the detailed report of the actual field work performed, and following up the basic work as may be required.

1.02 QUALIFICATIONS

A. The Firm shall be one which is organized to provide professional services of this specified type in the State of Texas and as a minimum shall have one (1) professional engineer licensed in the State of Texas, with current registration, to perform such professional services. This engineer shall be personally responsible for developing the job site data as required in the test procedures outlined in these Specifications.

B. The Firm shall have operated a minimum of five (5) years under its current Firm name, and shall be in good standing with the State of Texas, Franchise Tax Board. The firm shall submit their full incorporated name, Charter Number and Taxpayer's I.D. Number for proper verification of the firm's status.

C. The Firm shall be capable of providing a performance bond, by a bonding company licensed to do business in the State of Texas, if determined by the Owner that such a bond is required. The amount of the bond which may be required shall be equal to the cost of the proposal submitted, or in the case of more than one proposal, the sum of all such proposals and any awarded work in progress.

D. All personnel used on the job site shall be either professional engineers or engineering technicians, who shall have been permanent, full time employees of the firm for a minimum of six (6) months prior to the start of work for this specific project.

E. The TAB firm shall submit biographical data on the individual proposed to directly supervise the TAB work, as well as other personnel scheduled to perform the technical work under the contract. It shall also submit a background record of at least five years of specialized experience in the field of air hydronic system balancing, and shall possess properly calibrated instrumentation. The supervisory personnel for the TAB firm shall be registered engineers in the mechanical field and all of the employees used in the TAB firm shall be permanent, full-time employees of the firm.

1.03 REFERENCES


1.04 DOCUMENTS

A. The TAB firm shall, as a requirement of the TAB contract, arrange with the Architect to compile one set of mechanical specifications, all pertinent change orders, and the following:

1. One complete set of Drawings less the structural sheets.

2. One set of mechanical floor plans of the conditioned spaces. These Drawings shall be ozalid type (blue or black on light background) reproductions to facilitate marking.

B. Approved submittal data on equipment installed, and related changes as required to accomplish the test procedures outlined in Paragraphs 1.06 through 1.10 of this Specification will be available through the Construction Inspector.

1.05 RESPONSIBILITIES OF THE TAB FIRM

A. The TAB personnel shall check, adjust, and balance the components of the air conditioning system which will result in optimal noise, temperature, and airflow conditions in the conditioned spaces of the building while the equipment of the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents. It is the responsibility of the Mechanical Contractor to place the equipment into service. Variable air volume systems shall be balanced in accordance with AABC 2002 Standard, Sixth Edition.

B. Liaison and Early Inspection:

1. The TAB firm personnel on the job shall act as liaison between the Owner, Architect and Contractor. The following reviews (observations) and tests shall be performed by the TAB Agency:

   a. During the design stage, before the documents are finalized, review the mechanical drawings and specifications for balanceability and provide commentary.

   b. During construction, review all HVAC submittals such as control diagrams, air handling devices, etc., that pertain to commissioning work and balanceability.

   c. Allow for a fixed number of trips to the project site, over and above those required for testing and balancing for inspection of installation of the mechanical piping systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems during the construction stage. These inspections shall be made prior to and/or at the above ceiling inspection. Commentary will be provided to the RCM of each observation.

   d. Test one (1) 8" single duct terminal box for performance capability and leakage as described in Section 23 36 00. The shipment of the box to the
TAB Agency's lab will be at the manufacturer's cost and the test period will be for three (3) weeks from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason the second test will be at the Contractor's cost and the time allowed will restart when the box is received at the TAB Agency.

e. Test one (1) 8" fan powered box for performance capability and leakage as described in Section 23 36 00A. The shipment of the box to the TAB Agency's lab will be at the manufacturer's cost and the test period will be for three (3) weeks from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason the second test will be at the Contractor's cost and the time allowed will restart when the box is received by the TAB agency.

f. Test 10% of the single and dual duct boxes for casing and damper leakage when the shipment arrives at the project site. All testing (except for the initial boxes) shall be performed on site.

Boxes requiring re-testing will be charged to the Contractor at the unit price provided to the Owner.

2. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the Construction Inspector shall be advised in writing so that the condition can be corrected by the Mechanical Contractor. The written document need not be formal, but must be understandable and legible. Data from malfunctioning equipment shall not be recorded in the final TAB report. The TAB firm shall not instruct or direct the Contractor in any of the work, but will make such reports as are necessary to the Owner.

1.06 FINAL HEATING AND STEAM BALANCE

General: When systems are completed and ready for operation, the TAB Consultant will perform a final water balance for each steam and hot water system. The general scope of balancing by the TAB Consultant will include, but not be limited to, the following:

1. **Adjusted System Tests:** Adjust balancing valves at each coil and heat exchanger for design flow, +5%. Adjust balancing valves at pumps to obtain design water flow. Record pressure rise across pumps and GPM flow from pump curve. Permanently mark the balanced position for each valve (Note: If discharge valves on the pumps are used for balancing record the head being restricted by the valves).

2. **Temperature Readings:** Read and record entering and leaving water temperature at each water coil, converter and heat exchanger. Adjust as necessary to secure design and conditions. Provide final readings at all thermometer well locations.

3. **Pressure Readings:** Water pressure shall be recorded at all gauge connections. Pressure readings at coils and pumps shall be related to coil and pump curves in terms of GPM flow through flow measuring status, if provided and installed, at each air handler. The flow of water through all water coils shall be adjusted by manipulating valves until the rated pressure drops across each coil is obtained and total water flow is verified by flow measuring status. For coils equipped with 3 way valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then be adjusted on each coil until an equal pressure drop between supply and return connections is the same as with the flow through the coil.

4. **Ampere Readings:** Reading and record full load amperes for each pump motor.
1.07 REPORTS

A. The activities described in this section shall culminate in a report to be provided in a single (1) bound copy to the RCM and six (6) electronic versions on CD or USB drive. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operations personnel.

B. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the reports must have been made onsite by the permanently employed technicians or engineers of the firm.

C. At the option of the Construction Inspector, all data sheets tabulated each day by TAB personnel shall be submitted for initial by the Construction Inspector. Those work sheets so initialed, or copies thereof, shall be presented as a supplement to the final TAB report.

D. Submit reports on forms approved by the Owner & Engineer which will include the following information as a minimum:

1. Title Page
   a) Company Name
   b) Company Address
   c) Company telephone number
   d) Project name
   e) Project location
   f) Project Manager
   g) Project Engineer
   h) Project Contractor
   i) Project Identification Number

2. Instrument List
   a) Instrument
   b) Manufacturer
   c) Model
   d) Serial Number
   e) Range
   f) Calibration date
   g) What test instrument was used for

3. Fan Data (Supply and Exhaust)
   a) Location
   b) Manufacturer
   c) Model
   d) Air flow, specified and actual
   e) Total static pressure (total external), specified and actual
   f) Inlet pressure
   g) Discharge pressure
   h) Fan RPM

4. Return Air/Outside Air Data (If fans are used, same data as for 3 above)
a) Identification/location
b) Design return air flow
c) Actual return air flow
d) Design outside air flow
e) Return air temperature
f) Outside air temperature
g) Required mixed air temperature
h) Actual mixed air temperature

5. Electric Motors
a) Manufacturer
b) HP/BHP
c) Phase, voltage, amperage, nameplate, actual
d) RPM
e) Service factor
f) Starter size, heater elements, rating

6. V-Belt Drive
a) Identification/location
b) Required driven RPM
c) Driven sheave, diameter and RPM
d) Belt, size and quantity
e) Motor sheave, diameter and RPM
f) Center-to-center distance, maximum, minimum and actual

7. Duct Traverse
a) System zone/branch
b) Duct size
c) Area
d) Design velocity
e) Design air flow
f) Test velocity
g) Test air flow
h) Duct static pressure
i) Air temperature
j) Air correction factor

8. Air Monitoring Station Data
a) Identification/location
b) System
c) Size
d) Area
e) Design velocity
f) Design air flow
g) Test velocity
h) Test air flow

9. Air Distribution Test Sheet
a) Air terminal number
b) Room number/location
c) Terminal type  
d) Terminal size  
e) Area factor  
f) Design velocity  
g) Design air flow  
h) Test (final) velocity  
i) Test (final) air flow  

10. Pump Data  
a) Identification/number  
b) Manufacturer  
c) Size/model  
d) Impeller  
e) Service  
f) Design flow rate, pressure drop, BHP  
g) Actual flow rate, pressure drop, BHP  
h) Discharge pressure  
i) Suction pressure  
j) Total operating head pressure  
k) Shut off, discharge and suction pressure  
l) Shut off, total head pressure  
m) Pressure differential settings  

11. Cooling Coil Data  
a) Identification/number  
b) Location  
c) Service  
e) Manufacturer  
f) Entering air DB temperature, design and actual  
g) Entering air WB temperature, design and actual  
h) Leaving air DB temperature, design and actual  
i) Leaving air WB temperature, design and actual  
j) Water pressure flow, design and actual  
k) Water pressure drop, design and actual  
l) Entering water temperature, design and actual  
m) Leaving water temperature, design and actual  
n) Air pressure drop, design and actual  

12. Heating Coil Data  
a) Identification/number  
b) Location  
c) Service  
d) Manufacturer  
e) Air flow, design and actual  
f) Water flow, design and actual  
g) Water pressure drop, design and actual  
h) Entering water or steam temperature, design and actual  
i) Leaving water temperature, design and actual  
j) Entering air temperature, design and actual  
k) Leaving air temperature, design and actual  
l) Air pressure drop, design and actual  

13. Sound Level Report
a) Location (Location established by the design engineer)
b) NC curve for eight (8) bands - equipment off
c) NC curve for eight (8) bands - equipment on

14. Vibration Test on equipment having 10 HP motors or above

a) Location of points:
   1) Fan bearing, drive end
   2) Fan bearing, opposite end
   3) Motor bearing, center (if applicable)
   4) Motor bearing, drive end
   5) Motor bearing, opposite end
   6) Casing (bottom or top)
   7) Casing (side)
   8) Duct after flexible connection (discharge)
   9) Duct after flexible connection (suction)

b) Test readings:
   1) Horizontal, velocity and displacement
   2) Vertical, velocity and displacement
   3) Axial, velocity and displacement

c) Normally acceptable readings, velocity and acceleration

d) Unusual conditions at time of test

e) Vibration source (if non-complying)

15. Control verification indicating date performed and any abnormalities identified.

a) Point Location/Description and verification back to graphics
b) EMS Readout (Setpoint and Actual)
c) Actual Readout
d) Interlocks
e) Safeties
   1) VSD Normal Operation
   2) VSD Bypass Operation
f) Alarms
g) Sequences of Operation

END OF SECTION
SECTION 23 05 93.A
SYSTEM PREPARATION FOR TESTING, ADJUSTING AND BALANCING

PART 1          GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements
B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
C. Section 23 05 53 – Mechanical Identification

1.01 SUMMARY

A. Perform all work required to prepare the building HVAC systems for testing, adjusting and balancing indicated by the Contract Documents as follows:

1. Responsibilities of project contractor.
2. Preparation for balancing of air systems.
3. Preparation for balancing of hydronic and steam systems.

B. The scope of the TAB work as defined in Section 23 05 93 is indicated in order that the Contractor will be advised of the coordination, adjustment, and system modification which will be required under the project work in order to complete the Owner's requirements for final TAB. The TAB firm will not have a contractual relationship with any Contractor referred to herein, but will be responsible to the Construction Inspector and the Owner for the satisfactory execution of the TAB work. The Contractor in his original bid shall allow for the costs required to cover all work which may be required in the TAB phases as defined herein and as may be necessary for the completion of the TAB work as defined by the TAB firm.

1.02 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements.
B. Section 23 06 20.13 - Hydronic Specialties.
C. Section 23 22 00.A - Steam and Steam Condensate Specialties.
D. Section 23 05 93 - System Testing, Adjusting & Balancing.

1.03 SCOPE OF WORK

A. Testing, adjusting, and balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by an impartial technically qualified TAB firm selected and employed directly by the Owner, separate and apart from the Construction Contract. However, the preparation for and corrections necessary for the Testing, Adjusting and Balancing of these systems, as described herein, are the responsibility of the Contractor.

B. As a part of this project Construction Contract, the Contractor shall make any changes or replacements to the sheaves, belts, dampers, valves, etc. required for correct balance as advised by the TAB firm, at no additional cost to the Owner.
C. The Contractor shall provide and coordinate the services of qualified, responsible Subcontractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting and balancing period.

D. In order that all systems may be properly tested, balanced, and adjusted as required herein by these Specifications, the Contractor shall operate said systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB. This length of time shall be subject to the approval of the Construction Inspector.

E. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The contractor shall allow adequate time for the testing and balancing activities of the owner provided services, during the construction period, and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.

F. The Drawings and Specifications indicate valves, dampers and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor or the Construction Inspector shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.

1.04 RESPONSIBILITIES OF THE PROJECT CONTRACTOR:

A. The Contractor shall:

1. Have the building and air conditioning systems in complete operational readiness for TAB work to begin.

2. The contractor shall allow sufficient time for the TAB firm to perform his contracted work within the construction schedule. The contractor shall complete his work by systems or floors whichever is the most efficient for scheduling. After awarding of the contract and the contractor has developed a construction schedule, a TAB coordination meeting shall be held at the RCM's office with the TAB agency, the general contractor and his primary subcontractors (i.e. mechanical, electrical, building automation etc.) to develop a testing schedule for the project. The contractor shall submit copies of the proposed schedule two (2) weeks prior to this meeting to the RCM and TAB Agency.

   The following are minimum time requirements:

   TAB Agency will provide Engineer with tentative schedules for each area, floor and/or system to be included in this section.

   Note: The hot water and chilled water systems must be 100% complete to balance. The air systems are pressure independent and can be balanced by floors, risers, systems, etc., but once the total system is complete the total flows and system tracking will require finalization. Lab certification will be performed when the building is 100% operational and balanced.

3. Promptly correct deficiencies of materials and workmanship identified as delaying completion of TAB work.
4. Be responsible for any added costs to the Owner resulting from his failure to have the building and air conditioning systems ready for TAB when scheduled, or from his failure to correct deficiencies promptly.

B. Complete operational readiness of the building requires that construction status of the building shall permit the closing of doors, windows, ceilings installed, etc., to obtain simulated or projected operating conditions.

C. Complete operational readiness of the air conditioning systems also requires that the following be accomplished:

1. Water Circulating Systems:
   a. Check and verify pump alignment and rotation.
   b. Open all valves to their full open position, close bypass stop valves. Set mixing valves to full-flow through systems components. After the system is flushed and checked for proper operation, remove and clean all strainers. The Contractor shall repeat the operation until circulating water is clean.
   c. Record each pump motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating.
   d. Verify that the electrical heater elements are of the proper size and rating.
   e. In preparation of TAB all water circulating systems shall be full and free of air, expansion tanks shall be set for proper water level, and all air vents shall be installed at high points of systems and operating freely. Systems shall be cleaned and flushed. Chemicals shall be added to closed systems to treat piping and inhibit corrosion.
   f. Check and set operating parameters of the heat exchangers and control devices to the design requirements.

B. Notification of System Readiness:

1. After completion of the work in Paragraph 1.05 A through C above, the Contractor shall notify the Owner in writing, certifying that the work has been accomplished and that the building and the air conditioning systems are in operational readiness for testing, adjusting, and balancing. He shall include a copy of the tabulated data of Paragraph 1.04.C.4 above.

2. The Owner will, in turn, notify the TAB firm of the readiness for balancing and forward copies of the Contractor's certification and the tabulated voltages and currents.

3. Should the TAB firm be notified as described above, and the TAB work commenced and the systems are found NOT to be in readiness or a dispute occurs as to the readiness of the systems, the Contractor shall request an inspection be made by duly appointed representative of the Owner, Architect, TAB firm and the Contractor. This inspection will establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for TAB services. Should the inspection reveal the TAB services notification to have been premature, all cost of the inspection and wasted work accomplished by the TAB firm shall be reimbursed to the appropriated parties by the Project Contractor.
1.05 RESPONSIBILITIES OF THE TAB FIRM

A. Refer to Section 23 05 93 entitled "System Testing, Adjusting and Balancing".

END OF SECTION
PART 1 GENERAL

1.00 The following sections are to be included as if written herein:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C. Section 23 05 53 – Mechanical Identification

1.01 WORK INCLUDED
   A. Expansion tanks.
   B. Air vents.
   C. Strainers.
   D. Pump suction fittings.
   E. Relief valves.
   F. Water flow measuring and balancing system.

1.02 RELATED WORK
   A. Section 23 00 00 - Basic Mechanical Requirements.
   B. Section 23 21 00 - Hydronic Piping.

1.03 REFERENCES

1.04 REGULATORY REQUIREMENTS
   A. Conform to ANSI/ASME Boilers and Pressure Vessels Code Section 8D for manufacture of tanks.

1.05 QUALITY ASSURANCE
   A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.06 SUBMITTALS
   A. Submit shop drawings and product data under provisions of Section 23 00 00.
   B. Submit shop drawings and product data for manufactured products and assemblies required for this project.
   C. Submit manufacturer’s installation instructions under provisions of Section 23 00 00.
1.07 OPERATION AND MAINTENANCE DATA
   A. Submit operation and maintenance data under provisions of Section 23 00 00.
   B. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

1.08 DELIVERY, STORAGE, AND HANDLING
   A. Deliver products to site under provisions of Section 23 00 00.
   B. Store and protect products under provisions of Section 23 00 00.

PART 2 PRODUCTS

2.01 AUTOMATIC AIR VENTS:
   A. Provide at the highest points of the chilled water system and on the chilled water coils as shown on the Drawings, an automatic air vent, Armstrong No. 21AR or approved equal, with a pressure rating of 250 psig. Provide shut-off valve to facilitate maintenance of air vent. Locate all air vents and their discharge lines in accessible locations, preferably clustered.

2.02 STRAINERS:
   A. Each control valve for chilled water and heating water, and each pressure reducing valve assembly regardless of its size shall be preceded by a sediment strainer. The arrangement of these sediment strainers shall be such that the screens may be removed for cleaning with ease through a gasketed plug. Monel or stainless steel shall be used to fabricate the noncollapsible, lapped screens, which shall contain no soldered joints.
   B. Sediment strainers shall be placed in piping systems wherever shown on the Drawings and at such other points as may be required for the removal of foreign material from the piping systems.
   C. Strainers for water piping 2-1/2" and larger shall be Crane No. 989-1/2 Sediment Separators or approved equal. In piping two inches (2") and smaller, they shall be Crane No. 988-1/2, or approved equal.
   D. Strainers, 2" and smaller, bronze body, screwed ends, No. 10 mesh strainer, screwed cap with bronze blow-off valve (size to be determined by standard tap size in cap). Cast iron body, 2 1/2" and larger, isolating type flanged ends where installed in copper lines, No. 7 perforated monel strainer, flanged cap with bronze ball blow-off valve (size of blow-off valve shall be determined by standard tap size in cap). Special Note: All strainers 6" and larger shall have studs mounted in the body flange in lieu of bolts for removal of cap. Baskets for strainers 6" and larger shall have stainless steel reinforcing bands at ends to prevent collapsing.
   E. Full sized blow off valves shall be installed on all strainers in steam, condensate, chilled and hot water lines and a drain shall be installed from each valve to the nearest floor drain.

2.03 GAUGES AND GAUGE CONNECTIONS:
   A. Furnish and install Ashcroft No. 1279A Duragauges on both suction and discharge sides of pumps, complete with Ashcroft No. 1095 lever handle shut-off cocks, and Ashcroft No. 1106B pulsation piston type dampeners, or approved equal. Porous type will not be accepted. See pump Specifications. Gauges shall have stainless steel movement and 1/2
of 1% accuracy. Gauges shall have back connection when used on a panel; otherwise they shall have bottom connections. The graduation of the dials and the arrangement of the mechanisms shall conform to the pressure range details shown on the Drawings.

B. Combination pressure or vacuum gauges shall be Ashcroft Duragauges No. 1279AC, or approved equal. The accessories for these gauges shall conform to those prescribed for pressure gauges.

C. Furnish and install, where noted or indicated on the accompanying Drawings or called for elsewhere in these Specifications, gauge connections complete with Ashcroft No. 1095 lever handle union shutoff cocks, or approved equal. All gauge connections shall be made up with brass pipe, nipples and brass screw fittings.

2.04 THERMOMETER AND THERMOMETER WELLS:

A. Furnish and install thermometers of not less than 9” scale complete with brass separable sockets with extension neck to allow for insulation of piping. These thermometers shall be mercury red reading type in one piece glass tubes extending from top of scale to sensor, and shall be located so that they may be easily read. Field adjustable angle thermometers are acceptable. Thermometers shall in all cases be installed upright or at the proper angle to be read while standing on the floor. The wells for thermometers shall be located in vertical pipes where possible and when necessary in horizontal pipes they shall be installed in the side and not on the top of the pipe. They shall be Weksler Industrial Thermometers, or approved equal, with range of 0 to 100 degrees F. for chilled water, and 0 to 220 degrees F for hot water.

B. Thermometer wells and thermometers shall be located where noted on the accompanying Drawings and where called for in other sections of the Specifications. Thermometer test wells only shall be installed in a vertical position in horizontal lines and at 45 degrees, in vertical lines to hold a fluid in the well.

C. Thermometer test wells shall be 3/4” Weksler Thermal Wells, brass with stem of minimum length to extend beyond the mid-diameter of the pipe, 2-1/2” extension neck, and brass screw plug. Wells shall be suitable for use of industrial type thermometers.

D. Indicating thermometers shall be placed in lines wherever shown on the Drawings. These thermometers shall be Weksler Industrial Thermometers having stainless steel separable sockets and scales of the range shown on the Drawings.

2.05 WATER RELIEF VALVES:

A. The pressure relief valves installed for the protection of the water circulating circuits shall be McAlear No. 307 single seated diaphragm and spring type valves with screwed connections or approved equal. They shall be 3/4” size of bronze construction with bronze seat, composition shut-off disc and rubber diaphragm.

PART 3 EXECUTION

3.01 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions to permit intended performance.

B. Support tanks inside building from building structure in accordance with manufacturer's instructions.
C. Provide manual air vents at system high points and as indicated.

D. Provide manual air vents at entrance to all heating hot water coils, with a "cane" shaped discharge tube, positioned to permit draining to a portable receptacle.

E. For automatic air vents in ceiling spaces or other concealed locations, extend vent tubing to nearest drain.

F. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems. Clean all permanent strainers after circulating systems for a minimum of 48 hours at full capacity.

G. Support pump fittings with floor mounted pipe and flange supports.

H. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

I. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

J. Pipe relief valve outlet to nearest floor drain.

K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

L. Heating water branch lines serving reheat coils shall have a balancing valve with memory stop and flow measuring station located upstream of the shut-off valve on the return side similar to Tour and Anderson.

M. Provide pressure/temperature test port in a straight run of pipe adjacent to each temperature or pressure sensor installed in the hydronic piping and at the inlet and outlet of each pump and coil to facilitate proper calibration and maintenance.

N. Provide to the owner, one portable flow meter equivalent to Omega FDT-81.

END OF SECTION
PART 1   GENERAL

1.00   The following sections are to be included as if written herein:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C. Section 23 05 53 – Mechanical Identification

1.01   SECTION INCLUDES
   A. Equipment insulation.
   B. Covering.
   C. Breaching insulation.

1.02   RELATED SECTIONS
   A. Section 09 91 00 - Painting: Painting insulation covering.
   B. Section 23 00 00 - General Mechanical Requirements.
   C. Section 23 05 53 - Mechanical Identification.

1.03   REFERENCES
   A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
   G. ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
   H. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   I. ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.
   J. ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
   K. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
M. ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
N. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
O. ASTM E84 - Surface Burning Characteristics of Building Materials.
R. UL 723 - Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS
A. Submit under provisions of Section 23 00 00.
B. Product Data: Provide product description, list of materials and thickness for equipment scheduled.
C. Samples: Submit two samples of any representative size illustrating each insulation type.
D. Manufacturer’s Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE
A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with NFPA 255.

1.06 QUALIFICATIONS
A. Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.
B. Deliver materials to site in original factory packaging, labeled with manufacturer’s density and thickness.
C. Store insulation in original wrapping and protect from weather and construction traffic.
D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.08 ENVIRONMENTAL REQUIREMENTS
A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.
PART 2 PRODUCTS

2.02 CONDENSATE RECIEVER

A. Receivers of the condensate shall be insulated with 6 lb. (minimum) density fiberglass board or rigid wrap insulation with a factory applied All Service Jacket. All joints shall be filled with insulating cement and covered with All Service Jacket material stapled in place and sealed with adhesive. Thickness shall be 1 ½” and provide a vapor barrier similar to chilled water piping.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install materials in accordance with manufacturer's instructions.

B. Do not insulate factory insulated equipment.

C. On exposed equipment, locate insulation and cover seams in least visible locations.

D. Apply insulation close to equipment by grooving, scoring, and bevelling insulation. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

F. Insulated dual temperature equipment or cold equipment containing fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory applied or field applied.
   2. Finish with glass cloth and vapor barrier adhesive.
   3. Insulate entire system.

G. For insulated equipment containing fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
   2. Finish with glass cloth and adhesive.
   3. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
   4. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union.

H. Inserts and Shields:
   1. Application: Equipment 2 inches diameter or larger.
2. Shields: Galvanized steel between hangers and inserts.

3. Insert location: Between support shield and equipment and under the finish jacket.

4. Insert configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.

5. Insert material: Heavy density insulating material suitable for the planned temperature range.

I. Finish insulation at supports, protrusions, and interruptions.

J. For equipment in mechanical equipment rooms or in finished spaces, finish with aluminum jacket.

K. For exterior applications, provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

L. Cover cellular glass and cellular foam insulation with aluminum jacket.

M. Do not insulate over any nameplate or ASME stamps. Bevel and seal insulation around such.

N. Install insulation for equipment requiring access for maintenance, repair, or cleaning, in such a manner that it can be easily removed and replaced without damage.

O. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

P. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

Q. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

R. All surfaces to be insulated shall be clean and dry before applying the insulation. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3”). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. All materials used shall be fire retardant or nonflammable.

S. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation
with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

T. Extreme Care shall be taken in covering high and medium pressure (high and medium pressure ductwork shall be all ductwork between the fan discharge and mixing boxes) ductwork to insure the duct is not pierced with sheetmetal screws or fasteners. All high and medium pressure ducts in these specifications are classified as high velocity ductwork.

U. Where specified, aluminum bands shall be used on piping insulation. The bands shall be applied 3 to a section of pipe. Fittings, valves, etc., shall have bands on each side.

V. Where canvas finish is specified, use Arabol lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating.

W. For purpose of definition in this Specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

X. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturer’s recommendations.

END OF SECTION
SECTION 23 07 19
PIPING INSULATION

PART 1  GENERAL

1.00.  The following sections are to be included as if written herein:

A.  23 00 00 -- Basic Mechanical Requirements
B.  23 05 29 -- Sleeves, Flashings, Supports and Anchors
C.  23 05 53 -- Mechanical Identification

1.01.  SECTION INCLUDES

A.  Piping insulation.
B.  Jackets and accessories.

1.02.  PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

C.  Section 23 21 00 - Hydronic Piping: Placement of hangers and hanger inserts.
D.  Section 23 22 00 - Steam Piping: Placement of hangers and hanger inserts.

1.03.  RELATED SECTIONS

A.  Section 09 91 00 - Painting: Painting pipe and insulation jacket.
B.  Section 23 00 00 - General Mechanical Requirements.
C.  Section 23 05 53 - Mechanical Identification.

1.04.  REFERENCES

A.  ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
E.  ASTM C449 - Mineral Fiber Hydraulic-setting Thermal
G.  ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.
H.  ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
J. ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.

K. ASTM C578 - Preformed, Block Type Cellular Polystyrene Thermal Insulation.

L. ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

M. ASTM C591 - Rigid Preformed Cellular Urethane Thermal Insulation.

N. ASTM C610 - Expanded Perlite Block and Pipe Thermal Insulation.

O. ASTM C640 - Corkboard and Cork Pipe Thermal Insulation.


Q. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.


S. ASTM D2842 - Water Absorption of Rigid Cellular Plastics.


W. UL 723 - Surface Burning Characteristics of Building Materials.

1.05. SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Product Data: Provide product description, list of materials ‘k’ value, ‘R’ value, mean temperature rating, and thickness for each service, and locations.

C. Samples: When requested, submit two samples of any representative size illustrating each insulation type.

D. Manufacturer’s Installation Instructions: Submit the manufacturer’s published installation documents for installation details, support and anchor methods, sealing, installation procedures and installation environment. Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.06. QUALITY ASSURANCE

A. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor’s submittal data for this section of the Specifications. No material may be used that, when tested by the
ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

B. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together without voids. A mastic filler is not acceptable to fill voids. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3") on end sections and the longitudinal tape shall be 4" on jackets. Where insulation terminates, it shall be neatly beveled and finished moisture proof. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 23 00 00.

C. No insulation material shall be installed in combination with or contiguous to other types of insulation in a manner which could adversely impact the performance of either insulation material.

D. All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

E. The manufacturer’s representative for the insulation shall visit the site a minimum of 4 times to review the installation practices, confer with the installer and prepare a field observation report that notes variations from manufacturer’s recommendations or recommendations to improve the installations.

F. To be considered, alternate materials shall have equivalent thermal, permability, water absorption and moisture resistance of the specified materials.

1.07. QUALIFICATIONS

A. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation.

B. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work and torn vapor jackets will not be acceptable and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation. The company performing the work of this section shall have a minimum of three years experience specializing in the trade.

1.08. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 23 00 00.

B. Deliver materials to site in original factory packaging, labeled with manufacturer’s identification, including product thermal ratings and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

1.09. ENVIRONMENTAL REQUIREMENTS
A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

C. All insulation materials to be asbestos free.

PART 2 PRODUCTS

2.03 STEAM AND CONDENSATE PIPING:

A. Steam and condensate piping in the main loop system and up to and including PRV’s and in the building shall be insulated with Manville’s Thermo-12 or Owens/Corning “Kaylo” calcium silicate insulation with a factory applied aluminum cover .016” thick (Metal-On). If metal-on factory applied cover is not available, provide a manufacturer’s written letter and provide for a filed-installed aluminum jacket as specified herein. Joints shall be sealed with aluminum snap straps provided, fastened in place with ⅜” wide x .020” stainless steel bands. Fittings and valves shall be insulated with the same thickness as that applied to the adjacent pipe and shall have an outer removable covering of aluminum as manufactured by Premetco.

B. Consideration will be given to the use of Manville’s Thermo-12 or Owens/Corning “Kaylo” with an outer covering of Premetco smooth finish, pre-cut, pre-rolled, Kraft paper lined aluminum Jacketing with zee type closure and 1-3/4” wide snap strap with permanent sealant in lieu of “Metal-On”. Thickness of this jacketing shall be .016” on pipe sizes 8” and smaller and .020” on 10” pipe and larger.

C. If Premetco jacketing is used, it shall be aluminum banding (.020N thick) using three section of covering

D. Pipe insulation shall be firmly wired in place by the use of no less than six (6) loops of No. 16 annealed copper clad iron wire per three foot section of insulation. These sections shall be staggered. The ends of these loops shall be twisted together tightly and bent over and hammered into the insulation so as to leave no projection. Bands shall be .020” thick, ⅜” wide, 3 bands per section of insulation. Fittings, valves, etc., shall have bands on each side.

E. All fittings on pipe 4” and larger shall be covered with the same material as the pipe, mitered and smoothed, and securely wired to the pipe.

F. Fittings and valves for pipe smaller than 4” shall be insulated with Manville’s No. 301 hydraulic setting cement and each application shall be in layers not thicker than ½”. Each layer shall be allowed to dry before the next layer is applied.

G. All cracks and voids in this insulation shall be filled carefully with Manville’s Cement No. 301 so that the resulting surface is smooth and continuous.

H. At all pipe flanges, the insulation shall be beveled in such a manner that access may be had to the bolt studs and nuts without injuring the insulation where removable covers have been specified.

I. A layer of 40 pound rosin-size paper or ¾ pound deadening felt shall be wrapped around the insulation before an 8 ounce canvas jacket is pasted in place. This canvas jacket shall be pasted onto the covered pipe valves and fittings (where insulated) in a neat and workmanlike fashion, using Arabol adhesive.
J. All flanges, valves, pressure regulating valves, strainers, and any other hot surfaces shall be covered with a built-up removable covering made of Thermo-12 or “Kaylo” Pipe Covering with a finishing coat of Ryder hydraulic setting cement. This removable covering shall be banded on the valve or joint in such a fashion that it can readily be removed and replaced; it shall be of the same thickness as the insulation on the adjoining pipe.

K. Piping insulated with calcium silicate pipe insulation and finished with canvas outer jacket shall be properly labeled.

L. Refer to Section 23 05 53 for Mechanical Identification requirements.

M. Blankets by Specialty Insulation Solutions or equal manufacturer, may be used on steam traps, strainers, and all other items that require regular maintenance for ease in removal and replacement.

2.04. CHILLED & HEATING WATER PIPING:

A. Chilled Water Piping - “FOAMGLAS” as manufactured by the Pittsburgh Corning Corporation Insulation and shall be installed on chilled water lines in tunnels and in buildings. The “FOAMGLAS” “StrataFab System” may also be installed on larger pipe sizes as appropriate. Prior to application of any insulation, all metal surfaces shall be thoroughly cleaned. The metal shall then be primed with an asphaltic primer consisting of one (1) coat of Foster No. 60-26 Primer or Pittcote 300 Primer. Cleaning and priming specified in this paragraph is not included in requirements for “Cleaning and Painting” specified in other sections of the Specifications. Regular “FOAMGLAS” insulation shall be applied to the piping with butt joints staggered and all joints tightly butted and sealed with a ¼” bead of joint sealer ½” from outside edge. Hold in place with 14 ga. copper clad wire 9” o.c. After insulation has been wired in place, a 1/16” minimum thick, 3” wide band of asphaltic vapor seal mastic shall be brushed or trowelled on the outside of the “FOAMGLAS” insulation at the approximate location of the aluminum bands. (Note that the asphaltic material specified in this paragraph is intended to be an exception to the flame spread and smoke generation limitations found elsewhere in this specification.) Any voids in the completed installation of the insulation shall not be filled with vapor seal coating but shall be eliminated by refitting or replacing insulation.

B. Chilled Water Piping Alternate: Insul-Phen as manufactured by Reolco or “KOOLPHEN K” as manufactured by Kooltherm. These materials shall be installed in strict compliance with the more stringent of these specifications or the manufacturer’s published installation manual which shall be available on site at all times. For cold water pipe all horizontal and circumferential joints shall be sealed with a very thin coat of vapor barrier mastic prior to closing the joints. All joints shall be staggered. The vapor barrier jacket shall be equal to Venture Wrap 1555W/U 3.4 mil, “0” perm cleanable material with 4” seam tape overlap and 6” joint tape or equal. Refer to the foamglass above for the method of insulating valves, fittings, etc. If Insulphen or Koolphen are used, an aluminum jacketing 0.016” thickness equal to Premetco precast will be required, pre rolled Z-lock Kraft paper lined pipe covering with zee type closure and ¾” wide snap straps with permanent sealant shall then be fitted to O.D. of insulation and applied over the insulated pipe with 4” end and side caps secured with aluminum bands on 12” centers. Longitudinal joint of aluminum jacketing shall be placed with overlap directed to bottom of pipe.

C. For cold water pipe, seal the ends of insulation and provide vapor dams at each end location or every 18’, which ever is shorter. Provide vapor dams between pipe and insulation at each flange, valve, change to vertical and end of insulation at equipment.
D. “FOAMGLAS”, “Insul-Phen” or “KOOLPHEN K” insulation on flanges, valves and other fitting shall consist of prefabricated fitting covers of the same thickness as specified for adjoining pipe insulation per the manufacturer’s published installation instructions.

C. Fitting covers shall be applied in same manner as pipe application except that 16 ga. aluminum wire may be used to secure fitting covers. Protruding metal parts (such as valve stems) shall be completely sealed off. Fitting cover jacketing shall be equal to Gasco, Papco or RPR Metals prefabricated fitting covers of 0.016” paper coated aluminum, secured as recommended by the manufacturer.

D. The insulation thickness shall be as scheduled.

E. “FOAMGLAS”, Insul-Phen, or “KOOLPHEN K” installed inside the building (where ambient conditions are typically below 76°F and humidities are below 60% RH) shall be installed with factory applied Class I, Fire Rated, Kraft-Aluminum jacketing on heating water and “0” perm jackets on cold water pipe, with 4” longitudinal laps and 6” joint tape. It shall be applied in strict accordance with the manufacturer’s recommendations after the pipe has been primed with one (1) coat of Foster No. 60-26 Primer or Pittcoat 300 Primer. (Note that the asphaltic material specified in this paragraph is intended to be an exception to the flame spread and smoke generation limitations found elsewhere in this specification.) It will be necessary to include expansion joints at regular intervals on dual temperature service. Thickness shall be as scheduled.

F. Fitting covers shall be built up of shaped segments of “FOAMGLAS”, Insul-Phen or “KOOLPHEN K”. These fitting covers shall be adhered in place using “Foster No. 30-35 80” water based vapor seals, then smoothly covered by a one-quarter inch (1/4”) thick application of one coat white insulating cement. All this piping and fittings shall be finished with an eight ounce canvas jacket neatly applied using Arabol adhesive.

G. Valves, fittings, etc., in congested areas around coil and heat exchanger equipment, etc., shall be insulated by building up fitting segments and premolded sections, plus white vapor seal mastic, plus Manville No. 301 finishing cement to smooth surfaces, plus canvas applied and sized for painting with fire resistant adhesive. In addition, all manufactured vapor barrier jacketing in mechanical rooms and finished spaces shall be finished with canvas applied and sized for painting with fire resistant adhesive.

H. No chilled water pipe supporting structures shall pierce the insulation except as anchor points as shown on the Drawings. At these points, the anchor member shall occur on the bottom of the piping to allow condensation to drain.

I. The application of the protective shields at rack and guide points in tunnels and in central chilling stations shall be as detailed on the accompanying Drawings. Heavy density insulation shall be installed at every hanger and supported by pipe saddles as scheduled herein.

2.05. PROTECTIVE JACKETING:

A. Provide protective jacketing as described elsewhere.

B. Jacketing and fitting covers shall be .016 aluminum smooth as manufactured by Premetco or Childers. The jacket shall be pre-cut, pre-rolled, and lapped a minimum of two inches (2”) in all directions to shed water. The metal shall be secured at each joint with a minimum of one each (1 ea.) ¾” wide .020 aluminum or stainless steel band and seal. The metal jacketing and fitting covers shall be fabricated of 0.016” aluminum or stainless steel with a smooth finish.
PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install materials in accordance with manufacturer’s instructions in the absence of more restrictive requirements or specific instruction herein.

B. For domestic cold water pipe, seal the ends of fiberglass insulation and provide vapor dams at each end location or every 18’, which ever is shorter. Provide vapor dams between pipe and insulation on elastomeric insulation at each section end location or every 20’ which ever is shorter.

C. For cold water pipe, seal the ends of insulation and provide vapor dams at each end location or every 18’ which ever is shorter. Provide vapor dams between pipe and insulation on elastomeric insulation at each section end location or every 18’ which ever is shorter.

D. On exposed piping, locate insulation and cover seams in least visible locations, but not higher than at the side of the pipe at the “90°” position, with the seam lapped such that the lap is directed down.

D. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature: Vapor barriers are required. The vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

1. Provide vapor barrier jackets, factory applied or field applied. Vapor barrier jacket shall be equal to a Venture Wrap 3.4 mil, “0” perm, cleanable surface vapor jacket with 4” overlap tape strip.

2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.

3. Finish with glass cloth and vapor barrier adhesive.

E. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

F. For insulated pipes conveying fluids above ambient temperature:

1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.

2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.

G. If PVC fitting covers are used they shall have 25/50 rating.

H. For hot piping conveying fluids 140°F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
I. For hot piping conveying fluids over 140°F, insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union. See 2.04K.

3.03 INSERTS, SUPPORTS and SHIELDS:

A. Application: Piping 2 inches diameter or larger for all systems except direct buried.

B. Shields: Install between pipe hangers or pipe hanger rolls and inserts. Hangers shall be on the outside of the insulation and shall not be in contact with the pipe. Curved metal shields shall be used between the hangers or support points and the bottom of the insulated pipe for Insulated pipes 2" and larger. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi, shall be curved to fit up to mid-perimeter of the insulated pipe and to prevent sharp corners from contacting the jacket. Shields shall be made of galvanized iron, or black iron painted on both sides with two coats of aluminum paint. Required metal shield sizes are as follows:

<table>
<thead>
<tr>
<th>Nominal IPS</th>
<th>Metal Thickness</th>
<th>Lengths</th>
</tr>
</thead>
<tbody>
<tr>
<td>up thru 2&quot;</td>
<td>14 gauge</td>
<td>12&quot;</td>
</tr>
<tr>
<td>thru 6&quot;</td>
<td>12 gauge</td>
<td>16&quot;</td>
</tr>
<tr>
<td>and above</td>
<td>10 gauge</td>
<td>20&quot;</td>
</tr>
</tbody>
</table>

C. Insert Location: Between support shield and piping and under the finish jacket.

D. Insert Configuration: Minimum 2" inches longer than length of shield, of same thickness and contour as adjoining insulation; may be factory fabricated.

E. Insert Material: Heavy density insulating material suitable for the planned temperature range, and the weight of the pipe.

F. The shields at support points shall be secured with ½" x 0.016" stainless steel bands and seals.

G. Finish insulation at supports, protrusions, and interruptions.

H. The application of the protective shields at rack and guide points in tunnels and in central chilling stations shall be as detailed on the accompanying Drawings.

I. In lieu of the above the following system of support may be used:

1. At the pipe support positions, the insulation and vapor barrier shall be continuous and shall not be punctured by the support. The insulation at the support shall be the full circumference of 5lbs/ft³ Phenolic Foam material to withstand the bearing loads transmitted from the pipe to the support, it shall extend for at least 1” on either side of the support to allow sealing of the joints with the pipe insulation jacket.

2. The load bearing insulation at the support shall be capable of withstanding the maximum static compressive loads generated by pipe supported at the centers shown in Table 1.

Variations: Pipe loads greater than those generated at the support centers shown in Table 1 shall be referred to the manufacturer to establish the length and density of the insulated support block. The support centers are based on the weight of Sch 80 pipe filled with water and covered with 1” thickness of 2.2 lbs/ft³ standard insulation including FSK/ASJ vapor barrier.
Table 1 K Block Support Centers

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>3/4</th>
<th>1</th>
<th>1 1/4</th>
<th>2</th>
<th>2 1/2</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max support centers (feet)</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Sch 80 pipe filled with water covered with 1&quot; of Standard Insulation</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Metal Saddle Gauge (Galvanized Steel)</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>16</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Length of K Block (inches)</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

1. The Insulation at supports shall be a equal to Kooltherm K Block. K Blocks shall be faced with factory applied vapor barrier and fitted with a galvanized steel 180° saddle bonded to the bottom section of the K Block, for all pipe sizes 1 1/2" and larger.

2. The vapor barrier shall be completed by the use of a vapor barrier jacket 4” overlap and factory applied self-seal lap tape and sealed with vapor barrier adhesive.

3. At all support positions, other than those where the insulated pipe support block is surrounded by a clip or saddle in direct contact with the block, a block designed to accept the loads generated by the pipe shall be presented to the engineer for approval. e.g. Of the type Kooltherm Insulation products K Block. Ref:- Kooltherm sketch 106/2c for use with Roller or flat beam support.

4. In all cases where roller supports are used the length of the insulation and the wearing plate where fitted shall extend beyond the limits of the pipe movement.

C. Where canvas finish is specified, use Arabol lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating.

D. For purpose of definition in this Specification: "concealed" areas are those areas which cannot be seen by the building occupants, and "exposed" areas are all areas which are exposed to view by the building occupants, including under counter and inside cabinet areas, plus all mechanical rooms.

E. Self Sealing Lap and butt joints will not be acceptable as the only seal on piping insulation joints. Self Sealing Lap and butt joints may be utilized only if the joints are additionally secured with field applied vapor barrier adhesive (on piping Systems requiring vapor barriers) or staples and field applied adhesive (on piping system which do not require a vapor barrier jacket). Mechanical fasteners shall be used whenever possible to assure permanent installation.

F. Insulation minimum thickness shall be as scheduled; however, additional thickness shall be provided to prevent condensation on the cold surfaces and to provide a maximum exterior insulation surface of 140°F on the hot surfaces.
G. Special Protection: All insulated piping in the mechanical rooms within 8'-0" of the floor shall be encased in a protective jacket, and where applicable, finish at top with nickel-plated brass flange plate with set screws or end joint sealing butt strips.

H. Interior or conditioned areas are those where ambient conditions are typically below 76°F and humidities are below 60% RH. All other areas shall be considered exterior or exposed to outside conditions. Where enclosed and not conditioned but subject to high humidities the insulation shall be designed to prevent condensation at 80°F and humidities are at 90% RH.

I. All exposed outdoor piping shall have metal jacket.

J. Fitting insulation shall be applied in same manner as pipe application. Protruding metal parts (such as valve stems) shall be completely sealed off. Fitting cover jacketing shall be equal to Gasco, Pabco or RPR Metals prefabricated fitting covers of 0.016" paper coated aluminum, secured as recommended by the manufacturer.

K. Valves, fittings, etc., in congested areas around coil and heat exchanger equipment, etc., shall be insulated by building up fitting segments and premolded sections as necessary.

L. No pipe supporting device (other than guides or anchors attached directly to the pipe) shall penetrate the insulation.

3.04 INSULATION TABLE:

<table>
<thead>
<tr>
<th>Service</th>
<th>Oper 'k' @</th>
<th>‘k’ @</th>
<th>Min. R value for each Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oper Temp</td>
<td>Mean</td>
<td>1”</td>
<td>1-1/4”</td>
</tr>
<tr>
<td>Hot(1)</td>
<td>350+</td>
<td>.33 @ 250</td>
<td>7.5</td>
</tr>
<tr>
<td>Hot(2)</td>
<td>251-350</td>
<td>.30 @ 200</td>
<td>6.5</td>
</tr>
<tr>
<td>Hot(3)</td>
<td>201-250</td>
<td>.29 @ 150</td>
<td>5.2</td>
</tr>
<tr>
<td>Hot(4)</td>
<td>141-200</td>
<td>.27 @ 125</td>
<td>5.6</td>
</tr>
<tr>
<td>Hot(5)</td>
<td>105-140</td>
<td>.26 @ 100</td>
<td>3.8</td>
</tr>
<tr>
<td>Cold(6)</td>
<td>40-55</td>
<td>.25 @ 75</td>
<td>2.0</td>
</tr>
<tr>
<td>Cold(7)</td>
<td>below 40</td>
<td>.25 @ 75</td>
<td>4.0</td>
</tr>
</tbody>
</table>

(1) HTHW; Steam @ over 120#  
(2) HTHW; Steam @ 16# to 120#; med & hp condensate; water and fire line freeze protection  
(3) HTHW; Steam @ 0# to 15#; LP Condensate  
(4) HW  
(5) HW  
(6) Ch. Wtr; Dom. cold wtr; Storm; Cold condensate  
(7) Ch. Wtr; Brine; Refrig lines

Minimum ‘R’ does not consider water vapor transmission and condensation. Additional insulation and/or vapor retarders may be required to limit water vapor transmission and condensation under extreme conditions.

A minus 15 percent tolerance, on the insulation performance listed shall be permitted for manufacturers’ standard insulation systems.
No chilled or heating water, steam or condensate insulation shall be less than 2” thickness. No chilled water pipe insulation in unconditioned space shall be less than three inch thickness.

Insulation may be ½” less inside the AHU downstream of the coils.

END OF SECTION
SECTION 23 20 00 – HVAC PUMPS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C. Section 23 05 53 – Mechanical Identification

1.2 WORK INCLUDED
   A. Base mounted pumps

1.3 RELATED WORK
   A. Section 23 05 13 – Motors
   B. Section 23 05 16 – Expansion Compensation
   C. Section 21 05 48 - Vibration Isolation
   D. Section 23 07 19 - Piping Insulation
   E. Section 23 07 16 - Equipment Insulation
   F. Section 23 21 00 - Hydronic Piping
   G. Section 23 06 20.13 - Hydronic Specialties
   H. Section 26 29 23 – Variable Speed Drives

1.4 REFERENCES
   A. ANSI/UL 778 - Motor Operated Water Pumps

1.5 QUALITY ASSURANCE
   A. Manufacturer: Company specializing in manufacture, assembly, and field performance of pumps with minimum three years experience.
   B. Alignment: Base mounted pumps shall be aligned by qualified millwright and alignment certified.

1.6 SUBMITTALS
   A. Submit shop drawings and product data under provisions of Section 23 00 00.
   B. Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
   C. Submit manufacturer’s installation instructions under provisions of Section 23 00 00

1.7 OPERATION AND MAINTENANCE DATA
   A. Submit operation and maintenance data under provisions of Section 23 00 00.
B. Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site under provisions of Section 23 00 00.
B. Store and protect products under provisions of Section 23 00 00.

1.9 EXTRA PARTS
A. Provide one extra set of mechanical seals for pumps under provisions of Section 23 00 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Armstrong
B. Aurora
C. Bell & Gossett
D. Gould
E. Paco
F. Taco
G. Substitutions: Under provisions of Section 23 00 00

2.2 HIGH TEMPERATURE PUMPS:

NOTE TO UTEP SPECIFICATION WRITER: PLEASE SUBMIT PREFERRED SPECIFICATION FOR CLOSE COUPLED PUMP FOR REPLACEMENT OF THE TEXT BELOW.

A. Furnish and install a high temperature hot water pump with performance characteristics as scheduled on the Drawings. The pump shall be designed for a maximum working temperature of 500 degrees F. when the suction pressure plus differential pressure is 420 psi or less and shall have the following construction: casing - ductile iron, impeller - ductile iron, gland - ductile iron, channel rings - cast iron, shaft - AISI-C-1045 steel, and shaft sleeve - 400c hardened stainless steel.

B. The pump shall be equipped with vacuum degassed ball bearings. The outboard thrust bearing shall be a double row deep groove angular bearing. The inboard is a single row deep groove bearing. The bearing shall be designed to give less than .001" (one thousandth inch) end play and a maximum of .002" (two thousandths inch) deflection at the mechanical seal faces. The bearing shall be oil lubricated and be equipped with constant level oiler with a clear PMMA oil reservoir to indicate oil reserve.

C. Pump shaft seal: Seals shall be mechanical. Mechanical seals shall be John Crane Type "1" or approved equal with stainless steel spring and metal parts, ethylene propylene elastomer bellows and solid tungsten carbide sealing face. The seal shall have a minimum life of 8000 hours when the pump is operating at 150 psig suction and 300 degrees F.

D. The pump shall be equipped with water cooled stuffing box. The water cooled stuffing box shall be so constructed that it can be supplied with low pressure cooling water which shall circulate around seal housing and then to drain.
E. The pump shall be mounted on a rigid steel baseplate which is equipped with a tapered drip basin with 1" (one inch) pipe tap. The pump shall have a centerline mounted casing to insure proper alignment and allows for expansion all directions from the horizontal centerline of the shaft. The pump shall be coupled to the motor with a Rexnord Thomas flexible disk coupling with a spacer and extended hubs, Type DBZ-C, of the proper size and with coupling guard, or approved equal.

F. The pump shall be an Aurora Pump Company Model 154 "Apco Chem" peripheral turbine pump or approved equal.

2.3 END SUCTION PUMPS:

A. Furnish and install chilled water pumps of the capacities and efficiencies shown on the Drawings. These pumps shall be selected to be nonoverloading over the entire pump curve range, and shall be further selected such that the selected impeller size does not exceed 90% of the maximum impeller diameter catalogued.

B. The pump casing shall be cast iron. The casing shall be of end suction design with tangential discharge outlet. The casing shall have tapped and plugged holes from priming and draining.

C. Both suction and discharge nozzles shall be provided with appropriate flanges by means of which the proper piping systems may be attached to the pumps. These flanges shall be dimensioned, faced, drilled, and spot faced to conform with the latest American Flange Standard.

D. The impeller shall be of the enclosed type and shall be investment cast. It shall be finished all over. The exterior shall be turned and the interior shall be finished smooth and clear of all burrs, trimmings, and irregularities. The impeller shall be dynamically balanced. The impeller shall be keyed to the shaft and fastened with a washer, gasket, and capscrew.

E. The seal plate and motor bracket shall be of a two piece design, and shall provide an adequate area for internal recirculation of the pumped fluid around the sealing medium.

F. Mechanical seals shall be John Crane Type “1” or approved equal with stainless steel spring and metal parts, ethylene propylene elastomer bellows and solid tungsten carbide sealing face. The seal shall have a minimum life of 8000 hours when the pump is operating at 150 psig suction and 300 degrees F.

G. The impeller shall be direct-coupled to the motor shaft. The motor shaft shall be machined to provide a keyway, and drilled and tapped to accept the impeller fastener. Stub shafts are not acceptable. The outboard shaft extension shall be machined with a keyway to accept a coupling to the driving unit. Lip seals shall be furnished on both the inboard and outboard shaft extensions, and a water slinger shall be furnished on the inboard shaft extension closest to the mechanical seal.

H. The pump shaft shall be fitted with a shaft sleeve to minimize shaft wear. The sleeve shall be sealed to the impeller hub by an O-ring, and shall be positively driven to the keyway by a pin. The use of adhesive compounds to fasten the sleeve to the shaft seal is not acceptable.

I. The power frame shall house a single-row outboard regreaseable thrust bearing. Bearings shall be selected for a 3 year minimum life at maximum load. The outboard bearing shall be locked in place by a retainer ring. The inboard bearing shall not be locked in order to accommodate thermal expansion of the shaft. Lubrication fittings shall be provided in a convenient location. A bearing cartridge end cap shall be provided on the outboard side of the power frame to allow inspection of the thrust bearing without the need for disassembling the power frame housing.

J. The pump and motor shall be mounted on a groutable formed steel baseplate or a drip-rim baseplate with integral drip channels incorporated on each side. Each channel shall include an NPT drain connection and plug. Each channel shall include an NPT drain connection and plug.
The base shall be sufficiently rigid to support the pump and the motor without the use of additional supports or members. See Drawings for construction details of pump base.

K. Each pump shall be coupled to the motor with a Rexnord Thomas flexible disk coupling with a spacer and extended hubs, Type DBZ-C, of the proper size and with coupling guard, or approved equal.

2.4 HORIZONTAL SPLIT CASE PUMPS:

A. Furnish and install chilled water pumps of the capacities and efficiencies shown on the Drawings. These pumps shall be selected to be nonoverloading over the entire pump curve range, and shall be further selected such that the selected impeller size does not exceed 90% of the maximum impeller diameter catalogued.

B. The pump casings shall be cast iron members. They shall be split at the horizontal centerline of the shaft in each case. The flanges of the upper and lower sections of the casing shall be arranged so that they may be held together rigidly with the use of appropriate bolts. The pump suction and discharge nozzles shall be located in the lower section of the casings. The design shall be such that the rotors of the pumps may be exposed for inspection or for removal by resorting to the expediency of removing the top section of the casing, but without disconnecting any part of the main interconnecting pipe systems.

C. Both suction and discharge nozzles shall be provided with appropriate flanges by means of which the proper piping systems may be attached to the pumps. These flanges shall be dimensioned, faced, drilled and spot faced to conform to the latest American Flange Standard.

D. The impellers of these pumps shall be arranged for single stage, double suction service. These enclosed impellers shall be made of bronze. They shall be machined carefully and balanced. Their arrangement shall be such as to minimize end thrust.

E. The pump shafts shall be stainless steel members of liberal proportions. These shafts shall be machined with care, ground to gauge and heat treated.

F. The pump rotors shall be supported in the case of each pump upon two ball type bearings. One ball bearing shall be located on each side of the pump impeller and each shall be in split bearing housings. The design of the split bearing housings shall be such as to make them dust-tight, grease-tight, water-tight with integral bearing arms cast to the main pump frame.

G. The shaft sleeves provided for each pump shall be bronze and shall extend from the hub to the impellers out beyond the stuffing boxes. The sleeves shall be held rigidly to the rotating elements and they shall protect the steel shafts from the corrosive action of the water.

H. Leakage from the discharge side of the pumps to the suction sides shall be prevented by the provision of the cast bronze case wearing rings. The design of these members shall be such that they may be removed and replaced with facility. All water pumps shall also have impeller wearing rings.

I. Pump shaft seal: Seals shall be mechanical. Mechanical seals shall be John Crane Type "1" or approved equal with stainless steel spring and metal parts, ethylene propylene elastomer bellows and solid tungsten carbide sealing face. The seal shall have a minimum life of 8000 hours when the pump is operating at 150 psig suction and 300 degrees F.

J. Each pump shall be coupled to the motor with a Rexnord Thomas flexible disk coupling with a spacer and extended hubs, Type DBZ-C, of the proper size and with coupling guard, or approved equal.

K. Each pump shall be mounted upon a steel bed plate. The proportions of these bed plates shall be such as to accommodate not only the pump in each case but the pump driving member as well. These bed plates shall be provided with continuous drip canal around three (3) sides. Each bed plate shall, moreover, be provided with grout holes and leveling pads, with bolts. Each bed plate
shall be arranged with a threaded drainage opening. Bed plates on chilled water pumps shall be extended sufficiently wide to assure that any dripping from pumps, pump nozzles and companion flanges will fall on the base 3" (three inches) beyond pipe companion flange). See Drawings for construction details of pump base.

L. Provide and deliver to the Owner three complete sets of assembly drawings and repair parts lists for each device, i.e., for the pumps and the motors. The Drawings and literature provided shall relate to the actual units involved. They shall not be of such a general nature as to include details which are not incorporated in the devices. They shall, on the other hand, be so complete that no part or parts are omitted. Three manuals of instructions for the proper care, operation and maintenance of these devices shall be provided, likewise.

M. After the pumps have been built and assembled, they shall be factory tested using shop turbine per Hydraulic Institute Standards and a complete set of test curves shall be obtained. These curves shall be certified by affidavit and delivered in triplicate to Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pumps in accordance with manufacturer’s instructions.

B. Provide access space around pumps for service. Provide no less than a minimum of three feet, not including piping and piping appurtenances.

C. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 15 percent of midpoint of published maximum efficiency curve.

D. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over. Refer to Section 23 05 48 for vibration isolation.

E. Provide line sized shut-off valve (ball or butterfly) and strainer on pump suction, and line sized soft seat check valve and balancing (ball or butterfly with memory stop) valve on pump discharge.

F. Provide air cock and drain connection on horizontal pump casings.

G. Provide drains for bases and seals, piped to and discharging into floor drains.

H. Lubricate pumps before start-up.

I. Alignment: A qualified millwright shall check, align and certify pumps. A reverse alignment procedure utilizing laser instruments shall be used. Alignment shall be performed in both hot and cold operating extremes. The maximum parallel and angular misalignment shall not exceed .002 inch. Record and deliver copies of the alignment report to the Owner’s RCM and include copy of the report in the O&M Manual.

J. Vibration Testing: Vibration velocity readings shall be taken at all bearing locations of all pumps. Pumps driven by variable speed drives shall be tested throughout their range of speeds. Vibration shall not exceed 0.15 inch/second (peak). Record and deliver copies of the test report to Owner’s RCM and include report in the O&M Manual.

END OF SECTION 23 20 00
SECTION 23 20 00.A
PIPING, VALVES AND FITTINGS

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:

A. Section 23 00 00 – Basic Mechanical Requirements
B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
C. Section 23 05 53 – Mechanical Identification

1.01 SECTION INCLUDES

A. Pipe and pipe fittings.
B. Valves.

1.02 RELATED SECTIONS

A. Section 23 00 00 - Basic Mechanical Requirements.
B. Section 23 05 29 - Sleeves, Supports and Anchors.
C. Section 23 05 53 - Mechanical Identification.
D. Section 23 05 48 - Vibration Isolation.
E. Section 23 07 19 - Piping Insulation.

1.03 REFERENCES

A. AGA - American Gas Association.
B. ANSI B31.1 - Power Piping.
C. ANSI B31.9 - Building Service Piping.
D. ASME Sec. 9 - Welding and Brazing Qualifications.
E. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800.
F. ASME B16.3 - Malleable Iron Threaded Fittings.
G. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250.
H. ASME B16.18 - Cast Bronze Solder-Joint Pressure fittings.
I. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings
J. ASME B16.23 - Cast Copper Alloy Solder-Joint Drainage Fittings - DWV.
L. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

M. ASME B16.32 - Cast Copper Alloy Solder-Joint Fittings for Solvent Drainage Systems.

N. ASTM A47 - Ferric Malleable Iron Castings.

O. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

P. ASTM A74 - Cast Iron Soil Pipe and Fittings.

Q. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

R. ASTM B32 - Solder Metal.

S. ASTM B42 - Seamless Copper Pipe.


U. ASTM B75 - Seamless Copper Tube.

V. ASTM B88 - Seamless Copper Water Tube.

W. ASTM B251 - Wrought Seamless Copper and Copper-Alloy Tube.

X. ASTM B302 - Threadless Copper Pipe (TP).

Y. ASTM B306 - Copper Drainage Tube (DWV).

Z. ASTM C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.


BB. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.


EE. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.


GG. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).


II. ASTM D2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.


KK. ASTM D2683 - Socket-Type Polyethylene Fillings for Outside Diameter-Controlled Polyethylene Pipe.
LL. ASTM D2729 - Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

MM. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.

NN. ASTM D2846 - Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, Solvent Cements and Adhesives for Potable Hot Water Systems.


PP. ASTM D3033 - Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

QQ. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

RR. ASTM D3309 - Polybutylene (PB) Plastic Hot Water Distribution System.

SS. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.


UU. ASTM F845 - Plastic Insert Fittings for Polybutylene (PB) Pipe.

VV. AWS A5.8 - Brazing Filler Metal. BA. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.

WW. AWWA C110 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids.


YY. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.

ZZ. AWWA C651 - Disinfecting Water Mains.


BBB. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.

CCC. CAN-3 B281 - Aluminum Drain, Waste, and Vent Pipe and Components.

DDD. NCPWB - Procedure Specifications for Pipe Welding.

EEE. TDH - Texas Department of Health, Water System Regulations

1.04 SUBMITTALS

A. Submit under provisions of Section 23 00 00.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.05 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 00 00.

E&C Engineers & Consultants
E&C No. 3484.00
B. Record actual locations of valves, etc. and prepare valve charts.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00.

B. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.07 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welders Certification: In accordance with ASME Sec. 9. Submit welder's certifications prior to any shop or field fabrication. Welder's certifications shall be current within six months of submission.

D. Maintain one copy of each document on site.

1.08 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing the work of this section with minimum of three years documented experience.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding are wet or frozen.

1.11 EXTRA MATERIALS

A. Furnish under provisions of Section 23 00 00.

B. Provide two repacking kits for each size valve.

E&C Engineers & Consultants
E&C No. 3484.00
PART 2 PRODUCTS

2.01 STEEL PIPING:

A. Scope: This section applies to all piping systems providing for welded piping, fittings, and other appurtenances. Specific systems requiring welded piping include, but are not limited to: chilled water, hot water, steam, steam condensate, and fire protection systems.

B. Pipe: Unless otherwise indicated, chiller and boiler plants piping shall be Schedule 40, and underground and building piping shall be Standard weight, Grade A or B, seamless black steel pipe conforming in all details to Standard ASTM Designation A135, A106, and A53, latest revisions. Steam condensate shall be Schedule 80. All piping shall be domestic made.

C. Fittings:

1. All weld fittings shall be domestic made wrought carbon steel butt-welding fittings conforming to ASTM A234 and ASME/ANSI B16.9, latest edition, as made by Weld Bend, Tube Turn, Hackney, or Ladish Company. Attach to only pipe with a hole for the entire length. Each fitting shall be stamped as specified by ASME/ANSI B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fittings selected at random. Fittings which have been machined, remarked, printed or otherwise produced domestically from non-domestic forgings or materials will not be acceptable. Each fitting to be marked in accordance with MSS SP-25. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these specifications.

2. All screwed pattern fittings specifically called for shall be Class 150 malleable iron fittings of Grinnell Company, Crane Company or Walworth Company manufacture (300 lb. for unions).

D. FABRICATION:

1. Welded piping and fittings in chiller and boiler plants and distribution systems shall be fabricated in accordance with ASME/ANSI the latest editions of Standard B31.1 Downstream of building PRV station Standard B31.3 shall be used for Steam and Condensate systems. Standard B31.9—Building Services Piping may be used within buildings for non-steam and condensate systems. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

2. Ensure complete penetration of deposited metal with base metal. Contractor shall provide filler metal suitable for use with base metal. Contractor shall keep inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process. All pipe shall have the ends beveled 37-1/2 degrees and all joints shall be aligned true before welding. Except as specified otherwise, all changes in direction, intersection of lines, reduction in pipe size and the like shall be made with factory-fabricated welding fittings. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.

3. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

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4. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.

5. Do not split, bend, flatten or otherwise damage piping before, during or after installation.

6. Remove dirt, scale and other foreign matter from the inside of piping, by swabbing or flushing, prior to the connection of other piping sections, fittings, valves or equipment.

7. In no cases shall Schedule 40 pipe be welded with less than three passes including one stringer/root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two filler and one lacer. In all cases, however, the weld must be filled before the cap weld is added.

8. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with Teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

E. WELD TESTING:

1. All welds are subject to inspection, visual and/or X-ray, for compliance with specifications. The owner will, at the owners option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing. Initial visual and X-ray inspections will be provided by the owner. The contractor shall be responsible for all labor, material and travel expenses involved in the reinspection and retesting of any welds found to be unacceptable. In addition, the contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.1, B31.9 and B31.3 due to the discovery of poor, unacceptable or rejected welds. For every failed x-ray, contractor shall be liable to provide five additional joint x-rays.

2. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators Code, current edition.

2.02 CAST IRON PIPING:

A. PIPE & FITTINGS:

1. Service weight cast iron soil pipe conforming to ASTM Specification A-74 and CISPI Standard 301, hub and spigot for pipe ten inch (10") and larger and hubless for eight inch (8") and smaller. Each piece of pipe and each fitting shall be coated at the factory with asphaltum or coal tar pitch and with the manufacturer's mark or name cast on it.

2. All joints in hub and spigot cast iron pipe shall be made water and gas tight with Tyseal neoprene gaskets. Lead and Oakum may be used only under special conditions, with prior written permission from the Resident Construction Manager. Joints in hubless cast iron soil pipe and fittings shall be made by the use of a neoprene sleeve and 24 gage, Type 304 Stainless Steel shield made tight with a torque wrench and torqued to a minimum of 100 inch-pounds. Each clamp shall consist of a neoprene gasket with a stainless steel outer band which effectively captures the gasket material. Each clamp shall bear the FM and UPC stamp, shall be approved to Class I of Factory Mutual Standard #1680, and shall be Clamp-All or approved equal. All elbows and tees shall be braced against thrust loads.
which might result in joint separation due to static pressure or dynamic forces caused by sudden, heavy impulse loading (water hammer) conditions. Hubless piping systems shall not be used in a directly buried, underground application.

2.03 DUCTILE IRON PIPING

A. Pipe: All pipe used for underground water piping mains shall be Class 52 centrifugally cast, close grained cast iron pipe or Class 50 DUCTILE iron pipe arranged with bell and spigot mechanical joints and shall conform in every detail to Federal Specifications WW-P-421, E-4, Type II for CAST IRON PIPE CENTRIFUGALLY CAST IN SAND LINED MOLDS. This pipe shall be provided in laying lengths of sixteen feet (16'). Each length of pipe shall be plainly marked in such a fashion as to indicate the name or trademark of the manufacturer and the year in which the pipe was cast. Exterior surfaces shall be completely coated with coal tar pitch varnish to which sufficient oil has been added to effect a smooth coating, tough and tenacious when cold, not "tacky" and not brittle.

B. Fittings:

1. All fittings used for underground water piping mains shall be Class D bell and spigot mechanical joint fittings made in strict conformity with the Specifications of the American Water Works Association A.W.W.A.-C100-08. All dimensions and weights of such fittings shall conform to the dimensions and weights shown in tables included in the latest edition HANDBOOK OF CAST IRON PIPE published by Cast Iron Pipe Research Association. All fittings shall be coated outside with the same coal tar pitch varnish used on cast iron pipe.

2. All mechanical joints shall be for cast iron pressure pipe made by pit cast or by centrifugal methods and cast iron pressure fittings. Mechanical joints shall be of the stuffing box type and shall consist of a bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting; a pipe or fitting spigot; a sealing gasket; a separate cast iron follower gland having cored or drilled bolt holes. The joint shall be designed to permit normal expansion, contraction, and deflection of the pipe line.

3. Bolts shall be high strength, heat treated cast iron tee-head bolts with hexagon nuts.

4. Gaskets shall be made of a vulcanized crude rubber compound and, unless otherwise specified, the rubber shall be first grade plantation rubber. The joint, gaskets, bolts, and nuts shall meet the latest requirements of ANSI 21.11 for Mechanical Joints for Cast Pressure Pipe and Fittings.

5. All underground cast iron or ductile iron pipe shall be encased in black 8-mil thick, polyethylene plastic sheet, per ANSI/AWWA, C105/A21.5-82, Method C.

6. Tie rods and retaining bolts shall be all stainless steel construction.

C. Valves: All valves used in underground water piping systems shall be A.W.W.A., iron body, mechanical joint, double hump, double disc, parallel seats, brass trimmed nonrising stem gate valves.

2.04 CONCRETE PIPING:

A. Precast concrete sewer pipe conforming to ASTM Specification C-14 in sizes up to and including eight inches (8") and shall be precast reinforced concrete sewer pipe conforming to ASTM Specification C-76 in size twelve inches (12") and larger. Bell and spigot fittings with elastomeric seal joints.
2.05 GALVANIZED STEEL PIPE

A. Pipe: Schedule 40 and shall conform in every detail to ASTM Standard Specifications for BLACK AND HOT-DIPPED ZINC-COATED GALVANIZED WELDED AND SEAMLESS STEEL PIPE ASTM Designation A-135, latest revision. This threaded pipe shall be supplied with thread protectors on each end. All steel water pipe shall be hot-dipped galvanized pipe zinc coated both inside and outside.

B. Fittings: All fittings for six inch (6") and larger water lines shall be 125 lb., cast iron, flanged pattern fittings. These fittings shall be hot-dipped galvanized, after all machining operations have been completed. These fittings shall be of Crane Company, or approved equal, manufacture and their flanges shall be dimensioned, faced drilled and spot faced to conform to the Class 150 American Standard for Steel Pipe Flanges and Flanged Fittings.

2.06 COPPER PIPE

A. Copper Pipe: Piping four inches (4") and smaller shall be fabricated of Type K, hard drawn, copper pipe made of deoxidized copper (99.9% pure). This Type K copper pipe shall conform in every detail to ASTM Standard Specifications for COPPER WATER TUBE, Serial Designation B-88-66, and it shall be provided in 20 foot straight lengths. Copper pipe 4" and smaller may only be joined using non-lead-bearing solder, such as 95-5 silver or antimony solder (95 percent tin, and 5 percent silver or antimony). Copper pipe 4" and larger may be joined using roll grooved fittings.

(Note: For U.T. Austin, substitute the following sentence for the previous two sentences: "Copper pipe may only be joined using "Silvabrite" solder. No other solders may be used.")

B. Fittings: All fittings for four inch (4") and smaller water lines shall be Streamline Solder Fittings manufactured by Streamline Pipe and Fittings Division, Mueller Brass Company, or approved equal. These wrought copper fittings shall be rigid and strong with openings machined to accurate capillary fit for the pipe.

C. Lead: It is forbidden that lead in any form be used in any water system other than waste. If lead is used in the fabrication or installation of any water system other than waste, then ALL of the installed equipment and material, which may have come in contact with the lead, shall be marked with bright red or orange spray paint, and shall be removed from the project site. The system(s) shall then be restored and reinstalled using ALL NEW MATERIALS.

2.07 VALVES:

A. All valves shall be located such that the removal of their bonnets is possible. All flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested and inspected for final acceptance. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings. All valves must be of threaded or flanged type. No solder connected or grooved fitting valves shall be used on this project. All bronze and iron body gate and globe valves shall be the product of one manufacture for each project. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.

B. All valves used in circulating systems, plumbing and steam systems (low and medium pressure) shall be Class 150 SWP. Class 300 valves shall be constructed of all ASTM B-61 composition. All gate, globe and angle valves shall be union bonnet design. Metal used in the stems of all
bronze gate, globe and angle valves shall conform to ASTM B371 Alloy 694, ASTM B99 Alloy 651, or other corrosion resistant equivalents. Written approvals must be secured for the use of alternative materials. Alloys used in all bronze ball, gate, globe, check valves, or angle valves shall contain no more than 15% zinc. **No yellow brass valves will be allowed.**

C. All iron body valves shall have the pressure containing parts constructed of ASTM designated of 126 class B iron. Stem material shall meet ASTM B16 Alloy 360 or ASTM 371 Alloy 876 silicon bronze or its equivalent. Gates and globes shall be bolted bonnet with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting is preferred on yoke cap for maintenance lubrication of the yoke bushing.

D. All cast steel body valves shall have the pressure containing parts constructed of ASTM designation A-216-GR-WCB carbon steel. Gate and globe valves shall be bolted bonnet outside and screw and yoke design with pressure-temperature rating conforming to ANSI B16-34-1977. Stems shall meet ASTM designation A-186-F6 chromium stainless steel. Wedge (gate valves) may be solid or flexible type and shall meet ASTM A-182-F6 chromium stainless steel on valves from 2" to 6". Sizes 8" and larger may be A-216-WCB with forged rings or overlay equal to 182-F6. Seat ring shall be hard faced carbon steel or 13% chromium A-182-F6 stainless. Handwheels shall be A47 Grade 35018 malleable iron or Ductile Iron ASTM A536.

E. All forged steel body valves shall have the pressure containing parts constructed of ASTM 105, Grade 2 forged carbon steel. Seat and wedges shall meet ASTM A-182-F6 chromium stainless steel. Seat rings shall be hard faced. Valves shall conform to ANSI B16-34 pressure-temperature rating.

F. All valves shall be repackable, under pressure, with the valve in the full open position. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron hand wheels, except iron body valves 2-1/2" and larger which may have either malleable iron or ASTM A-126 Class B, gray iron hand wheels.

G. Packing for all valves shall be free of asbestos fibers and selected for the pressure-temperature service of the valve. It is incumbent upon the manufacturer to select the best quality, standard packing for the intended valve service. At the end of one year, period spot checks will be made, and should the packing show signs of hardening or causing stem corrosion then all valves supplied by the manufacturer shall be repacked by the Contractor, at no expense to the Owner, with a packing material selected by the Owner.

H. Valves 12" and larger located with stem in horizontal position shall be drilled and tapped in accordance with MSS-SP-45 to accommodate a drain valve and equalizing by-pass valve assembly.

I. Balancing and/or Shutoff Valves for Hot Water Systems: Two inches and smaller, three piece full port bronze body ball valve, stainless steel ball and stem. Teflon seats, packing and gasket, bronze gland follower, adjustable stuffing box, steel lever type handle, with plastic sheathed operating handle, adjustable memory stops, and shall be class 150 SWP/600 WOG, screwed pattern. Manufacturer shall certify ball valves for use in throttling service. Stem extensions shall be furnished for use in insulated lines. Cold water service valves shall be as above, except two piece construction. All valves 2 1/2" and larger shall be tapped full lug butterfly valves with aluminum bronze discs of ASTM B148 Alloy C955 and 316, 416, or 420 stainless steel shafts. Design must incorporate bushing between shafts and body of material suitable to provide a bearing surface to eliminate seizing or galling. Valve must be capable of providing a bubble tight seal at 200 psi for valves up to 12" (150 psi for larger valves) when used for end of line service without requiring the installation of a blind flange on the downstream side. Liners shall be resilient material suitable for 225 °F temperature and bodies of ductile iron. Butterfly valves 8" and larger and butterfly valves used for balancing service, regardless of size, shall have heavy duty weather proof encased gear operators, with malleable iron handwheel or crank. Valves 2 1/2" through 6"
shall have lever handles which can be set in interim positions between full open and full closed. All butterfly valves shall be absolutely tight against a pressure differential of 150 psi.

J. Check Valves for Water Systems: Bronze body, 2" and smaller, bronze body regrinding disc and seat with screw-in cap. Iron body, 2 1/2" and larger, bronze disc and seat or non slam wafer type with stainless pins and springs, and bronze plate. Forged steel lift check valves, 2" and smaller shall be bolted cap and body, screwed end connections and conform to ANSI B16.34 and pressure temperature rating.

K. Valves for Fire Protection Service: 2" and smaller, bronze body ball valve as above, Underwriters' Laboratories Listed and Factory Mutual Approved, screw pattern. 2 1/2" and larger, Underwriters Laboratories Listed and Factory Mutual Approved butterfly valves with tapped full lug body and gear operated with malleable iron hand-wheel and position indicator. All valves to be furnished with two factory mounted internal supervisory switches.

Gate valves 2 1/2" and larger shall have approved rating of 175 psi WWP or greater. Iron body with resilient rubber encapsulated wedge, epoxy-coated interior, pre-grooved stem for supervisory switch.

L. Check Valves Fire Protection System: Iron body, swing-check, bronze disc, seat ring and hinge pin, 300 psi rated working pressure, Underwriters' Laboratories and Factory Mutual approved. Complete with ball drip assembly.

M. All underground direct-burried valves shall be ductile-iron butterfly with a Pratt "Ground Hog" gear box. Valves shall be flanged with stainless steel rim.
N. Standards of Quality for Valves:

<table>
<thead>
<tr>
<th>Standard of Quality for Valves:</th>
<th>Stockham or as noted</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Class</th>
<th>Milwaukee</th>
<th>Nibco</th>
<th>Stockham</th>
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<tbody>
<tr>
<td>2&quot; &amp; smaller</td>
<td>Gate Valve</td>
<td>L.P. Steam</td>
<td>150</td>
</tr>
<tr>
<td>2-1/2&quot; &amp; larger</td>
<td>Gate Valve</td>
<td>L.P. Steam</td>
<td>125</td>
</tr>
<tr>
<td>*2&quot; &amp; Ball Valve smaller</td>
<td>for shut-off</td>
<td>Domestic Cold Water Plbg.</td>
<td>150</td>
</tr>
<tr>
<td>*2&quot; &amp; Ball Valve larger</td>
<td>for shut-off</td>
<td>Domestic Cold Water Plbg.</td>
<td>150</td>
</tr>
<tr>
<td>2&quot; &amp; Globe, Angle &amp; Balancing Valve</td>
<td>Chilled Water, L.P. Steam</td>
<td>150</td>
<td>590T</td>
</tr>
<tr>
<td>2-1/2&quot; &amp; larger</td>
<td>Globe, Angle &amp; Balancing Valve</td>
<td>Chilled Water, L.P. Steam</td>
<td>125</td>
</tr>
<tr>
<td>2-1/2&quot; &amp; larger</td>
<td>Butterfly Valve for shut-off</td>
<td>Domestic Hot &amp; Cold Water Plbg. Systems Recirculating Chilled and Heating Water</td>
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</table>

Requires extended stems in insulated lines with adjustable memory stop.

Valves 8" and larger, and valves used for balancing service regardless of size shall have a heavy duty weatherproof encased operator.

<table>
<thead>
<tr>
<th>Class</th>
<th>Milwaukee</th>
<th>Nibco</th>
<th>Stockham</th>
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<tr>
<td>2&quot; &amp; Ball Valve smaller</td>
<td>Fire Protection</td>
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<td>BB_SC</td>
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<td>2-1/2&quot;</td>
<td>Butterfly Valve</td>
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<td>Fire Protection</td>
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<td>Check Valve</td>
<td>***Fire Protection</td>
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<td>510T-433</td>
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<td>2-1/2&quot; &amp; larger</td>
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<td>All Water Systems</td>
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<td>Gate Valve</td>
<td>High Pressure Steam</td>
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</tr>
<tr>
<td>2&quot; &amp; Gate Valve, larger</td>
<td></td>
<td>High Pressure Steam</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>2&quot; to 12&quot; (below ground)</td>
<td>Hub End</td>
<td>(AWWA)</td>
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<td>1-1/2&quot; &amp; smaller</td>
<td>Lubricated Gas Cock</td>
<td>Medical, Lab gases &amp; Natural Gas</td>
<td>150</td>
<td>BB2-100</td>
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<td></td>
<td>Wrench</td>
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<td></td>
</tr>
<tr>
<td>2&quot; &amp; Lubricated, larger</td>
<td>Gas Cock</td>
<td>Medical, Lab gases &amp; Natural Gas</td>
<td>150</td>
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<tr>
<td></td>
<td>Wrench</td>
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<td></td>
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<tr>
<td>2&quot; &amp; Isolation, smaller</td>
<td>Ball Valve</td>
<td>Medical, Lab gases, Natural Gas</td>
<td>150</td>
<td>Spirax Sarco Model 60</td>
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</table>

* Requires extended stem in insulated lines.

** Valves 8" and larger, and valves used for balancing service regardless of size, shall have heavy duty weather proof encased gear operators.

*** Requires ball drip assembly.

**** All modulating ball valves shall be characterized.

2.08 UNIONS:

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items, machinery items and other special pieces of apparatus. Unions in 2" and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2 1/2" and larger shall be ground flange unions. Unions in copper lines shall be Class 125 ground joint brass unions or Class 150 brass unions.

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flanges if required by the mating item of equipment. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

B. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type equal to Epco.

C. In all water lines where the material of the pipe is changed from ferrous to copper or brass, a dielectric coupling shall be used at the transition.

2.09 FLANGES:

A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16.5 and ASTM A-181 Grade I or II or A-105-71 as made by Tube Turn, Hackney or Ladish Company. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. Allthread rods will not be an acceptable for flange bolts. Steam system flange bolts shall have a tensile strength of 105,000 psi and an elastic limit of 81,000 psi and rated at least ANSI Grade V. Other bolts shall have a tensile strength of 80,000 psi and an elastic limit of 36,000 psi and rated at least ANSI Grade I.

B. Flat faced flanges shall be furnished to match 125 lb cast iron flanges on pumps, check valves, strainers, etc. with full flange gaskets. Bolting of raised face flanges to flat faced flanges is not allowed.

C. FLANGE GASKETS

1. Gaskets shall be placed between the flanges of all flanged joints.

2. Gaskets for steam piping - All steam flange joints shall use Flexitallic Class 150 spiral wound for low pressure applications and Flexitallic Class 300 spiral wound gaskets for medium or high pressure applications. Raised and flat face flange gaskets shall be Flexitallic compression gauge (CG) style. External ring shall be Type 304 stainless steel and color coded yellow. Filler material shall be Flexite Super and color coded with pink stripe. Equivalents may be submitted with all design data so that an evaluation of the gasket can be made.

3. Gaskets for all other applications: Gaskets shall be ring form gaskets fitting within the bolt circle of their respective flanges. Gaskets shall be 1/16” thick asbestos free material recommended for service by Anchor, Garlock, or John Crane. The inside diameter of such gaskets shall conform to the nominal pipe size and the outside diameter shall be such that the gasket extends outward to the studs or bolts employed in the flanged joint.

4. Spares - Contractor shall provide ten spares for every flange size and rating.
D. Flange Bolt Installation:

1. Bolt Lubrication: Bolts shall be well lubricated with a heavy graphite and oil mixture.

2. Torque Requirements - Bolts shall be stressed to 45,000 psi.

<table>
<thead>
<tr>
<th>Nominal Bolt Dia. (Inch)</th>
<th>Torque (Ft-Lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.25</td>
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<tr>
<td>.3125</td>
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<td>.375</td>
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</tr>
<tr>
<td>1.5</td>
<td>1200</td>
</tr>
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</table>

3. Torque shall be checked with a calibrated breaking action torque wrench on the final torque round. Bolts shall be cold and hot torqued.

4. Torque Pattern - Shall be a cross or star pattern with at least four passes. Limit each pass to 30% of full torque increases.

5. Hot Torque - Re-torque the flange bolts with system at normal operating pressure and temperature for at least four hours.

6. Inspection - Owner shall verify hot torquing of all medium and high pressure steam flange bolts.

PART 3 EXECUTION

Refer to other Sections for service specific requirements.

3.01 EXAMINATION

A. Verify excavations under provisions of Section 23 00 00.

B. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION
A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

B. Route piping in orderly manner and maintain gradient.

C. Install piping to conserve building space and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Provide access where valves and fittings are not exposed. Coordinate access door location with architectural features.

H. Establish elevations of buried piping outside the building to ensure a minimum of cover. Refer to Section 23 00 00.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Provide support for utility meters in accordance with requirements of utility companies.

K. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting. Refer to Division 09.

L. Excavate in accordance with Section 23 00 00 for work of this Section.

M. Backfill in accordance with Section 23 00 00 for work of this Section.

N. Install bell and spigot pipe with bell end upstream.

O. Install valves with stems upright or horizontal, not inverted.

3.04 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/8 inch per foot (one percent) minimum. Maintain gradients through each joint of pipe and throughout system.

B. Slope water piping and arrange to drain at low points.

END OF SECTION
PART 1 GENERAL

1.00 The following sections are to be included as if written herein:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C. Section 23 05 53 – Mechanical Identification

1.01 WORK INCLUDED
   A. Pipe and pipe fittings.
   B. Valves.
   C. Chilled water piping system.

1.02 SCOPE OF WORK: Furnish and install all labor, materials, equipment, tools and services and perform all operations required in connection with, or properly incidental to, the construction of complete HVAC piping and accessories systems as indicated on the Drawings, reasonably implied therefrom, or as specified herein unless specifically excluded.

1.03 RELATED WORK
   A. Section 08 31 13 - Access Doors.
   B. Section 09 91 00 - Painting.
   C. Section 23 00 00 - Basic Mechanical Requirements
   D. Section 23 20 00.A - Piping, Valves and Fittings
   E. Section 21 05 29 - Sleeves, Flashings, Supports and Anchors.
   F. Section 23 05 53 - Mechanical Identification.
   G. Section 23 07 19 - Piping Insulation.
   H. Section 23 06 20 - Hydronic Specialties.

1.04 REFERENCES
   B. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.
   C. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
   D. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
E. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.

F. ANSI/ASME B31.9 - Building Services Piping.


H. ANSI/AWS A5.8 - Brazing Filler Metal.


J. ANSI/AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.


M. ANSI/AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.

N. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

O. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

P. ASTM B32 - Solder Metal.

Q. ASTM B88 - Seamless Copper Water Tube.

R. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.


V. ASTM D2466 - Socket-Type PVC Plastic Type Fittings, Schedule 40.

W. ASTM D2467 - Socket-Type PVC Plastic Type Fittings, Schedule 80.


Y. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.


AA. ASTM D2855 - Making Solvent-Cemented Joints with PVC Pipe and Fittings.

BB. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
1.05 REGULATORY REQUIREMENTS
   A. Conform to ANSI/ASME B31.9.

1.06 QUALITY ASSURANCE
   A. Valves: Manufacturer’s name and pressure rating marked on valve body.
   B. Welding Materials and Procedures: Conform to ANSI/ASME SEC. 9, and applicable state labor regulations.
   C. Welders Certification: In accordance with ANSI/AWS D1.1.

1.07 SUBMITTALS
   A. Submit product data under provisions of Section 23 00 00.
   B. Include data on pipe materials, pipe fittings, valves, and accessories.
   C. Include welders certification of compliance with ANSI/AWS D1.1.

1.08 DELIVERY, STORAGE, AND HANDLING
   A. Deliver products to site under provisions of Section 23 00 00.
   B. Store and protect products under provisions of Section 23 00 00.
   C. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.01 WALL, FLOOR AND CEILING PLATES:
   A. See Section 23 05 29.

2.02 SLEEVES, INSERTS, AND FASTENINGS:
   A. See Section 23 05 29.

2.05 CHILLED AND HEATING WATER PIPING - ABOVE GROUND:
   A. See Section 23 20 00.A and 23 06 20.
      1. All piping shall be Standard Weight black steel pipe.
      2. All unions: Class 300.
      3. Low Zone (0’ to 150’ elevation)
         a. Fittings on piping 2-1/2” and larger shall be standard weight butt welding type. Flanges shall be 150# welding neck type. Standard weight Weld-O-Lets, Thread-O-Lets, and shaped nipples may be used only when take-off is 1/3 or less nominal size of main. Bushings shall not be used.
         b. Fittings on piping 2” and smaller shall be Class 150 black malleable iron screw fittings. (Class 300 for unions.)
2.04 EQUIPMENT DRAIN PIPING:

A. All factory fabricated or field erected air conditioning units with drain pans, all centrifugal water pumps and all other items or equipment or apparatus that require drains shall be connected with drain line run with adequate slope to a floor drain or other point of discharge as shown on the Drawings. On A.C. units the drain line shall include a properly sized water-sealed trap.

B. All drain piping shall be one inch (1") size minimum or larger as may be indicated on the Drawings. Such piping shall be Type L hard copper tube. The drain piping shall be assembled with adapter tees at each change in direction. Install screw plugs in unused openings for access to rod and clean.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. After completion, fill, clean, and treat systems. Refer to Section 22 13 16.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space and other work.

C. Group piping whenever practical at common elevations.

D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

E. Provide clearance for installation of insulation, and access to valves and fittings.

F. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 13.

G. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to weld area.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Section 09 91 00.

J. Install valves with stems upright or horizontal, not inverted.
K. Piping taps shall be made off of the top half of the pipe. Either off of the top or at a 45 degree angle up..

3.03 FABRICATION OF PIPE:

A. All the various piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material. Lines shall also be graded for proper drainage.

B. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the site.

C. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.

D. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected.

E. All piping shall be clean when it is installed. Before installation it shall be checked, upended, swabbed, if necessary, and all rust or dirt from storage or from laying on the ground shall be removed.

F. Procedure of Assembling Screw Pipe Fittings: All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with Teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

G. Procedure for Assembling Other Joints: Procedures for assembling joints in cast iron and copper lines have been set forth elsewhere in these Specifications. For any special materials, consult the manufacturers for the recommended procedures in assembling the joints.

3.04 APPLICATION

A. Roll grooved mechanical couplings and fasteners may be used only for pump fit-up assemblies.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

D. Install butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.

E. Install butterfly valves for throttling, bypass, or manual flow control services.

F. Provide spring loaded check valves on discharge of condenser water pumps.

G. Use gas plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

H. Use butterfly valves in heating, chilled and condenser water systems.
I. Use only butterfly valves in chilled and condenser water systems for throttling and isolation service.

J. Use lug end butterfly valves to isolate equipment.

K. Provide 3/4 inch (20 mm) ball drain valves at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest drain.

3.05 PIPE PRESSURE TESTS:

A. See Section 23 00 00.

3.06 CLEANING AND FLUSHING OF WATER SYSTEMS

A. Water circulating Systems shall be thoroughly cleaned before placing in operation to rid systems of rust, dirt, piping compound, mill scale, oil, grease, any and all other material foreign to water being circulated.

B. Extreme care shall be exercised during construction to prevent dirt and other foreign matter from entering the pipe or other parts of systems. Pipe stored on the project shall have open ends capped and equipment shall have openings fully protected. Before erection, each piece of pipe, fitting, or valve shall be visually examined and dirt removed.

C. At pipe end locations a temporary bypass will be installed. Bypass shall be same size as the supply and return pipe. Prior to flushing the distribution system, the Contractor shall install the temporary bypass and a temporary line size strainer between the supply and return pipes. Contractor shall verify that the isolation valves are open.

D. After the temporary bypasses are installed, the Contractor shall provide and operate one pump which will cause a velocity of 10 feet per second in the main piping. This pump will be provided with a shot chemical feeder and a strainer assembly. Pump shall be connected to system at the point where piping goes into the building from the tunnel. If the pump is electric driven, rather than engine driven, the Contractor shall provide all temporary electrical disconnects, wiring, fuses, and other electrical devices that are required for safe operation.

E. Circulation will be started using the temporary pump. A nonhazardous cleaning compound (Entec 324 or approved equal) shall be added using the shot feeder until the concentration level of 20 parts per million is reached. Once this 20 parts per million concentration is reached, circulation will be maintained for 48 hours. After this period of time, the cleaning water shall be dumped to the sanitary sewer.

F. The distribution system will then be refilled with city water and circulated with continual bleed and make-up until the water is certified clean by the water treatment consultant, and accepted by the Owner. At the completion of this step an inhibitor shall be introduced. All waste water shall be dumped into the sanitary sewer system.

G. After the system is certified as clean, the Contractor shall close the valves. The bypass piping shall be removed as final connections to the building are accomplished.

H. During the flushing procedure, strainers shall be cleaned as often as necessary to remove debris and, in any event, all strainers shall be cleaned by physically removing the strainer screen from the body of the strainer at the end of flushing. Replace strainer basket and gasket. Contractor shall not flush through control valves, coils, etc. Contractor shall provide temporary bypasses at coils and spool pieces at control valves.

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Flush the coils individually wasting water to sanitary sewer. Connect coils and install control valves after flushing.

I. Test samples shall be taken at all bypass locations and all tests shall indicate that the entire system has reached a PH, conductivity, and chemical concentration level as approved by the Owner to match present systems. Contractor shall purchase needed chemicals from Owner’s chemical treatment supplier.

J. Contractor shall provide a smaller assembly to clean and flush any miscellaneous piping that can not be included in the initial system flush. All other criteria shall remain the same.

K. Contractor shall add inhibitor to the cleaning and flushing chemicals if, once the system is approved as clean, there is any delay in connecting the new system to the existing system. This is to prevent any corrosion after the new pipe is clean.

END OF SECTION
SECTION 23 22 00
STEAM AND STEAM CONDENSATE PIPING

PART 1 GENERAL

1.00 The following sections are to be included as if written herein:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C. Section 23 05 53 – Mechanical Identification

1.01 WORK INCLUDED
   A. Pipe and pipe fittings.
   B. Valves.
   C. Steam piping system.
   D. Steam condensate piping system.

1.02 RELATED WORK
   A. Section 08 31 13 - Access Doors.
   B. Section 09 91 00 - Painting.
   C. Section 23 00 00 - Basic Mechanical Requirements
   D. Section 23 20 00.A - Piping, Valves and Fittings
   F. Section 21 05 29 - Supports and Anchors.
   G. Section 23 05 53 - Mechanical Identification.
   H. Section 23 05 48 - Vibration Isolation.
   I. Section 23 07 19 - Piping Insulation.
   J. Section 23 22 00.A - Steam and Steam Condensate Specialties.

1.03 REFERENCES
   A. ANSI/ASME SEC 9 - Welding and Brazing Qualifications.
   B. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
   C. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
   D. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
F. ANSI/ASME B31.9 - Building Services Piping.
G. ANSI/AWS A5.8 - Brazing Filler Metal.
I. ASTM A135 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
J. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
K. ASTM B32 - Solder Metal.
L. ASTM B88 - Seamless Copper Water Tube.

1.04 REGULATORY REQUIREMENTS
A. Conform to ANSI/ASME B31.9, and ANSI/ASME B31.1.

1.05 QUALITY ASSURANCE
A. Valves: Manufacturer's name and pressure rating marked on valve body.
B. Welding Materials and Procedures: Conform to ANSI/ASME SEC 9, and applicable state labor regulations.
C. Welders Certification: In accordance with ANSI/AWS D1.1.

1.06 SUBMITTALS
A. Submit product data under provisions of Section 23 00 00.
B. Include data on pipe materials, pipe fittings, valves and accessories.
C. Include welder’s certification of compliance with ANSI/AWS D1.1.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site under provisions of Section 23 00 00.
B. Store and protect products under provisions of Section 23 00 00.
C. Deliver and store valves in shipping containers with labeling in place.

PART 2 PRODUCTS

2.01 PIPING AND FITTINGS: (See also Section 23 20 00.A)
A. Piping systems shall conform to the following requirements.
B. Piping systems designed for steam pressure below 15 psig are low pressure steam systems. Piping systems designed for steam pressures from 15 psig up to and including 125 psig are medium pressure steam.
C. Condensate Return and Pumped Condensate Return Piping:
   1. All piping shall be Schedule 80 black steel piping.
   2. Fittings on piping 2-1/2" and larger shall be extra heavy butt welding type. Flanges shall be 150# welding neck type. Extra strong Weld-O-Lets, Thread-O-Lets, or shaped nipples may be used only when take-off is 1/3 or less nominal size of main.
   3. Screwed fittings around traps and for piping 2" and smaller shall be 125# black cast iron. (300# for unions). At contractor’s option, socket weld fittings may be used.

D. Low and Medium Pressure Steam Piping:
   1. All piping shall be Schedule 40 black steel piping, except sizes 1" and smaller shall be Schedule 80.
   2. Fittings on piping 2-1/2" and larger shall be standard weight butt welding type. Flanges shall be 150# welding neck type. Standard weight Weld-O-Lets, Thread-O-Lets, and shaped nipples may be used only when take-off is 1/3 or less nominal size of main. Bushings shall not be used.
   3. Screwed fittings around traps and for piping 2" and smaller shall be 125 lb. black cast iron. (250 lb. for unions.) At contractor’s option, socket weld fittings may be used.

F. Weld Fittings, Flanges and Unions:
   1. Refer to Section 23 20 00.A.

G. Piping Materials:
   1. Sizes shown on the Drawings are nominal pipe sizes unless otherwise indicated.

2.02 VALVES:
   A. See Section 23 20 00.A.

2.03 STRAINERS:
   A. See Section 23 06 20.

2.04 UNIONS:
   A. See Section 23 20 00.A.

PART 3 EXECUTION

3.01 PREPARATION
   A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
   B. Remove scale and dirt on inside and outside before assembly.
C. Prepare piping connections to equipment with flanges or unions.

D. After completion, fill, clean, and treat systems.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

B. Install piping to conserve building space and not interfere with use of space, other work, or equipment.

C. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

D. Provide clearance for installation of insulation and access to valves and fittings.

E. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with the General Contractor.

F. Slope steam piping one inch in 40 feet (0.25 percent) in direction of flow. Use eccentric reducers to maintain bottom of pipe level.

G. Slope steam condensate piping one inch in 40 feet (0.25 percent). Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.

H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Section 09 91 00.

J. Install valves with stems upright or horizontal, not inverted.

3.03 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections. Install dielectric unions where joining dissimilar materials.

B. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

C. Install valves for shut-off and to isolate equipment, part of systems, or vertical risers.

D. Install valves for throttling, bypass, or manual flow control services.

E. All high pressure steam valves 12” and larger shall be piped with an equalizing bypass valve assembly.

3.04 CLEANING AND FLUSHING OF STEAM SYSTEMS:

A. Steam and condensate systems shall be thoroughly cleaned before placing in operation to rid systems of rust, dirt, piping compound, mill scale, oil, grease, any and all other material foreign to water being circulated.
B. Extreme care shall be exercised during construction to prevent dirt and other foreign matter from entering the pipe or other parts of systems. Pipe stored on the project shall have open ends capped and equipment shall have openings fully protected. Before erection, each piece of pipe, fitting, or valve shall be visually examined and dirt removed.

C. Chemicals, feeding devices, and water technician services shall be furnished by a single reputable manufacturer who will be responsible for the complete cleaning and flushing of the systems.

1. Add a temporary line with drain and isolate the building steam and condensate piping from the campus distribution piping to allow for proper circulation and cleaning of the new piping in the new tunnel and/or in the new or modified building piping system(s).

D. Systems shall be cleaned with a chemical compound specifically formulated for the purposes of removing the above listed foreign matter. These chemicals shall be injected to the systems, circulated and completely flushed out. Repeat the process if required. After each flushing, remove and thoroughly clean all strainers.

E. Final connection is not to be made to the campus loop system until the Chemical Contractor has filed with the Owner’s representatives, a report stating that the systems are clean.

3.05 PIPE PRESSURE TESTS:

A. See Section 23 00 00.
PART 1 GENERAL

1.00 The following sections are to be included as if written herein:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C. Section 23 05 53 – Mechanical Identification

1.01 WORK INCLUDED
   A. Steam traps.
   B. Flash tanks.
   C. Condensate return pumping units.
   D. Steam pressure reducing valves.
   E. Steam relief valves.
   F. Steam safety valve discharge elbows.
   G. Steam pipe guides.
   H. Drip traps.
   I. Sediment strainers.
   J. Gauges and gauge connections.
   K. Thermometer and thermometer wells.
   L. Steam integrating (condensate) meters.

1.02 RELATED WORK
   B. Section 23 05 13 - Motors.
   C. Section 23 07 19 - Piping Insulation.
   D. Section 23 07 16 - Equipment Insulation.
   E. Section 23 06 20 - Hydronic Specialties
   F. Section 23 22 00 - Steam and Steam Condensate Piping.

1.03 REFERENCES
   B. ASTM A105 - Forgings, Carbon Steel, for Piping Components.

D. ASTM A216 - Steel Casings, Carbon, Suitable for Fusion Welding, for High Temperature Service.


F. ASME B31.9 - Building Services Piping.

1.04 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 - Building Services Piping.

1.05 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.06 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 33 00 and 01 33 23.

B. Submit shop drawings and product data for manufactured products and assemblies required for this project.

C. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.

D. Submit schedule indicating manufacturer, model number, size, location, rated capacity, and features for each specialty.

E. Submit manufacturer's installation instructions under provisions of the Owner's Special Instructions.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of the Owner's Special Instructions.

1.08 EXTRA STOCK

A. Provide two service kits for each size and type of steam trap under provisions of the Owner's Special Instructions.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - STEAM TRAPS

A. Armstrong

B. Spirax/Sarco

C. Shipco.

D. Substitutions: Under provisions of Section 23 00 00.
2.02 INVERTED BUCKET TRAPS

A. Cast iron or semi-steel body and bolted cover for 250 psig WSP; provide access to internal parts without disturbing piping; with top test plug and bottom drain plugs, brass or stainless steel bucket, stainless steel seats and plungers, and stainless steel lever mechanism with knife edge operating surfaces, integral inlet strainer of monel or stainless steel.

2.03 FLOAT AND THERMOSTATIC TRAPS

A. ASTM A126, cast iron or semi-steel body and bolted cover for 250 psig WSP; provide access to internal parts without disturbing piping; with bottom drain plug, stainless steel or bronze bellows type air vent, stainless steel or copper float, stainless steel lever and valve assembly.

2.04 THERMOSTATIC TRAPS

A. Pressure balanced type with ASTM A216 WCB cast steel body and bolted or screwed cover, and integral ball joint union, for 300 psig WSP; monel or stainless steel bellows, stainless steel valve and seat; integral stainless steel strainer.

B. Freeze proof type with cast iron body for 300 psig WSP, bronze bellows, stainless steel valve and seat, external adjustment.

C. Bi-metallic type with ASTM A105 forged steel body and cover, for 300 psig WSP, bi-metal element with stainless steel components, integral Type 304 stainless steel strainer screen, 1/4 inch blow down valve.

2.05 STEAM PRESSURE REDUCING VALVES:

A. All pressure reducing valves shall be capable of maintaining the set pressure from zero to the maximum steam flow within reasonable limits when subjected to usual steam pressure fluctuations. They shall be single seated valves with stainless steel trim, with renewable valve, lugs and seats. Valve bodies shall be cast steel for high pressure service and cast iron for medium and low pressure service. These valves shall be self contained type with upstream and downstream pressure gauges and shall be installed as per manufacturer's recommendations. Valve capacities are scheduled on the drawings. Pressure reduction is one stage (125 to 25 psig). Station shall consist of two PRV's sized 1/3 and 2/3 capacity. Discharge pressure shall be adjustable to any value between 10 psig and 75% of the supply pressure.

B. All pressure regulators 2-1/2" and larger shall have flanged connections and those 2" and smaller may have screwed connections. Unions shall be installed on each side of any screwed pattern regulators installed.

C. Each reducing valve shall be preceded by a sediment strainer complete with a full-sized blow off valve with threaded end for hose connection.

D. These valves shall be Leslie, Spence (delete Spence on Austin projects, list first on Galveston projects), Spirax Sarco, Fisher, Mason Neilan or approved equal, with suitable automatic controllers.

2.06 STEAM RELIEF VALVES:

A. Relief valves 2" and smaller shall have brass bodies and arranged for screwed connections. Such relief valves shall be Crane No. 2501 or Spirax Sarco 6010 Brass Safety Valves for steam or approved equal. Bushings shall not be used.
B. Relief valves 2-1/2" and larger shall in the case of all medium and low pressure steam piping systems be arranged for flanged inlet and screwed outlet connections. Such relief valves shall be Consolidated Type 1511 or Spirax Sarco 252, ASME Standard Cast Iron Safety Valves, or approved equal.

C. The pressure at which each relief valve shall open is designated on the Drawings. When such valves are ordered by the Contractor, he shall definitely specify the pressure at which each relief valve is to be set. Each valve shall have a metal tag attached stamped with the valve identification plus the pressure setting.

2.07 STEAM SAFETY VALVE DISCHARGE ELBOWS:

A. All vent lines from safety valves shall be provided with safety valve discharge elbows at the point at which such lines rise to an elevation higher than that of the safety valve. The nature and design of the piping systems involved shall be such as to drain effectively all condensate from the discharge side of all relief valves. These safety valve discharge elbows shall be Grinnell Company's Safety Valve Drip Pan Elbows Figure No. 1538F, Spirax Sarco No. 299, or approved equal. No force shall be exerted on the safety valve by the discharge piping.

2.08 STEAM PIPE GUIDES:

A. All steam piping systems shall be properly guided as shown on the Drawings.

2.09 DRIP TRAPS:

A. High pressure drip trap assemblies shall be provided wherever called for on the Drawings and where required to keep such piping systems completely drained of condensate. Traps used in assemblies shall be 3/4" traps unless specifically shown to the contrary, i.e., they shall have 3/4" inlet and outlet connections. They shall have semi-steel bodies and the internal operating mechanisms shall be made of heat treated chrome steel. The caps shall be bolted to the bodies by the use of alloy steel heat treated machine bolts. These No. 213 Armstrong Traps, manufactured by Armstrong Machine Works, or approved equal, shall have a capacity for discharging at least 3,500 pounds of condensate per hour when operating at a pressure of 250 pounds per square inch. Where drip traps are installed in conjunction with 3" and larger steam lines, a drip pocket of the nature detailed on the Drawings shall be provided where a natural pocket does not exist. The piping and valves in trap assemblies shall be arranged as detailed on the Drawings; extra strong pipes shall be used on both sides of the trap.

B. All drip traps used in medium pressure steam piping systems where automatic steam control valves are not employed shall be arranged as shown on the Drawings. They shall be 3/4" Armstrong No. 811 Inverted Bucket Traps, or approved equal, with cast iron bodies, vacuum breakers and stainless steel trim. Each trap shall be provided with a valved test line and shall be preceded by a sediment strainer.

C. Condensate from coils, converters, hot water generators, low pressure drips and from all other devices where modulating steam valves are employed shall be of the float and thermostatic type. These traps shall be sized to handle 200% of the load with an inlet pressure drop of 0.5 psig and shall be equal to Armstrong "A" or "B" series, with vacuum breaker suitable for the system pressures. Installed traps with less than 12" of height between equipment outlet and trap inlet shall be sized for not less than 300 percent of the load. Each trap shall be provided with a 1/2" valve test line and shall be preceded by a sediment strainer. Under no circumstances shall a float and thermostatic trap be installed in a manner to lift condensate up in a return line.
D. Shop Drawing submittal of traps shall contain an itemized list with a tabulation of the load, trap type, and trap size.

2.10 SEDIMENT STRAINERS:

A. Each drip trap assembly, each control valve, for steam and each pressure reducing valve assembly regardless of its size shall be preceded by a sediment strainer. The arrangement of these sediment strainers shall be such that the screens may be removed for cleaning with ease through a gasketed plug.

B. Sediment strainers shall be placed in steam piping systems wherever shown on the Drawings and at such other points as may be required for the removal of foreign material from the piping systems.

C. Strainers in high pressure steam piping shall be cast steel sediment strainers and shall be suitable for working steam pressures as high as 300 pounds per square inch and temperatures not in excess of 750 degrees F. These strainers shall be the size designated on the Drawings. In the case of pipe sizes 2-1/2" and larger, flanged pattern sediment strainers shall be used. In the case of pipe smaller than 2-1/2", screwed pattern shall be used. Such strainers shall be Yarway No. 821 or 822 strainers manufactured by Yarnall Waring Company, or approved equal. The flanges of flanged strainers shall be dimensioned, faced, drilled, and spot faced to conform to the 300 pound American Standard for Steel Pipe Flanges and Flanged Fittings (B16e-1939).

D. Strainers in low and medium pressure steam piping systems 2-1/2" and larger shall be flanged iron body strainers having bolted covers. These strainers shall be suitable for operating pressures as high as 125 psig. They shall be Crane Company No. 989-1/2 Sediment Separators, or approved equal.

E. Sediment strainers in low and medium pressure steam piping systems 2" and smaller shall be arranged for screwed pipe connections. They shall be Crane No. 988-1/2 Sediment Separators, or approved equal.

F. Full sized blow off valves shall be installed on all strainers in steam, condensate, chilled and hot water lines and a drain shall be installed from each valve to the nearest floor drain.

2.11 GAUGES AND GAUGE CONNECTIONS:

A. See Section 23 05 19.

B. Furnish and install, where noted or indicated on the accompanying Drawings or called for elsewhere in these Specifications, gauge connections complete with Ashcroft No. 1095 lever handle union shutoff cocks, or approved equal. All gauge connections shall be made up with brass pipe, nipples and brass screw fittings.

2.12 THERMOMETER AND THERMOMETER WELLS:

A. See Section 23 21 00.A.

B. Thermometer wells and thermometers shall be located where noted on the accompanying Drawings and where called for in other sections of the Specifications. Thermometer test wells only shall be installed in a vertical position in horizontal lines and at 45 degrees, in vertical lines to hold a fluid in the well.
3.01 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions.

B. Install thermostatic steam traps to drain condensate from steam radiation units, convectors, and other similar terminal heating units.

C. Install float and thermostatic traps to drain condensate from unit heaters, converters, heating coils, steam separators, flash tanks, steam jacketed equipment, and direct steam injected equipment.

D. Install inverted bucket steam traps to drain condensate from steam main headers and branch lines.

E. Size steam traps to handle minimum of two times maximum condensate load of apparatus served.

F. Traps used on steam mains and branches shall be minimum 3/4 inch (20 mm) size.

G. Install steam traps with union or flanged connections at both ends.

H. Provide gate valve and strainer at inlet, and gate valve [and check valve] at discharge of steam traps.

I. Provide minimum 10 inch (250 mm) long dirt pocket of same pipe sizes as apparatus return connection between apparatus and steam trap.

J. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.

K. Provide pressure reducing stations with pressure reducing valve, valved bypass, strainer and pressure gage on upstream side, relief valve and pressure gage on downstream side of pressure reducing valve.

L. Pressure reducing station shall be one or two stages as indicated, to produce flat reduced pressure curve over range of capacity.

M. Rate relief valves for pressure upstream of pressure reducing station, for full operating capacity. Set relief at maximum 20 percent above reduced pressure.

N. Terminate relief valves to outdoors. Provide drip pan elbow with drain connection to nearest floor drain.

O. When several relief valve vents are connected to a common header, header cross section area shall equal sum of individual vent outlet areas.

END OF SECTION
SECTION 23 57 00 – HEAT EXCHANGERS

PART 1 - GENERAL

1.1 THE FOLLOWING SECTIONS ARE TO BE INCLUDED AS IF WRITTEN HEREIN:
   A. Section 23 00 00 – Basic Mechanical Requirements
   B. Section 23 05 29 – Sleeves, Flashings, Supports and Anchors
   C. Section 23 05 53 – Mechanical Identification

1.2 SECTION INCLUDES
   A. Shell and tube type heat exchangers
   B. Accessories and trim

1.3 RELATED SECTIONS
   A. Section 23 20 00.A – Piping, Valves and Fittings
   B. Section 23 21 00 - Hydronic Piping
   C. Section 23 06 20.13 - Hydronic Specialties
   D. Section 23 22 00 - Steam and Steam Condensate Piping
   E. Section 23 22 00.A - Steam and Steam Condensate Specialties
   F. Section 23 09 00 - Controls and Instrumentation

1.4 REFERENCES
   A. ANSI/ASME - Boilers and Pressure Vessels Code

1.5 REGULATORY REQUIREMENTS
   A. Conform to Section VIII D of the ANSI/ASME Boilers and Pressure Vessels Code for manufacture of tubular heat exchangers and heat exchanger shells.

1.6 SUBMITTALS
   A. Submit shop drawings and product data under provisions of Section 23 00 00.
   B. Submit shop drawings and product data for manufactured products and assemblies required for this project.
   C. Indicate dimensions, locations, and size of tappings and performance data.
   D. Submit manufacturer's installation instructions under provisions of Section 23 00 00.
   E. Submit manufacturer's certificate under provisions of Section 23 00 00 that heat exchangers meet or exceed specified requirements.
   F. Submit design data in sufficient detail to verify that heat exchangers meet or exceed specified requirements.
G. Submit test reports of tube bundle pressure tests.

1.7 OPERATION AND MAINTENANCE DATA
   A. Submit operation and maintenance data under provisions of Section 23 00 00.
   B. Include start up and shut down instructions, assembly drawings, and spare parts lists.

1.8 DELIVERY, STORAGE, AND HANDLING
   A. Deliver products to site under provisions of Section 23 00 00.
   B. Store and protect products under provisions of Section 23 00 00.
   C. Protect internals from entry of foreign material by temporary caps on flanged openings.

1.9 EXTRA MATERIALS
   A. Provide two sets of replacement gaskets under provisions of Section 23 00 00.
   B. Provide one set of wrenches for disassembly of plate type heat exchangers.

PART 2 - PRODUCTS

2.1 HOT WATER CONVERTERS:
   A. Hot water converters shall be manufactured by Taco, Bell and Gossett, or approved equal.
   B. Provide converters of shell and U-tube type, steam in shell, 100 psi minimum steam working pressure, 150 psi water pressure, conforming to ASME Code for Unfired Pressure Vessels.
   C. Provide units with steel shell, mounting saddles, Muntz metal or other approved corrosion resistant tube sheet and tube supports, 3/4" (three-fourths inch) type K copper tubes and removable carbon steel head; 2 (two) pass heater with capacity scheduled when selected for a 0.005 total scale factor and water velocity approximately 4.0 fps. Provide unit with steam inlet, condensate outlet, vent, water inlet and outlet, and other connections as may be required.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install to permit removal of tube bundle with minimum disturbance to installed equipment and piping.
   C. Support heat exchangers on welded steel pipe and angle floor stand.
   D. Pitch shell to completely drain condensate.
   E. Pipe relief valves to nearest floor drain.
   F. Pipe drain valves to nearest floor drain.
   G. Install all water and steam connections to heat exchanger with dielectric fittings.

3.2 STEAM TO WATER HEAT EXCHANGER TRIM
   A. Shell: Pressure gauge tapping with pigtail siphon, vacuum breaker.
B. Water Inlet: Thermometer well, pressure gauge tapping, valved drain.

C. Water Outlet: Thermometer well for temperature regulator sensor, ASME rated pressure and temperature relief valve, thermometer well, pressure gauge tapping.

3.3 WATER TO WATER HEAT EXCHANGER TRIM

A. Water Inlets and Outlets: Thermometer wells, pressure gauge tappings.

B. Heated Water Outlet: Thermometer well for temperature regulator sensor, ASME rated pressure and temperature relief valve, valved drain.

END OF SECTION 23 57 00
**LIGHTING/SWITCHES**

<table>
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<tr>
<th>ABBREVIATIONS</th>
<th>LIGHTING/SWITCHES</th>
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<th>DUCTWORK</th>
<th>GENERAL NOTES MECHANICAL</th>
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**LIGHTING/SWITCHES**

- **Lighting Fixtures Circuiting Notes**
  - The lighting plan, fixture switching and power circuiting is shown. Group A, B, C and D lighting fixtures indicate switches where the control panel is not shown. Power supply circuits enter the specified fixtures at the point of common attachment to the switch box. Group E lighting fixtures shall be installed in other common attachment to the switch box. Group F lighting fixtures shall be connected to a separate circuit or switch box. Group G lighting fixtures shall be connected to a separate circuit or switch box. Group H lighting fixtures shall be connected to a separate circuit or switch box. Group I lighting fixtures shall be connected to a separate circuit or switch box. Group J lighting fixtures shall be connected to a separate circuit or switch box. Group K lighting fixtures shall be connected to a separate circuit or switch box. Group L lighting fixtures shall be connected to a separate circuit or switch box. Group M lighting fixtures shall be connected to a separate circuit or switch box. Group N lighting fixtures shall be connected to a separate circuit or switch box. Group O lighting fixtures shall be connected to a separate circuit or switch box. Group P lighting fixtures shall be connected to a separate circuit or switch box. Group Q lighting fixtures shall be connected to a separate circuit or switch box. Group R lighting fixtures shall be connected to a separate circuit or switch box. Group S lighting fixtures shall be connected to a separate circuit or switch box. Group T lighting fixtures shall be connected to a separate circuit or switch box. Group U lighting fixtures shall be connected to a separate circuit or switch box. Group V lighting fixtures shall be connected to a separate circuit or switch box. Group W lighting fixtures shall be connected to a separate circuit or switch box. Group X lighting fixtures shall be connected to a separate circuit or switch box. Group Y lighting fixtures shall be connected to a separate circuit or switch box. Group Z lighting fixtures shall be connected to a separate circuit or switch box.

**Ductwork**

- **Supply Air Duct Size**
  - All duct work shall comply with applicable state and local construction requirements.

- **Ventilation Air Duct Size**
  - All duct work shall comply with applicable state and local construction requirements.

**General Notes Electrical**

- **Lighting Switches**
  - All electrical work shall comply with applicable state and local construction requirements.

- **General Notes Electrical**
  - All electrical work shall comply with applicable state and local construction requirements.

- **Ductwork**
  - All duct work shall comply with applicable state and local construction requirements.

**General Notes: Mechanical**

- **Mechanical Notes**
  - All mechanical work shall comply with applicable state and local construction requirements.

- **Sprinkler System**
  - All mechanical work shall comply with applicable state and local construction requirements.

- **Fire Protection Sprinkler**
  - All mechanical work shall comply with applicable state and local construction requirements.

- **Lighting Switches**
  - All mechanical work shall comply with applicable state and local construction requirements.

- **Ductwork**
  - All duct work shall comply with applicable state and local construction requirements.

- **General Notes Electrical**
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- **Lighting Switches**
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- **Ductwork**
  - All duct work shall comply with applicable state and local construction requirements.

- **General Notes: Mechanical**
  - All mechanical work shall comply with applicable state and local construction requirements.

**MISCELLANEOUS**

- **Miscellaneous**
  - All mechanical work shall comply with applicable state and local construction requirements.

- **Lighting Switches**
  - All electrical work shall comply with applicable state and local construction requirements.

- **Ductwork**
  - All duct work shall comply with applicable state and local construction requirements.

- **General Notes: Mechanical**
  - All mechanical work shall comply with applicable state and local construction requirements.

- **Sprinkler System**
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- **Fire Protection Sprinkler**
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- **Ductwork**
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- **General Notes Electrical**
  - All electrical work shall comply with applicable state and local construction requirements.
HEAT EXCHANGER DEMOLITION PLAN

DRAWING NOTES:

1. PHASE REPLACEMENT OF HEAT EXCHANGERS AND PUMPS TO ALLOW FOR ONE PUMP AND ONE HEAT EXCHANGER TO BE OPERATING AT ALL TIMES.

2. PREVIOUS LOCATION OF EXISTING PUMP THAT HAS BEEN REMOVED. REPLACEMENT OF THIS PUMP SHALL BE FIRST AND THE CORRESPONDING HEAT EXCHANGER.

3. ISOLATE PUMP LOCATION AND HEAT EXCHANGER. REMOVE PIPING AS REQUIRED TO INSTALL NEW HEAT EXCHANGER.

4. PROVIDE ADD ALTERNATE M1 TO REPLACE THE PNEUMATIC CONTROLS RELATED TO THE HEAT EXCHANGER WITH A NEW DDC SYSTEM INCLUDING ELECTRIC ACTUATORS.

SCALE: 1/4" = 1'-0"
HEAT EXCHANGER RENOVATION PLAN

SCALE: 1/4" = 1' - 0"

1. INSTALL NEW PUMP AND HEAT EXCHANGERS AS SCHEDULED. INSTALL ONE HEAT EXCHANGER AND PUMP BEFORE REMOVAL OF THE OTHER EQUIPMENT.

2. RECONNECT TO EXISTING PIPING INCLUDING HEATING WATER SUPPLY AND RETURN INTO THE PUMP, STEAM, CONDENSATE, AND HEATING WATER SUPPLY AND RETURN TO THE HEAT EXCHANGER. MAKE TRANSITIONS INTO THE EQUIPMENT AS REQUIRED.

3. RECONNECT ELECTRICAL TO NEW PUMPS. RE: E100.

4. INSULATE ALL EQUIPMENT INCLUDING JACKETING. UTHSC-H SHALL REMOVE APPROXIMATELY 50 SQFT OF ADDITIONAL INSULATION PRIOR TO THE PROJECT COMING IN ORDER TO REMOVE ASBESTOS. ASSUME REPLACING THAT 50 SQFT OF PIPE INSULATION.

5. PROVIDE ADD ALTERNATE M1 TO REPLACE THE PNEUMATIC CONTROLS RELATED TO THE HEAT EXCHANGER WITH A NEW DDC SYSTEM INCLUDING ELECTRIC ACTUATORS. RE: M.600 FOR CONTROL DIAGRAMS.
### PUMP SCHEDULE

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<th>RPM</th>
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### HEAT EXCHANGER SCHEDULE

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HEATING HOT WATER SYSTEM

A. General: A building heating hot water distribution system shall provide heating hot water to the building air handling units, the HVAC coils and all systems requiring heating hot water between 140°F and 180°F via steam to hot water converters supplied with reduced pressure steam from the TECO steam system. The TECO steam supply, the heat exchangers and all associated pumps and condensate return systems operate 24 hours a day, continuously, to provide building heating and humidity control.

B. BCAS Control: BCAS control for the hot water system shall be from a dedicated stand-alone local control panel (AN) with all associated components.

C. System Design: The heating hot water system consists of two steam to heating hot water converters and two constant volume heating hot water pumps and 2-way control valves in the return to maintain fairly constant hot water temperature. The heat exchangers will be located at each floor for space heating,lamp heating, and the water pumps and 3-way control valves in the reheat to maintain fairly constant hot water temperatures. The small steam control valve shall open first and close last. When the heat exchanger has been deactivated, the modulating control valves shall return to the closed position. The large steam control valves shall remain at their last position and shall be program sequenced to equalize operating hours. The large steam control valves shall be indicated at the BCAS through differential pressure sensors or signal to prevent excessive cycling of the pumps. Status of pumps shall have a new disconnect since the MCC is not truly in the line-of-sight of the pump. The pump shall be stopped and started through the BAS. A water flow switch in the pump discharge shall input pump run status to the BCAS.

D. Pump Start Stop Control: Upon a call for system operation by the BCAS, the DOC Panel shall enable the heating hot water system, start the heat hot water pump, open the two-position control valve on the heat converter and enable associated heat converter steam control valves. The BAS shall monitor all spaces temperatures (10 total zones) and the AHU discharge temperature. If a fire alarm temperature falls below setpoint for more than 10 minutes with the control valve open 100%, then, the discharge temperature shall return up 10 degrees, until it hits 180 degrees max (10 minute lag between axis). Once the temperature reaches 180 degrees, if there are a few degrees or if the heat converter is not meeting setpoint, the modulating control valve position shall automatically increase to meet setpoint. The small steam control valve shall open first and close last. Upon the failure of an analog sensor, steam valves shall remain at their last position and alarm shall be annunciated. Steam valves shall be provided with spring return actuators to be actuated as indicated above to the heat exchanger.

E. Converter Control: The heating water system flow requirements (gpm), analog outdoor air temperature and analog hot water supply and return temperatures shall be inputs to the DOC Panel for each converter. When a converter is activated the two position hot water valve shall open and a water flow switch shall indicate flow status to the DOC Panel. Heat exchanger control shall only be enabled when proof of water flow has been established. A proportional plus integral control algorithm shall output a control signal to the two steam valves modulating them in sequence to maintain the hot water supply temperature at the setpoint as returned from outdoor air temperature. A control algorithm shall be operator programmable with initial schedule temperature at 140 degrees hot at 60 degrees F (all temperatures operator programmable) within the range of 140°F to 180°F. Temperatures shall remain at 140 degrees to not overheat too quickly and the lag pumps shall be energized. If the temperature remains too low in the zone, the discharge temperature of the heat exchanger shall ramp up to 180 degrees in 10 degree increments every 10 minutes. Normally, the two-way valves shall return to their last position and shall be program sequenced to equalize operating hours.

F. Failure Modes: Heat exchanger control shall be disabled when water flow is not present and steam valves shall be closed. Upon the failure of an analog sensor, steam valves shall remain at their last position and alarm shall be annunciated. Steam valves shall be provided with spring return actuators to be actuated as indicated above to the heat exchanger.

PRICE AS ALTERNATE M1

1 HEATING WATER - CONTROL DIAGRAM

UTHSC-H
CYCLOTRON BUILDING - 6431 FANNIN STREET
Hydronic Heat Exchanger Replacement
1. Disconnect power from existing pumps and reconnect through new non-fused disconnects.

2. The existing pumps are served through the existing MCC. It appears the conduit may have been used as the ground when this building was built. If it is found there is no ground in the conduit, maintain the current installation of the conduit acting as the ground and provide proper connectors and terminations.

ELECTRICAL OVERALL PLAN
SCALE: 1/8" = 1' - 0"

UTHSC-H
CYCLOTRON BUILDING - 6431 FANNIN STREET
Hydronic Heat Exchanger Replacement

E&C PROJECT #5404.00