SECTION 23 00 00 - MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. Except as modified in this Section, General Conditions, Special Conditions, applicable provisions of Division 01, General Requirements, and other provisions and requirements of the contract documents apply to work of Division 23.

B. Applicable provisions of this Section apply to all Sections of Division 23 HVAC.

C. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements and provide coordination drawings.

D. All work in these Sections shall be installed by craftsmen skilled in their trade.

E. Unsightly, inadequate, or sloppy work will not be acceptable and shall be removed and replaced as necessary to achieve an acceptable installation.

F. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner’s operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Section 019000, General Commissioning, for detailed commissioning requirements.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, un-air-conditioned spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

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

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

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within un-air-conditioned shelters.

F. Furnish: The term "furnish" is used to mean supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. Install: The term "install" is used to describe operations at project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. Provide: The term "provide" means to furnish and install, complete and ready for the intended use.

1.4 CODE REQUIREMENTS AND PERMITS

A. Perform work in accordance with applicable statutes, ordinances, codes, and regulations of governmental authorities having jurisdiction.

B. Resolve any code violation discovered in contract documents with the Engineer prior to award of the contract. After award of the contract, make any correction or addition necessary for compliance with applicable codes at no additional cost to Owner.

C. Obtain and pay for all permits and inspections.

D. The following building codes are applicable to this project.
1. 2015 International Mechanical Code
2. 2015 International Building Code
3. 2015 International Energy Conservation Code
4. State Energy Conservation Office (SECO) mandated state building compliance with ASHRAE 90.1-2013

1.5 REFERENCES

A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, AWWA Specifications, Federal Standards or other standard specifications must comply with latest editions except where specified otherwise in individual Sections, revisions, amendments, or supplements in effect on date bids are received.

B. Requirements in reference specifications and standards are minimums for all equipment, materials and work. In instances where capacities, size or other features of equipment, devices, or materials exceed these minimums, meet listed or shown capacities.

1.6 SUBMITTALS

A. Equipment and Materials submittals must show sufficient data to indicate complete compliance with contract documents as follows:
1. Proper sizes and capacities.
2. That the item will fit in the available space in a manner that will allow proper service.
3. Construction methods, materials, and finishes.

B. Material and Equipment List: Within 30 days after award of the contract and before orders are placed or shop drawings are submitted, submit a list of equipment and principal materials specified. Give names of manufacturers, catalog and model numbers, and such other supplementary information as necessary for identification.

C. Material and Equipment Shop Drawings: Submit all detailed shop drawings, descriptive literature, physical data, and performance data for review for items of equipment and for principal materials proposed for installation. HVAC controls may be submitted separately provided the controls submittal is complete and coordinated with all other applicable trades. Include identifying symbols and equipment numbers used in plans and specifications, with reference to specification paragraphs, and drawing numbers of all equipment and material submitted.

D. Final Submittal: In addition to number of copies of shop drawings and other data required for review submittals, maintain a separate file of final approved copies of such material. Deliver approved copies in a hard-back binder for the Owner's use. Incorporate changes and revisions made throughout construction period. Delivery of approved copies is a condition of final acceptance for the project.

E. Contractor's Check: Shop drawings will be submitted only by the Contractor. Indicate by signed stamp that the drawings have been checked, that the work shown on the drawings is in accordance with contract requirements and that dimensions and relationship with work of other trades have been checked. If drawings are submitted for approval that have not been checked and signed by the Contractor, they will be returned for checking before being considered by the Architect/Engineer.

F. Refer to Section 01 33 00 for additional submittal requirements

1.7 COORDINATION DRAWINGS

A. Prior to starting work, the Contractor shall provide coordination drawings for all areas of the building. The Contractor shall submit the coordination drawing for confirmation of the coordination process. The Contractor is responsible for all trade confirmation.

B. CAD. Provide 1/4 inch scale 2D coordination drawings.
1. Drawings shall show all equipment, ductwork, cable trays, fire protection system, coil pull spaces, chilled water, heating water and condensate piping and trap, electrical conduit, electrical and control panels, etc. installed in mechanical room to verify space allocation and coordination of trades.
2. Provide plan and elevation views detailing installation.
3. Contractor may not proceed with construction of MEP systems until trade coordination process has been demonstrated to be completed by the Contractor to the Architect, Engineer and Owner.

1.8 INTERFERENCE DRAWINGS

A. Interference drawings are drawings that indicate conflict between the various systems and other components of the building such as beams, columns, walls, etc. They shall be drawn to scale and shall include plans, elevations, sections and other details as required to clearly define the interference and to indicate the contractor’s proposed solution.

B. They shall be submitted for approval whenever job measurements and an analysis of the drawings and specifications by the contractor indicate that the various systems cannot be installed without significant deviation from the intent of the contract. When such interference is encountered, work shall cease in the general area of the conflict until a resolution to the question has been approved.

1.9 GUARANTEE

A. Guarantee work for one year from the date of final acceptance of the project. During that period make good any faults or imperfections that may have arisen due to defects or omissions in materials or workmanship.

1.10 SERVICE

A. Perform service work required during the guarantee period including lubrication of bearings. Perform manufacturer’s recommended monthly service and provide Owner with written report. Cleaning of air filters and pipe strainers is not included.

1.11 RESOLUTION OF CONFLICTS

A. Where conflicts may exist between and/or within the drawings and/or specifications, the contractor shall contact the A/E to clarify. The Contractor shall notify the A/E for resolution of the issue prior to executing the work in question.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Furnish new and unused materials, pipes, pipe fittings, and equipment of domestic manufacture, where available. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

2.2 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are listed in individual Sections of Division 23. Where two or more units of same type or class of equipment are required, provide units of a single manufacturer.

B. Manufacturers' names and catalog numbers specified under Sections of Division 23 are used to establish standards of design, performance, quality and serviceability and not to limit competition.

C. Equipment of similar design, equal to that specified, manufactured by a manufacturer named in the acceptable manufacturers' list will be acceptable on approval.

D. Substitutions:
1. If the Contractor desires to substitute a material or method as an equal to the specified item, he shall request permission from the Architect/ Engineer, in writing, and shall include such literature, samples, etc., deemed necessary to establish the equal quality of his proposal.
2. If the Architect/Engineer deems it necessary in order to establish the equality between two or more products, he may require laboratory testing at the Contractor's expense in order to obtain information upon which to base a decision.
3. The Architect/Engineer will not give approval to material salesmen or subcontractors, and only in writing to the successful Contractor after the project has been awarded.
4. For each proposed substitution product, clearly show how the proposed product meets the requirements of the specifications, including performance.
5. No substitution will be considered unless it is presented in writing within that number of days after Notice to Proceed equal to 15 percent of the contract time.
6. Proposers of substitute products shall present samples, literature, test and performance data, record of other installations, names of Owners, architects, engineers, contractors and subcontractors as references, statement of current financial condition, and other technical information applicable to their products, to aid in determining the worth of the substitute product offered in relation to the material and work specified from the standpoint of the Owner's best interest. Substitute materials and products shall be used only if approved in writing by the Architect/Engineer in advance.
7. Approval of substitute materials offered shall not be a basis for contingent extra charges because of changes in other work or related work, such as roughing-in, electrical, structural or architectural, which may result from the substitution.
8. For any Contractor initiated substitutions or changes, Contractor shall be responsible for achieving results equal to or better than the product or design originally specified.

E. Basis of Design: Where a basis of design is indicated (i.e,, scheduled products), that product was used for the purposes of established space requirements, structural design for the building, utility connections, etc. If the contractor elects to furnish a product other than the basis of design product (either another named acceptable manufacturer or via substitution) the contractor is responsible for any construction or design costs associated with the non-basis of design product.

2.3 NOISE AND VIBRATION

A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions without cost to the Owner. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate (without cost to the Owner) that equipment performs within designated vibration limits indicated in the specifications, or as specified by manufacturer.

B. Seal all wall and partition penetrations (the penetration opening shall be one inch larger than penetrating member) by ducts and piping by stuffing the annular void with fiberglass insulation and then caulking over fully with a non hardening acoustical caulking applied to both sides of wall or partition.

2.4 AIR FILTERS AND PIPE STRAINERS

A. Immediately prior to final acceptance of project, inspect, clean and service hydronic system strainers and replace disposable type air filters.

B. Turn over to Owner additional sets of spare filters and other spare parts as specified.

2.5 ACCESS DOORS

A. Provide access doors for all walls or ceiling locations as required for access to valves, controls, regulating devices, water arresters, fire dampers, air distribution boxes, and other concealed equipment requiring maintenance adjustment or operation. Coordinate location with General Contractor.

B. Refer to architectural Sections for access door requirements.

2.6 FLAME SPREAD PROPERTIES OF MATERIALS

A. Materials and adhesives incorporated in this project 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cooperation with Other Trades: Cooperation with trades of adjacent, related, or affected materials or operations and of trades performing continuations of work under subsequent contract is considered a part of this work in order to effect timely and accurate placement of work and to bring together in proper and correct sequence the work of such trades.

B. Workmanship: Work must be performed by workmen skilled in their trade.

C. Installation of all equipment and materials must be complete. Installation shall meet requirements of specifications and manufacturer’s recommendations.

D. Electrical Wiring of Motors and Equipment. The Contractor shall note that the electrical design was based upon the mechanical equipment indicated on the mechanical construction documents and specifications. If Contractor proposes any mechanical equipment that requires changes to the electrical design, the required electrical changes shall be made at no cost to the Owner.

3.2 SPACE REQUIREMENTS

A. Consider space limitations imposed by contiguous work, including clearances required for service, in selection and location of equipment and material. Do not provide equipment or material which is not suitable in this respect.

B. The following space allocation and coordination shall be followed, unless otherwise indicated on the construction drawings:
1. Gravity-fed plumbing and roof drain line shall take priority over all other systems.
2. Light fixtures and cable tray arrangements shall take priority in spatial layout. In areas with ceilings, other systems shall be routed above the light fixtures, and offset from above cable tray allowing for access and maintenance clearance.
3. Install HVAC ductwork as close to the bottom of structural framing as possible while allowing clearance for installation of insulation wrap. Install ductwork to be accessible from the ceiling plane.
4. Install HVAC chilled/hot water piping in the plane directly below HVAC ductwork unless indicated otherwise on drawings.
5. Install fire sprinkler piping in the plane directly beneath the HVAC chilled/hot water piping. Do not install sprinkler piping directly below equipment requiring maintenance.
6. Install domestic hot and cold water in the plane directly above the light fixtures.
7. Refer to Division 26 for electrical and control wiring requirements.
8. Install piping to permit removal of coils at air handling units and to permit access to all terminal unit components.

3.3 OBSTRUCTIONS

A. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.

B. Before any cutting or trenching operations are begun, verify with Owner's Representative, utility companies and other interested parties that all available information has been provided. Verify locations given.

C. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.

D. Assume total responsibility for and repair any damage to existing utilities or construction.

3.4 OPENINGS

A. Framed, cast or masonry openings for ductwork, equipment and piping are specified under other divisions. However, drawings and layout work for exact size and location of all such openings are included under this division.

3.5 ACCESS DOORS

A. Coordinate location of access doors for ease of operation and maintenance of concealed equipment.

3.6 DELIVERY, STORAGE AND HANDLING

A. Adequately protect work, equipment, fixtures and materials from damage during storing, installation, start-up and testing.

B. Cover all equipment stored exposed to elements with waterproof tarps, provide adequate ventilation.

C. At work completion, all work must be clean and in like new condition.

D. Storage of all mechanical equipment, piping materials and ductwork shall be in strict accordance with manufacturers written installation instructions.

E. Rotate air handler fans and pump shafts on routine basis.

F. Provide factory installed pipe caps for all pipes to be installed on the project.

G. Provide covers over all openings in ductwork stored or installed on the project.

H. Energize motor heaters with temporary power as soon as the motor is received on site.

I. Air Handling Units shall not be used as storage containers

3.7 LUBRICATION AND OIL

A. Provide a complete charge of correct lubricant and/or oil for each item of equipment requiring lubrication. Contractor shall lubricate per manufacturers requirements until equipment is turned over to the owner.

3.8 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections for Interior Painting and Exterior Painting.

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

C. Paint mechanical items located outdoors, in building equipment rooms, in tunnels and on roof. Painting of mechanical systems includes preparing, painting, and color coding work.

D. Preparation and application shall be in accordance with Division 09 Painting Sections.

E. Mechanical items to be painted include, but are not limited to, piping, pipe hangers, heat exchangers and tanks, mechanical equipment, insulation, equipment supports, motors, and ductwork.

F. Thoroughly clean surfaces receiving paint of dirt, grease, oil, rust, and scale.

G. Unless otherwise specified, paint using three coats of selected colors. Mix and use exactly as specified by manufacturer. Allow each coat to dry thoroughly before applying succeeding coats. Painting may be done by spraying where feasible.

H. Upon completion of painting, remove all scaffolds, surplus material, rags, and trash to leave spaces neat and clean.

I. Machinery and Equipment: Paint motors, compressors, tanks, air handling units, and other similar equipment according to the following requirements:
   1. First Coat: Rust inhibitive primer (not required if factory painted). Use galvanized iron primer where applicable.
   2. Second Coat: Machinery enamel. Factory finished items require matching touch up only.
   3. Third Coat: Machinery enamel.

J. Piping and Ductwork:
   1. First Coat: Rust inhibitive primer. Use galvanized iron primer where applicable. Omit first coat on pre-sized insulated pipe.
   2. Second Coat: Enamel.
   3. Third Coat: Enamel.

K. Pipe Coding:
1. Paint all piping white. Each line shall receive pipe marker as specified.
2. Paint pipe in accordance with the following painting schedule:

PAINTING SCHEDULE
Color Code – Finish Coats

Item	Color
Treated Water	Federal Safety White
Drain and Exhaust	Navy Gray
Caustic	Federal Safety Red
Acid and Chemical	Federal Safety Purple
Chilled Water	Cascade Green
Condenser Water	Federal Safety Green
Air	Marlin Blue
Anything Hot	Federal Safety Orange

3.9 CUTTING AND PATCHING

A. General: Cut and patch walls, floors, etc., resulting from work or by failure to provide proper openings or recesses in new construction.

B. Methods of cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer.
1. Do not use impact-type equipment except where specifically acceptable to the Architect/Engineer.
2. Core drill openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., to exact size.

C. Restoration: Restore all openings to "as-new" condition under the appropriate Specification Section for the materials involved

D. Match remaining surrounding materials and finishes.

E. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.

F. Provide adequate support during cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.

G. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

3.10 TEMPORARY CONDITIONING OF BUILDING SPACES FOR COMPLETION OF CONSTRUCTION

A. The following mechanical system items shall be completed prior to requesting the Owner to provide chilled water or hot water from the campus distribution system:
1. All chilled and hot water piping systems must be complete.
2. All hydronic-piping systems must be cleaned in accordance with specifications.
3. All chilled water piping must be insulated and sealed.
4. All pumps, air handlers and other associated equipment must be installed in their permanent location with all valves, strainers, piping, vibration isolation, electrical connections and safety devices in place.
5. Controls to regulate temperature and water flow must be in place and operational.
6. Provide and service fine mesh construction inserts in pump strainers.

B. All permanent filters for air handlers must be in place. Temporary filters must be installed on VFD drives and fan powered VAV boxes during construction. Provide temporary filter media ahead of permanent filters and replace when dirty. Do not operate exhaust devices, including fume hoods, during gypboard finishing.

C. Factory startup of the VFD drives shall occur prior to turning on units.

D. A preliminary air balance of the supply air shall be performed within one week of start-up by the TAB firm. All air unit and fan motors amperage ratings shall be measured and provided to the University in the preliminary Air Balance Report.

E. All equipment utilized will be checked out by a factory representative, serviced, lubricated, checked for rotation, pressure, amp draw and vibration isolation, adjusted and certified. Record of this service must be provided monthly to the Owner. Submit appropriate reports to the University prior to submitting a written request for service.

F. All equipment operated shall be serviced on a regular basis by the contractor.

G. Prior to final inspection, clean all equipment inside and out to a like new condition, remove temporary filters, install new permanent filters in preparation for final inspection by Owner.

H. All warranties will be commenced at the time of final acceptance.

I. Refer to Division 1 requirements for a clean building.

3.11 OPERATING TESTS

A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequence and operation throughout the range of operation witnessed by Owner's Representative.

B. Prove operations of control systems and all safeties, freezestats and alarms.

C. Make adjustments as required to ensure proper functioning of all systems.

D. Special tests on individual systems are specified under individual Sections.

E. Functional Performance Testing is part of the Commissioning Process. Functional performance testing shall be performed by the contractor and witnessed and documented by the Commissioning Agent. Refer to Section 019113, General Commissioning, for functional performance testing and commissioning requirements.

3.12 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Furnish copies of commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings in accordance with Specification 01 78 32. Detailed requirements for these items are as follows:
   1. Information required for the preparation of O&M manuals may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Clearly distinguish between information which applies to the equipment and information which does not apply. Data shall include as a minimum the following items:
      a. Recommended procedures and frequencies for preventive maintenance; inspection, adjustment, lubrication, cleaning, etc.
      b. Special tools and equipment required for testing and maintenance.
      c. Parts lists reflecting the true manufacturer's name, part number and nomenclature.
      d. Recommended spares by part number and nomenclature and spare stocking levels.
      e. Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.

f. Troubleshooting, checkout, repair and replacement procurement procedures.
g. Operating instructions including start up and shutdown procedures.
h. Safety considerations including load limits, speed, temperature and pressure.

2. Provide O&M manuals for all HVAC equipment.

3.13 PROJECT RECORD DOCUMENTS

A. Maintain at the job site a separate set of white prints of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings.

B. Mark the drawings with a colored pencil.

C. Prepare, as the work progresses and upon completion of work, drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed.

D. Record underground and underslab piping installed, dimensioning exact location and elevation of such piping.

E. At conclusion of project, obtain without cost to Owner, reproducibles of original mechanical drawings and transfer as-built changes to these.

F. Delivery of as-built prints and reproducibles is a condition of final acceptance.

3.14 TRAINING

A. Upon completion of work, and at time designated by the Owner's Representative, provide services of a competent representative of the manufacturer/Contractor to instruct the Owner's Representative and up to 8 members of the Owner’s staff in the operation and maintenance of the entire system. Record training sessions on DVDs for instructing future technicians.

B. Provide training for the following pieces of equipment:

Items:	HRs of Training Pre-Substantial Completion	HRs of Training at 6 months from Substantial Completion	HRs of Training at 11 months from Substantial Completion	Video Taping Required
Pumps	4			X
DDC Controls	16	8	8	X
VFDs	4	4		X

C. All training sessions shall be scheduled in coordination with the Owner’s Representative 14 days in advance, attendance taken, and sign-in sheet and training materials included in the O&M manuals.

END OF SECTION 23 00 00

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. Section includes general requirements for 1-phase and 3-phase electric motors with NEMA frame machines sized through 200 horsepower and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation. Unless otherwise specified, provide motors meeting the basic requirements for general purpose alternating current motors, as defined in ANSI/NEMA MG 1-1.05.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

1.4 REFERENCES

A. ANSI/IEEE 117 - Standard Test Procedure for Evaluation of Systems of Insulating Materials for Random Wound AC Electric Machinery.

B. ANSI/NEMA MG 1 - Motors and Generators.

C. ANSI/NEMA MG 2 - Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors.

D. ANSI/UL 674 - Electric Motors and Generators for Use in Hazardous (Classified) Locations.

E. ANSI/UL 1004 - Electric Motors.

F. Energy Conservation Design Standard for New State Buildings.

1.5 SUBMITTALS

A. Provide the following information for each motor:
   1. Manufacturer.
   2. Rated full load horsepower.
   3. Rated volts.
   4. Number of phases.
   5. Frequency in hertz.
   6. Full load amperes (FLA).
   7. Locked rotor amperes (LRA) at rated voltage or NEMA code letter.

8. Nominal speed at full load (rpm).
9. Service factor.
10. NEMA design letter.
11. NEMA machine type (ODP, WP-I, TEFC, etc).
12. Motor space heater voltage, wattage and number of wires (where applicable)[Engineer to remove if space heaters not required by project]

B. For motors 3/4 horsepower and larger, include the following additional information:
1. NEMA frame size.
2. NEMA insulation system classification. For motors required to be installed outdoors, include information showing compliance with the intent of paragraph 2.3C.
3. Maximum ambient temperature for which motor is designed.
4. Time rating.
5. Bearing type.
6. Efficiency at full load.

C. For motors 20 horsepower and larger, include the following additional information:
1. No load amperes.
2. Efficiency at 1/2 and 3/4 load.
3. Power factor at no load, 1/2, 3/4 and full load.
4. Full load amperes.
5. Maximum guaranteed slip at full load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements for integral horsepower motors, provide products by one of the following:
1. General Electric.
2. Baldor/Reliance.
3. Toshiba
4. TECO Westinghouse.

2.2 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.3 MOTOR CHARACTERISTICS

A. Speed and Size:
1. Speed and approximate horsepower ratings are specified in the driven equipment specification Sections or are indicated on the Drawings.
2. Furnish motors sufficiently sized for the particular application and with full-load rating not less than required by the driven equipment at specified capacity.
3. Size motors so as not to overload at any point throughout the normal operating range.
4. Provide motors designed and rated for variable frequency drive applications where required.

B. Voltage:
1. Single phase: 115 volts for 120-volt nominal system voltage and 277 volts (refer to mechanical schedules).
2. Three phase: 460 volts for 480-volt nominal system voltage.

C. Frequency: 60 hertz.

D. Service Factor: According to NEMA MG 1-12.47 but not less than 1.15.

E. Acceleration Time: For integral horsepower motors, the calculated acceleration time of the combined motor and driven load shall not exceed 4 seconds at 90 percent of rated voltage.

F. Efficiency:
1. Provide single-speed NEMA Design B Premium efficiency induction motors having minimal full-load motor efficiency no less than those listed in the latest edition of NEMA MG 1 Section 12.60 (EFFICIENCY LEVEL OF PREMIUM EFFICIENCY ELECTRIC MOTORS). Motors and manufacturers shall be officially listed and labeled by the NEMA Premium program.
2. Base motor efficiencies on a statistically valid control procedure conforming to ANSI/IEEE 112-84, Test Method B (Dynamometer), using NEMA MG 1).
3. For motors rated at a horsepower not listed in the NEMA guidelines the motors shall conform to the next higher nominal motor horsepower efficiency rating.

2.4 DESIGN TYPE

A. Motors Smaller than 1/6 Horsepower: Single-phase squirrel-cage induction motors with integral thermal protectors.

B. Motors 1/6 through 1/2 Horsepower: Single-phase NEMA Design Letter N, squirrel-cage induction motors with integral thermal protectors.

C. Motors Larger than 1/2 Horsepower: 3-phase, NEMA Design Letter B, squirrel-cage induction motors.

D. Motor Driven by Variable Frequency Drives (VFDs): Inverter duty motors.

2.5 MOTOR INSULATION

A. Use Class F insulation system meeting the requirements of NEMA MG Part 31 and made of non-hygroscopic materials for motors 10 HP and larger.

B. Use Class B Temperature Rise: NEMA MG 1-12.41 for fractional horsepower motors and NEMA MG 1-12.42 for integral horsepower motors.

C. Outdoor Suitability:
1. Where motors must be suitable for outdoor installation, insulation must withstand 1 full week (168 hours) of testing in a chamber maintained at 100 percent relative humidity and 104°F (40°C) ambient temperature.
2. Immediately after the test period, insulation system must have a minimum resistance of 1.5 megohms.
3. Coat inside circumference of the stator and the outside circumference of the rotor and shaft with the same moisture-resistant insulation system.

D. VFD Motors: Inverter duty type and capable of withstanding repeated peaks of 1600 volts at 0.1 microsecond rise time. Comply with NEMA MG-1 Part 31.

2.6 LEADS

A. Use not less than ASTM B 173, Class G, stranded copper conductors with insulation the same as or better than specified in the preceding Motor Insulation paragraph.

B. Provide permanent identification numbers on leads according to NEMA MG 1-2.02.

C. Use crimp-on, solderless copper terminals on leads and place heat-shrink insulation sleeves or covers between leads and terminals.

2.7 ENCLOSURE

A. Indoors:
1. Open drip-proof (ODP).
2. Use steel frame for motors smaller than 3/4 horsepower and up to 10 HP, and cast-iron frame for motors over 10 horsepower.

B. Outdoors: Completely enclosed, fan cooled (TEFC), with a corrosion-resistant drain plug under each bearing. Use cast-iron frame.

C. Motors 5 HP and greater that are driven by variable frequency drives, provide motor with factory mounted AEGIS shaft grounding ring. Where factory mounting is not available, installation of shaft grounding shall be bolted in accordance with the manufacturers recommendations and shall not void the warranty. Conductive epoxy installation is not acceptable.

2.8 BEARINGS

A. Motors Smaller than 1/6 Horsepower: Motor manufacturer's standard bearing is acceptable.

B. Motors 1/6 Horsepower and Larger:
1. Antifriction:
a. Supply motors with grease-lubricated antifriction ball bearings conservatively rated for long life under the total radial and thrust loads produced by the actual combination of motor-driven equipment.
b. Provide each motor with suitable lubrication fittings and pressure relief devices suitable for in-service lubrication.
2. Oil Lubricated: If the driven equipment Section specifies oil-lubricated bearings for motors, include a suitable sight gauge on each bearing with maximum and minimum levels clearly indicated.

2.9 HARDWARE

A. Use structural bolts, washers, nuts, pins, and similar items manufactured of high-strength steel. Use only hexagon-head bolts and hexagon nuts.

B. Use corrosion-resistant materials or protect hardware from corrosion by hot-dip galvanizing, chrome plating, or cadmium plating.

2.10 NAMEPLATES

A. Main Nameplate: Provide each motor with a stainless steel nameplate meeting the requirements of NEMA MG 1-10.38, and the National Electrical Code, Section 430-7. Identify energy-efficient motors in accordance with MG-1-12.54.2.

B. Bearings Nameplate: When bearings are oil lubricated, include oil type information on a suitable nameplate. Indicate bearing data if nonstandard.

C. Attachment: Attach the nameplates to the motor with stainless steel fastening pins or screws.

2.11 CONDUIT BOX

A. For each motor not supplied with a cord and plug, provide a conduit box suitably sized for the motor lead terminations, in accordance with the National Electrical Code, Section 430-12. Include a grounding lug for motors 1/6 horsepower and larger. Supply a gasket suitable for the motor enclosure type and application.

2.12 PAINT

A. Manufacturer's standard shop paints for prime and finish coats are acceptable.

2.13 NOISE

A. Provide integral horsepower motors with overall sound power levels meeting the requirements of MG 1-12.49.

2.14 STARTERS

A. Provide starters for any motor not equipped with VFD.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Properly install and align motors in the locations as shown on Drawings. Use crimp-on, solderless copper terminals on the branch circuit conductors. For motors 20 horsepower and larger, use 5300 Series 3M motor lead splicing kit or approved equivalent.

B. Nameplate must be in full view when motor and equipment are installed.

C. If a motor horsepower rating larger than indicated is offered as a substitute and is accepted, provide required changes in size of conductors, conduits, motor controllers, overload relays, fuses, circuit breakers, switches, and other related items at no change in contract price.

3.2 FIELD TESTING

A. Provide instruments, labor and personnel required to perform motor inspection and testing.

B. Inspect all motors for damage, moisture absorption, alignment, freedom of rotation, proper lubrication, oil leaks, phase identification, and cleanliness. Report abnormalities to Owner’s Representative before energizing.

C. Megger test all motors 20 horsepower and larger in accordance with IEEE Report No. 43, “Recommended Practices for testing Insulation Resistance of Rotating Machinery” to determine insulation resistance.

D. Measure full load current and full load voltage.

E. Complete and submit Motor Test Report forms to Owner’s Representative.

F. After installation has been thoroughly checked and found to be in proper condition with thermal overloads in motor controllers properly sized and all controls in place, energize the equipment at system voltage for operational testing.

END OF SECTION 23 05 13

SECTION 23 05 19 - METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. Section Includes the following for hydronic piping:
   1. Thermometers.
   2. Gauges.
   3. Pressure and Temperature Taps.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, submit detailed shop drawings and manufacturer’s data, including:
   1. Measurement tolerances.
   2. Range.
   3. Accuracy.
   4. Device dimensions and connection sizes (include schedule indicating stem length versus pipe diameter).
   5. Scales.
   6. Materials of construction.
   7. Valves that will be used for isolating gauges.

B. Submit a schedule for each device to be installed, including:
   1. Location.
   2. Pressure or temperature range of device and fluid measured.
   3. Temperature or pressure of fluid.
   4. Pipe size and bulb length of thermometers.
   5. Type of valve used with the Pressure Gauge.

C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Thermometers: Calibrate against standards traceable to the NIST and guaranteed accurate to plus or minus one scale division.

B. Pressure Gauges: ASME B40.1 Grade 2A accuracy 0.5 percent of scale range.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products meeting all requirements of this specification Section of the following manufacturers are acceptable:
   1. Thermometers: Ashcroft, Dwyer, Marsh Instrument, Trerice, Weiss, Weksler

2. Pressure Gauges: Ashcroft, Dwyer, Trerice, Weiss, Weksler
3. Pressure/Temperature Taps: Peterson Engineering Company, Sisco or Trerice

2.2 GLASS THERMOMETERS

A. Construction: Provide mercury free liquid in glass thermometer with a molded Valox polyester or cast aluminum case. .

B. Window: Plastic or Glass.

C. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

D. Scale: 9-inches long, white scale with black graduations and figures..

E. Stem: Aluminum or Stainless steel, thermowell installation, ¼-inch diameter, minimum 3-1/2 inch straight or angle form of length to suit installation.

F. Accuracy: Plus or minus 1 percent of full scale.

G. Furnish thermometers for services in the following ranges and divisions:
1. Chilled Water: 0 to 120 degrees F, 1 degree divisions
2. Heating Hot Water: 30 to 240 degrees F, 2 degree divisions
3. Condenser Water: 0 to 120 degrees F, 1 degree divisions
4. Process Chilled Water: 0 to 120 degrees F, 1 degree divisions

2.3 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.

B. Description: Brass or stainless steel with pressure and temperature ratings suitable for their application. Wells for insulated piping shall have a 2-1/2 inch lagging protrusion. Locate thermometer wells so the sensing bulb will give a true and correct reading. Install thermometer so as not to cause undue restriction in small piping. Where wells are located in pipelines 1-1/2 inch and smaller, provide a section of pipe of such diameter that the net area of the pipeline will not be reduced by the thermometer well.

2.4 PRESSURE GAUGES

A. Direct-Mounting, Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.
1. Case: Liquid-filled type, polypropylene case, 4-1/2 inch diameter, solid front with blow-out back.
2. Bourdon Tube: Bronze or 316 stainless steel with brass or stainless steel socket.
3. Movement: 300 series stainless steel rotary type with stainless steel bushings
4. Dial: White face with black figure.
5. Pointer: Red or black, micro adjustable.
6. Window: Molded Acrylic.
7. Ring: Fiberglass polypropylene.
8. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
9. Gauge Ranges
   a. Provide 0 - 160 psi gauges for 150 psi chilled/hot water service.
10. Provide liquid filled gauges for all pressure gauges upstream and downstream of pumps.

B. Pressure-Gauge Fittings:
1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Siphons: NPS 1/4 coil of brass or stainless steel tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.5 PRESSURE AND TEMPERATURE TAPS:

A. Taps. Provide 1/2" solid brass fittings which will receive either a pressure or temperature probe, with valve core of Nordel and fitted with a color coded cap and gasket. P/T Taps shall be rated for 275 degrees F. and 1000 psig. Provide long stem type for insulated pipe.

B. Instruments. Provide two each, No. 500 "Pete's Plug" pressure gauge adapters with four gauges and probes and four each 5" stem pocket thermometers: Two each, thermometers for chilled water, heating and domestic hot water systems, when applicable. Applicable meaning the system is being installed as part of the project. “Pete’s Plugs” to match insulation thickness.

PART 3 - EXECUTION

3.1 THERMOMETER INSTALLATIONS

A. Provide thermometers and thermometer wells in the following locations:
1. Inlet and outlet of each air handling unit coil connection.
2. Inlet and outlet of for supply and return connections of each heat exchanger.
3. As shown on Drawings and control schematics.

B. Install direct-mounting thermometers and adjust vertical and tilted positions.

C. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

3.2 GAUGE INSTALLATIONS

A. Provide pressure gauges in the following locations:
1. Suction and discharge side of each pump.
2. Each hydropneumatic tank.
3. Inlet and outlet of each air handling unit coil.
4. Supply and return piping connections of coils (where shown on details).
5. Inlet and outlet of each heat exchanger vessel.
6. As shown on Drawings and control schematics.

B. Install direct-mounting pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

C. Install needle-valve in piping for each pressure gauge for fluids.

D. Install snubber for gauges associated with pumps.

E. Provide fittings as necessary to install pressure gauge in the vertical position.

3.3 PRESSURE AND TEMPERATURE TAP INSTALLATIONS

A. Provide pressure and temperature taps at the following locations:
1. Inlet and outlet of each coil connection.
2. Inlet and outlet of each hydronic control valve
3. Inlet and outlet of for supply and return connections of each heat exchanger.
4. Where shown in details on mechanical drawings.

B. Provide liquid filled gauges upstream and downstream of all pumps.

3.4 CONNECTIONS

A. Install thermometers and gauges adjacent to machines and equipment to allow service and maintenance for thermometers, gauges, machines, and equipment. Thermometer

3.5 ADJUSTING

A. Adjust faces of meters and gauges to proper angle for best visibility.

END OF SECTION 23 05 19

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. This Section includes requirements for furnishing and installing heating water, chilled water piping valves and appurtenances, including fittings and strainers.

B. Related Sections:
   1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
   2. Section 23 05 53, Identification for HVAC Piping and Equipment, for valve tags and schedules.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s product data showing compliance with requirements of Part 2. Clearly indicate piping, equipment, materials of construction, pressure rating and which options are to be provided.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect all piping, valves, fittings, etc. before installation in accordance with manufacturer’s written instructions.

B. Piping shall be sent from the factory with capped ends and shall be stored on supports off of the ground with ends covered to prevent nesting of insects, birds and other animals, or the accumulation of dirt and debris in and around the piping components.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Provide only domestically manufactured piping and fittings.

B. Refer to HVAC valve schedule articles for applications of valves.

C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

F. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Ball Valves: Provide an insulated stem extension.
2. Butterfly Valves: With extended neck.

G. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Check Valves: Apco, Crane, Kitz, Mission, Milwaukee, Mueller, Nibco, Powell, Stockham and Weco.
2. Plug Valves: DeZurik, Keystone, Mueller, or Stockham.
3. Globe Valves: Crane, Kitz, Milwaukee, Nibco, Powell, or Stockham.
4. Butterfly Valves: Bray, Clow, Demco, DeZurik, Crane, Kitz, Milwaukee, Nibco, Pratt, or Stockham.
5. PVC Ball Valve: George Fischer or Approved Equal.
6. Ball Valve: Apollo, Crane, DeZurik, Kitz, Milwaukee, Nibco, or Watts.
7. Strainers: Armstrong, Keckley, Mueller Spirax or Watts.
8. Coil Packs: IMI Hydronic Engineering Inc., Nexus, Nibco, Pro Hydronic Specialties.

2.3 CHECK VALVES

A. For pipe 2 inches in diameter and smaller, furnish 150-pound (class 150) screwed, horizontal, swing check valve, all bronze construction, with screwed cap.

B. For pipe 2-1/2 to 10 inches in diameter, provide 125-pound (class 125), lugged style, drill and tapped, or retainerless wafer lug style, double door valve, with cast iron body and aluminum bronze doors, Buna-N seat, and Type 316 stainless steel spring.

C. For pipe 10 inches in diameter and larger, provide 125-pound (class 125), raised-face, lugged style silent check valve, with cast iron body and aluminum bronze twin disc, Buna-N seat, steel lifting eye bolt, and Type 316 stainless steel hinge pin, stop pin, thrust bearing and spring.

2.4 PLUG VALVES

A. For pipe 2 inches in diameter and smaller, use 150-pound (class 150) screwed, eccentric plug valve with a bronze body, bolted bonnet, Fluorinated Hydrocarbon (Viton) Filled PTFE packing, Isobutene-Isoprene or Viton faced plug, stainless steel bearings, lever operated with adjustable memory stop, non-lubricated, short pattern plug valve.

B. For pipe 2-1/2 inches in diameter or larger, furnish 150-pound (class 150) flanged eccentric plug valve, with cast iron steel, bolted bonnet, Buna (Vee) packing, Isobutene-Isoprene or Viton faced plug, stainless steel bearings, lever operated with memory stop through 8 inch size, and totally enclosed handwheel actuators above 8-inch size, non-lubricated, short pattern plug valve.

2.5 GLOBE VALVES

A. For pipe 2 inches in diameter and smaller, provide 150-pound (class 150) screwed, rising stem, globe valve with bronze body, TFE disc, union bonnet.

B. For pipe 2-1/2 through 10 inches in diameter, provide 125-pound (class 125) flanged, OS&Y globe valve, with cast iron body, renewable bronze trim.

2.6 BUTTERFLY VALVES

A. For pipe 2-1/2 through 12 inches in diameter, furnish 200-pound flanged or tapped lug type butterfly valve with ductile iron body, stainless steel stem, aluminum-bronze disc with EPDM liner. Provide lever-operated valves 6 inches and smaller. Furnish valves 8 inches and larger with totally enclosed worm gear operators. Provide valves with enclosed worm gear operators with chain wheel and chain on valves installed higher than 84 inches above floor. Use valves designed for drip-tight shutoff in dead end service against 200 psi.

B. For 14 inch diameter pipe and larger, employ 150-pound, full-flanged or tapped lug butterfly valve with ductile iron body, stainless steel stem, and aluminum bronze disc with EPDM liner. Provide totally enclosed worm gear operators for all valves. Provide valves with enclosed worm gear operators with chain wheel and chain on valves 84 inches above floor or as indicated on drawings. Provide valves designed for drip tight shutoff in dead end service against 150 psi.

C. Where balancing valve is shown, provide butterfly valve with position lock operator (memory stop) for valves 6 inches and smaller and worm gear operator with memory stop for valves 8 inches and larger.

2.7 BALL VALVES

A. For pipe 2 inches in diameter and smaller, provide 600 psi WOG screwed, two piece bronze or forged brass body, Teflon seat, full port, stainless steel stem and ball. Provide extension stem and insulated handle for valves installed in insulated piping. Where ball valves are used as balancing valves, provide valve with memory stop.

2.8 STRAINERS

A. For pipe 2 inches in diameter and smaller, use 125-pound (class 125) cast bonze screwed Y-type strainer with 12-mesh stainless steel screen. Provide full size blowoff ball valve where shown on drawings.

B. For pipe 2-1/2 inches and larger, provide 150-pound (class 150) cast steel or iron flanged Y-type strainer with 0.045 inch stainless steel screen through 4, and 1/8 inch stainless steel screen for 6 inches and larger. Provide full size blowoff ball valve where shown on drawings.

2.9 VALVES FOR FAN COIL UNITS AND TERMINAL BOXES (COIL PACK)

A. General. The following products are for terminal boxes and fan coil units with pipe sizes 2-inches and less.

B. Combination Ball Valve w/PT Test Port and Strainer w/blowdown valve. Provide dezincification resistant or forged brass construction, 600-pound, 325F construction with multiple ¼” tapped ports for test plugs or other accessories and union end. Valve shall have blowout proof stem with stainless steel ball. Strainer shall have 20 mesh Type 304 stainless steel screen and ¾” hose bib & cap.

C. Combination Ball Valve w/Memory Stop and PT Test Port. Provide dezincification resistant or forged brass construction, 600-pound, 325F construction with multiple ¼” tapped ports for test plugs or other accessories and union end. Valve shall have blowout proof stem with stainless steel ball.

D. Combination PT Test Port w/Manual Air Vent. Provide dezincification resistant or forged brass construction, 600-pound, 325F construction with multiple ¼" tapped ports for test plugs or other accessories and union end.

E. PT Test Ports. Shall be rated for 1000 psi, 325F with brass body, Nordel check plugs and sealed cap.

F. Stainless Steel Flex Hoses. Shall be designed for water and conform to ASTM codes E84, with stainless steel outer braid. Hoses 1/2-inch thru 1-inch shall have a Kevlar reinforced EPDM tube core, brass end fittings, and designed for a working pressure of 400 psi, 248F. Hoses 1¼-inches thru 2-inches shall have Rayon reinforced EPDM tube core, brass end fittings, and designed for a working pressure of 300 psi, 248F. All hoses shall have at least one union or swivel end fitting and be maximum 18-inches in length.

G. Manual Air Vents. Shall be of brass construction and rated at 400 psi, 325F.

H. Shaft extensions (2" and smaller). For insulated pipe shall be at least 2¼" tall and constructed of brass with a stationary external shaft housing to ensure vapor barrier seal.

PART 3 - EXECUTION

3.1 STORAGE:

A. Protect all piping, valves, fittings, etc. before installation in accordance with manufacturer's written instructions. All piping shall be sent from the factory with capped ends and shall be stored on supports off of the ground with ends covered to prevent nesting of insects, birds and other animals, or the accumulation of dirt and debris in and around the piping components.

3.2 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.3 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Provide clearance for access to valves, fittings and equipment for operation and maintenance.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement and with operators and stems upright or horizontal.

F. Install chainwheels on operators for butterfly gate and globe valves NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor.

G. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

H. All piping shall be clean when it is installed.

I. Check Valves. Install lugged check valves between flat flange and full-face gasket. Install check valves a minimum three to four pipe diameters downstream of pump discharge or elbows to avoid flow turbulence.

3.4 ISOLATION VALVES

A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections at each floor and at branch takeoffs serving equipment, and at other locations as indicated and required for isolation of piping or equipment.

B. At air handling units, where multicoil (stacked) arrangement is used, provide each supply and return line to and from each stacked coil section with a union, pressure gauge and thermometer well and a balancing valve (with memory stop) for balancing, and valves for isolation of each coil.

3.5 DRAIN VALVES AND VENTS

A. Install drain valves at all low points and at base of all risers of water piping systems so that these systems can be entirely drained.

B. Install 2 inch drain for 2 inch pipes and larger.

C. Install a line size drain valve for pipes smaller than 2 inches.

D. Provide hose adapter and cap on all drain lines.

E. Provide automatic vents with isolation valves or manual vents at locations as indicated on Drawings and all high points in piping systems.

3.6 TESTING

A. Apply a hydraulic pressure 1-1/2 times the operating pressure, 150-psig minimum, and carefully check for leaks.

B. Remove or isolate valves, expansion joints, strainers and equipment that are rated at pressures less than test pressure.

C. Repair all leaks and retest the system until proven leak tight.

3.7 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 23 05 23

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. This Section includes requirements for furnishing and installing supports, anchors, hangers, sleeves, and concrete equipment pads for all direct and isolated suspended, roof mounted, and floor mounted HVAC equipment and exterior pipe and ductwork.

B. See Division 05 Section, Metal Fabrications, for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

C. See Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment, for vibration isolation devices.

D. See Section 23 31 00, Ductwork, for duct hangers and supports.

1.3 DEFINITIONS

A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer’s catalog data, dimensional drawings and construction materials for the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver all roof support material materials to project site in manufacturer's original packaging, marked with manufacturer's name, product model names and catalog numbers, identification numbers, and other related information.

B. Store material under cover until needed for installation

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers as applicable:
1. Anvil Intl., Inc.
2. Superstrut, Mult-A-Frame, Unistrut and Power-Strut pipe support systems
3. Specified Technologies, Inc.
4. Pipe Shields, Inc.

2.2 STRUCTURAL METAL

A. Furnish structural metal as specified in Division 05 and as shown on Drawings.

2.3 PIPE HANGERS AND SUPPORTS

A. Provide hangers for insulated and non-insulated pipes, provide galvanized carbon steel adjustable clevis hangers. Anvil Fig. 260 or equal.

B. Multiple or Trapeze Hangers: Provide Galvanized steel channels with welded spaces and hanger rods.

C. Wall supports: Provide galvanized welded steel brackets and galvanized wrought steel clamp, galvanized adjustable steel yoke and cast iron roll. Anvil Fig. 194, 195, 199 as required by pipe size and weight. Submit to structural engineer for approval detailing method of attachment to wall.

D. Vertical Support: Provide galvanized riser clamp with field welded shear lugs. Anvil Fig 261 or Fig 40 as required by installation and loads to be supported. Refer to mechanical details for main riser supports.

E. Floor supports for Pipe sizes to 4 inches and all cold pipe sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange and steel support. Anvil Figures 264 or 265 as required.

F. Floor supports for Hot pipe 6 inches and larger: Provide adjustable cast iron roll and stand, adjusting screws and steel support all galvanized. Anvil Fig. 274.

G. Copper Piping Supports and Hangers: Provide copper plated carbon steel clevis hanger. Anvil Fig. Anvil CT-65.

H. Provide galvanized hangers and supports for all piping and ductwork located in pipe shafts and chases and above suspended ceiling spaces. Use 316 stainless steel hangers and supports exterior to the building.
1. Provide hanger rods, bolts and nuts and all metal parts coated with same material as hangers.
2. Prime coat and paint exposed steel hangers and supports.

2.4 PIPE SHIELDS

A. Provide pipe shields for piping 2 inches and smaller fabricated of 20 gauge galvanized steel over insulation in 180 degree segments, minimum 12-inches long.

B. Provide pipe shields for piping 2-1/2 inches and larger fabricated of galvanized steel over insulation in 180 degree segment as follows:

PIPE SIZE	METAL GAUGE	SHIELD LENGTH
2-1/2 to 6 inches	18	12 inches
8 to 16 inches	16	18 inches
18 inches and larger	12	24 inches

C. Provide high density segment of insulation at shields at least two inches longer than shield. Foamglas blocks (HLB 1600) or factory made insulation shields as made by Pipe Shields, Inc. are acceptable. High density insulation segment shall be of sufficient compressive strength to prevent indentation of insulation jacket. Submit data indicating compressive strength of insulation segment. Furnish vapor barrier and sealant where used on low temperature service (below 100°F).

D. Secure insulation shields to insulation jacket with adhesive as recommended by insulation manufacturer or 2 stainless steel bands, 1/2 inch wide by 0.015 inch thick with matching seals.

2.5 HANGER RODS

A. Provide cadmium plated or galvanized steel, threaded both ends continuous sized for supported load. Use stainless steel hanger rods for all supports in the crawl space and exterior to the building. If rod couplings have to be used the contractor shall seek permission from UTMB. If permitted, each end of threaded rod shall be threaded until they join in the middle of the coupler.

2.6 INSERTS

A. Provide malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded rods. Submit data to structural engineer for approval. Anvil Fig. 282.

2.7 SLEEVES

A. Fit with sleeves all pipes passing through gyp board, masonry and concrete construction. Provide sleeves in floors and walls of mechanical rooms, pump rooms, etc. constructed of schedule 40 steel with galvanized finish. Sleeves outside mechanical room type spaces shall be galvanized EMT conduit for 2 inch and less diameter sleeves. Sleeves outside mechanical room type spaces over 2 inch and thru walls shall be rolled 20 gauge galvanized steel with welded seam. All galvanizing shall be done after welding.

B. Sleeves in floors shall be provided with a 1-1/2 inches wide center flange welded to sleeve and centered in slab. Refer to Drawings for additional requirements.

C. Sleeves thru roofs: schedule 40 galvanized steel pipe.

D. Caulk all sleeves water and air tight. Provide firestop compound at all penetrations of floor slabs and fire rated walls.

E. Sleeves below grade in outside walls are detailed on drawings. Provide Link Seal casings at sleeves at all exterior walls above and below grade. Use stainless steel retainers, nuts and bolts in sleeves below grade. Size sleeves in accord with Link Seal recommendations.

F. Size sleeves one pipe size larger than the pipe it serves including insulation thickness as appropriate.

G. Extend each sleeve through the floor or wall. Cut the sleeve 1/2 inch beyond flush from each surface, except that in exposed locations, extend floor sleeves 2 inches above finished floor line.

H. Refer to section 23 31 00 for sleeve requirements for ductwork.

2.8 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections for piping systems and equipment.

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

C. Use hangers and supports with galvanized or stainless steel, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use copper hangers with copper pipe and nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing. As an alternate, tape copper pipe at all points contacting steel hangers, structural members or sleeves. Use a dual wrap of polyvinyl tape.

E. Use padded hangers for piping that is subject to scratching.

3.2 PIPE HANGER AND SUPPORT INSTALLATION

A. Support horizontal steel piping on center as follows:

PIPE SIZE	MAX HANGER SPACING
1/2 to 1-1/4 inches	6 feet
1-1/2 to 2 inches	10 feet
2-1/2 to 6 inches	10 feet
6 to 12 inches	10 feet
14 inches and larger	10 feet

B. Support horizontal copper piping on center as follows:

PIPE SIZE	MAX HANGER SPACING
1 inches and less	5 feet
1-1/4 to 1-1/2 inches	7 feet
2 to 3 inches	9 feet

C. Support horizontal plastic piping on center as follows:

PIPE SIZE	MAX HANGER SPACING
All sizes	4 feet

D. Place a hanger within 6 inches of each elbow.

E. Provide hangers with vertical adjustment of 1-1/2 inches minimum.

F. Larger Sizes: Support as recommended by manufacturer.

G. Submit manufacturer's support and hanging recommendations.

H. Support piping from structure independent from other piping installed above.

I. Support risers as detailed on drawings at each floor and independently from connected horizontal pipe.

J. Where insulation occurs, design hangers to protect insulation from damage. Pipe saddles and insulation shields, where required, are specified above.

K. Perforated bar hangers, straps, wires or chains are not permitted.

L. Support piping from precast and pan joist structure as detailed on drawings.

M. Powder actuated anchors are not permitted.

N. Sleeves penetrating beams must be submitted for approval by Structural Engineer.

3.3 CONCRETE PADS

A. Pour 6-inch pads on roughened floor slabs unless otherwise noted.

B. Extend outer edges of pads minimum 2 inches beyond equipment.

C. Chamfer edges of pads.

D. Secure equipment with anchor bolts in accordance with equipment installation instructions.

E. Air handling units shall be installed on concrete pads with adequately sized neoprene isolation pads at each air unit support point.

F. Verify that housekeeping pads for air handling units are high enough to provide a condensate drain trap deep enough to override the air handler static pressure.

G. Install equipment on on 6 inch pads unless indicated otherwise on drawings.

3.4 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Bolt floor stands to concrete pads or as shown on Drawings.

C. Grouting: Place grout under supports for equipment and make smooth bearing surface.

D. Provide lateral bracing, to prevent swaying, for equipment supports.

E. Hot dip galvanize after fabrication.

3.5 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Hot dip galvanize after fabrication.

D. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.6 ROOF CURBS

A. Provide prefabricate curbs for roof mounted equipment.

B. Furnish curbs suitable for slope of roof to ensure equipment is set level.

3.7 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.8 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION ISOLATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. Section includes requirements for furnishing, installing, and adjusting vibration isolation, for mechanical equipment and piping, including bases of structural steel and concrete, with steel pouring forms and concrete reinforcing bars.

B. Related Sections Include:
   1. Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.
   2. Section 23 20 00, Hydronic Pumps.
   3. Section 23 21 00, Hydronic Piping and Fittings.
   4. Section 23 34 00, Fans.

1.3 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:
   1. Basic Wind Speed: 150 miles per hour.
   2. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.4 SUBMITTALS

A. Product Data: Submit product data showing type, size, load, deflection, and other required information. Include clearly outlined procedures for installing and adjusting isolators. Submit Drawings for each item of equipment with complete isolation installation information.

B. Submit detailing of inertia bases and locations of vibration, including weight of inertia base.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, “Structural Welding Code - Steel.”

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 10.

B. Include copies of approved submittals and any submittal comments.

C. Provide tab for each major type of equipment (fan coil units, pumps, piping, fans, etc.). Provide schedule of vibration isolator type with location and load on each. Include data on each isolator type that corresponds to:
   1. Spring diameter.
   2. Deflection.

3. Compressed spring height.
4. Point location of each isolator.
5. Calculated load at each point.
6. Field static deflection.

D. Include copy of written certification from factory representative as required in Part 3 of this specification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. Kinetics Noise Control
3. Korfund Dynamics
4. Mason Industries.
5. Metraflex
6. Vibration Eliminator Co., Inc.

2.2 ISOLATOR DESIGN

A. Materials:
1. Design and treat vibration isolators for resistance to corrosion.
2. Steel components shall be PVC coated or phosphatized and painted with industrial-grade, corrosion-resistant enamel.
3. Furnish zinc-electroplated or cadmium plated nuts, bolts and washers.
4. All isolators exposed to the weather shall have the steel parts hot dip galvanized and a PVC coating.
5. Clean steel bases thoroughly of welding slag and prime with zinc-chromate or metal etching primer.

B. Design:
1. Unless otherwise instructed, use spring-type vibration isolators for all equipment driven by motors of 3 horsepower and larger.
2. The isolator manufacturer must calculate the amount of spring deflection required for each isolator to achieve optimum performance and to prevent the transmission of objectionable vibration and noise.
3. Isolators must be sized for starting torque of equipment motors.
4. The following minimum spring deflections apply unless noted otherwise in the specifications:

BELT DRIVEN EQUIPMENT

Motor Size Horsepower	Installation Above Grade	Installation at Grade or Below
5 – 10	1"	1"
15 – 30	1-1/2”	1”
40 – 75	2”	1-1/2”

DIRECT DRIVEN EQUIPMENT

Motor Size Horsepower	Installation Above Grade	Installation at Grade or Below
5 – 20	1”	1”
25 – 75	1”	1”

5. All spring isolators must be completely stable in operation and must be designed for not less than 30 percent reserve deflection beyond actual operation conditions.
6. Height saving brackets used with isolators having 2-1/2 inch deflection or greater shall be of the precompression type to limit exposed bolt length.

2.3 ISOLATOR TYPES

A. Design of isolator types listed is based on model numbers manufactured by Kinetics Noise Control, unless otherwise indicated. Subject to compliance with requirements provide named product.

B. Type FDS: Adjustable, freestanding, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring mounting to base plate and compression plate must be rigid. Bond neoprene pad with a minimum thickness of 1/4 inch to the base plate. Base isolator shall have provisions for bolting the isolator to the supporting structure. A minimum horizontal-to-vertical spring rate of 1.0 is required.

C. Type FRS: Similar to Type FDS, but with addition of bottom load plate and restraint assembly for vertical restraint for wind loads or large torqueing forces.

D. Type SH: Spring hanger consisting of a rectangular steel box, coil spring, spring retainers, neoprene-impregnated fabric washer, and steel washer.

E. Type SRH: Combination spring and rubber hanger consisting of a rectangular steel box, coil spring, spring retainers, and an elastomeric mounting designed for 1/2 inch deflection.

F. Type SLP: Adjustable, open-spring isolator having one or more coil springs attached to a top compression plate and a base plate. Bond neoprene pad with a minimum thickness of 1/4 inch to the base plate. The spring assembly must fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. Isolator includes restraining bolts for connecting the top plate and lower housing to prevent the isolated equipment from rising when drained of water.

G. Type NGS: Pad-type mounting consisting of two layers of 3/8 inch thick ribbed or waffled neoprene pads bonded to a 16-gage galvanized steel separator plate. Size pads for approximately 20 to 40 psi load and a deflection of 0.1 inch to 0.16 inch.

H. Type RH: Elastomeric hanger consisting of a rectangular steel box and an elastomeric isolation element of neoprene. A high-quality synthetic rubber may be used if it contains anti-ozone and antioxidant additives. Design elements for approximately 1/2 inch deflection and load so that the deflection does not exceed 15 percent of the free height of the element.

I. Type SS: Type 321 stainless steel hose and Type 304 stainless braid sheath, with carbon steel threaded fittings for pipe sizes 2 inches and less, and carbon steel flanges for pipe sizes 2-1/2 inches and greater. Hose shall have a maximum working pressure of 200 psi at 70°F through 4”, 155 psi at 70°F through 12”.

J. Type REJ: Flexible pump connectors/expansion joints shall be of the molded twin spherical type. Provide neoprene with nylon construction or EPDM. Unit shall be rated at 225 PSI and maximum temperature of 225°F. Provide 150# flanges and galvanized aircraft cable or control rods.

K. Expansion Loop: Flexible expansion loop consisting of two Series 300 stainless steel hoses and braids, two 90 degree carbon steel elbows, and a 180 degree return. Provide drain plug and flanged connections. Rate 10 inch expansion loop for 220 psi at 70°F. Rate 6 inch expansion loop for a minimum of 200 psi at 70°F.

2.4 ISOLATION BASES

A. Type CIB-L: Mount equipment on concrete inertia blocks which weigh at least twice the weight of equipment supported. Obtain equipment assembly information from the equipment manufacturer and include with submittal, including dimensional data. Vibration isolation manufacturer shall furnish steel concrete pouring forms for floating concrete bases. Size each inertia base to extend a minimum of 4 inches outside the equipment base. In the case of belt-driven equipment, extend the base 4 inches beyond the end of the drive shaft. Provide T-shaped inertia bases where necessary to conserve space. Bases for split case pumps shall be large enough to provide support for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6". The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" bars welded in place on 6" centers running both ways in a layer 1-1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a minimum 1" clearance below the base. Wooden formed bases leaving a concrete rather then a steel finish are not acceptable. Install vibration isolation, as specified, between inertia blocks and equipment (housekeeping) pads.

B. Type SFB: A structural steel fan and motor base with NEMA standard 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. Suspended equipment shall be designed to spread the base area of equipment for increased stability and to permit suspension with hanger rods.

C. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

D. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. “Building” includes, but is not limited to, slabs, beams, columns, studs and walls.

E. Install motor driven equipment with vibration isolators as indicated in schedule below.

F. Isolate pumped water-piping systems with spring-type vibration isolators as indicated in schedule.

G. All open-type spring isolators shall be restrained as recommended by the manufacturer.

H. Install full line size flexible connectors at the suction and discharge connection of each piece of equipment as indicated in schedule below. All connectors to be suitable for use at the pressure and temperature encountered at point of operation. Do not insulate Type REJ flex pump connectors installed in heating hot water systems.

I. Isolation Bases
1. The isolated equipment and its driving motor shall be mounted on a common inertia base and the base, in turn, shall be mounted on the scheduled vibration isolator type to prevent transmission of vibration and noise to the building structure.

2. For floor mounted equipment, provide an equipment (housekeeping) pad under the isolation base.
3. 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.
4. After 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. 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 that will allow no more than 1 inch of additional height adjustment. After final adjustment, the inertia base shall not support any piping load. All springs supporting piping that is connected to a piece of isolated equipment shall be sized for static deflection equal to that of the isolated equipment.

3.2 APPLICATION

A. The following is a schedule of equipment and piping on a typical project that requires vibration isolation and base isolators of the types specified. Refer to Drawings for equipment scheduled for the Project. Any equipment, system or condition that may be altered, added, or changed; or that is not specifically described in the Contract Documents shall be isolated in a manner specified for similar equipment, system or condition in order to comply with these Specifications.

B. Provide isolation for the following equipment:

Equipment	Isolator Type	Minimum Deflection (inches)
Fan Coil Units:		
Suspended	SRH	1
Belt Drive - Suspended	SRH	1
Floor Mounted	NGS	0.1 – 0.16
Pumps:		
Up to 5 HP	FDS/CIB-L	1
5 HP, 7-1/2 HP	FDS/ CIB-L	1
10 HP and over	FDS/CIB-L	2

C. Provide isolation for the following piping systems:

Piping Systems	Isolator Type	Minimum Deflection (inches)
Piping in Pump Rooms:		
Chilled Water Piping – First two hangers adjacent to pumps	SH	Equal to Equipment Isolation
Chilled Water Piping – All piping 1-1/2 inches and larger, except first two hangers adjacent to pumps	SH	1
Heating Hot Water Piping – First two hangers adjacent to pumps	SH	Equal to Equipment Isolation
Heating Hot Water Piping – All piping 1-1/2 inches and larger, except first two hangers adjacent to pumps.	SH	1
Pumps Suction/Discharge:		
Chilled Water Pump	REJ	
Hot Water Pump	REJ	

3.3 STOCK REQUIREMENTS

A. The isolation manufacturer's representative must maintain an adequate stock of springs and isolators of type used so that changes required during construction and installation can be made.

3.4 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.5 FACTORY REPRESENTATION:

A. After installation, furnish factory-trained representative of the isolation manufacturer to check various isolators and report measured versus anticipated deflection on all isolators. Have the representative submit written certification that the isolators have been installed in accordance with the specifications, manufacturer's recommendations and approved submittals

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. This section includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Valve tags.
   6. Warning tags.
   7. Duct labels.

1.3 SUBMITTAL

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

1.5 RELATED WORK

A. Painting. Division 09.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 10.

B. Valve Tags
1. Provide three-ring binder including valve tag information (8-1/2 x 11 inch paper).
2. Each service shall be individually tabbed in the binder.
3. For each valve tag, indicate service, function, valve position (NC or NO), floor, room location and nearest column numbers.

C. Equipment Labels
1. Provide three ring binder including equipment label information (8-1/2 x 11 inch paper).
2. Each type of equipment (pumps, AHUs, etc) shall be individually tabbed in the binder.
3. For each item of equipment to be labeled, provide equipment identification number, floor, room location, and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufactures: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Marking Services, Inc.
3. Seton Identification Products.

2.2 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Material and Thickness: Brass, 0.032 inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 x 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: Background to contrast with letter color.
4. Maximum Temperature: Able to withstand temperatures up to 160°F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch x 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number.

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Background to contrast with letter color.

D. Maximum Temperature: Able to withstand temperatures up to 160°F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 inch x 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering 2/3 to 3/4 the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.5 DUCT LABELS

A. Identify ductwork with stencil.

B. Letter Color: Black.

C. Lettering Size: At least 1-1/2 inches high.

D. Paint: Shall meet VOC requirements per Division 09 painting specification.

E. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

2.6 VALVE TAGS

A. Provide valves with 1 1/2 inch diameter stainless steel or brass valve tag with stamped and black-filled numbers. Service designations shall be 1/4 inch letters, and valve numbers shall be 1/2 inch letters. Service designations shall be approved by Architect/Engineer. Secure tags to valves by use of brass "S" hooks and brass chain. Secure chain to valve by use of copper or monel meter seals.

B. Direct Underground Valves. Provide a stainless steel nameplate minimum 23 gauge thickness for all direct buried underground valves that indicates valve number, service and equipment or building served by the valve.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment. Use fasteners for all equipment labels where possible. Where it is not possible to use fasteners, use adhesive.

B. Locate equipment labels where accessible and visible.

3.3 VALVE TAG

A. Install valve tags for all major valves. This shall include branch isolation and balancing valves, isolation valves for equipment such as air handling units, pumps, chillers, etc.

B. Do not provide valve tags for isolation valves directly adjacent to fan coil units and terminal boxes.

3.4 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. Do not label drain piping where the floor drain is located adjacent to the equipment.

B. Provide pipe labels for the following piping systems:
   1. Chilled Water Systems
   2. Heating Hot Water Systems
   3. Drain lines
   4. Steam Piping Systems
   5. Steam Condensate Piping Systems

3.5 DUCT LABEL INSTALLATION

A. Identify ductwork with stencil.

B. Identify exhaust fan number, air handling unit number, service and area served.

C. Locate identification at air handling unit or fan, at each side of penetration of structure or enclosure at each obstruction, every 20 feet on long horizontal runs. Provide identification for the following ductwork:
   1. All exhaust (restroom, laboratory, kitchen, etc) and relief ductwork.
   2. All supply air ductwork served by Air Handling Units

3. All outside air ductwork, including pretreated outside air ducts.
4. All return air ductwork, not including return air boots and transfer ducts.

END OF SECTION 23 05 53

SECTION 23 05 93 - SYSTEM TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 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 as part of General Contractors scope of work.

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.

1.3 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. The Firm shall maintain current insurance coverages in the minimum amounts shown below. If the Firm normally carries such insurance coverages (minimum or higher) incident to its operation, additional insurance for the specific proposal or proposals is not required. The minimum insurance coverages required are:
   1. Worker's Compensation as required by law.
   2. General Liability for not less than $1,000,000 aggregate refer to Division 01, General Conditions.
   3. Fire Damage, and Extended Coverage, Vandalism and Malicious Mischief, in the full amount of Contract. The above policies shall be carried with companies satisfactory to the Owner. Certificates of each of the above policies, together with a written statement by the issuing company, stating that said policy will not be canceled without ten (10) days prior written notice to the Board of Regents of the University of Texas system, shall be delivered to the Owner before any work is started.

E. 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.

F. 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.

G. The scope of the TAB work as defined herein is indicated in order that the Mechanical 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 General Contractor shall engage one of the certified TAB firms from the approved list below:

Engineered Air Balance, Inc. - (713)873-7084

Technical Air Balance, Inc. - (281) 651-1849

Precision Air of Texas - (281) 449-0961

Air balance work shall be done by one of the above approved contractors and not by the Mechanical Contractors own forces.

1.4 REFERENCES

A. National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, Fifth Edition 1989.

B. ASHRAE - 1991 HVAC Applications Chapter 34: Testing, Adjusting and Balancing.

C. ANSI/ASHRAE Standard 111-1988 - Practices for Measurement, Testing, Adjusting and Balancing of Buildings, Heating, Ventilation, Air Conditioning and Refrigeration Systems.

1.5 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 1.6 through 1.10 of this Specification will be available through the Construction Inspector.

1.6 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 1989 Standard, Fifth 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. [_____] Model [_____].

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

1.7 FINAL AIR BALANCE

A. General: When systems are complete and ready for operation, the TAB Consultant will perform a final air balance for all air systems and record the results. The outside, supply, exhaust and return air volume for each air handling unit, supply fan and exhaust fan and the supply, exhaust or return air volume for each distribution device shall be adjusted to within +5% of the value shown on the drawings. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit. Air distribution device volume shall be adjusted using the spin-in tap damper for flexible duct connected devices and the device OBD for duct connected devices. Air distribution devices shall be balanced with air patterns as specified. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown. The general scope of balancing by the TAB Consultant will include, but is not limited to, the following:
1. Filters: Check air filters and filter media and balance only system with essentially clean filters and filter media. The Division 23 Contractor shall install new filters and filter media prior to the final air balance.
2. Blower Speed: Measure RPM at each fan or blower to design requirements. Where a speed adjustment is required, the Division 23 Contractor shall make any required changes.
3. Ampere Readings: Measure and record full load amperes for motors.
4. Static Pressure: Static pressure gains or losses shall be measured across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter and exhaust fan. These readings shall be measured and recorded for this report at the furthest air device or terminal unit from the air handler supplying that device. Static pressure readings shall also be provided for systems which do not perform as designed.
5. Equipment Air Flow: Adjust and record exhaust, return, outside and supply air CFM (s) and temperatures, as applicable, at each fan, blower and coil.
6. Coil Temperatures: Set controls for full cooling and for full heating loads. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and HVAC terminal unit. At the time of reading record water flow and entering and leaving water temperatures (In variable flow systems adjust the water flow to design for all the above readings).
7. Zone Air Flow: Adjust each zone of multizone units, each HVAC terminal unit and air handling unit for design CFM.
8. Outlet Air Flow: Adjust each exhaust inlet and supply diffuser, register and grille to within +5% of design air CFM. Include all terminal points of air supply and all points of exhaust. Note: For Labs and Rooms that are negative exhaust air flow shall be set to design +10% and supply to design -5%. Positive areas will have opposite tolerances.
9. Pitot Tube Traverses: For use in future troubleshooting by maintenance personnel, all exhaust ducts, main supply ducts and return ducts shall have air velocity and volume measured and recorded by the traverse method. Locations of these traverse test stations shall be described on the sheet containing the data.
10. Maximum and minimum air flow on terminal boxes.

1.8 FINAL CHILLED AND HEATING HOT WATER BALANCE

A. General: When systems are completed and ready for operation, the TAB Consultant will perform a final water balance for each chilled 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.

1.9 TESTING OF TEMPERATURE CONTROL SYSTEMS

A. In the process of performing the TAB work, the TAB Agency shall:
   1. Work with the temperature control contractor to ensure the most effective total system operation within the design limitations, and to obtain mutual understanding of intended control performance.
   2. Verify that all control devices are properly connected.
   3. Verify that all dampers, valves and other controlled devices are operated by the intended controller.
   4. Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).
   5. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes dampers in multizone units, terminal boxes and fire/smoke dampers.
   6. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.
   7. Observe the calibration of all controllers.
   8. Verify the proper application of all normally opened and normally closed valves.
   9. Observe the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts or cold walls.
   10. Observe the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the TAB Agency.
   11. Verify that the sequence of operation for any control mode is in accordance with approved shop drawings and specifications. Verify that no simultaneous heating and cooling occurs.
   12. Verify that all controller set points meet the design intent.
   13. Check all dampers for free travel.
   14. Verify the operation of all interlock systems.
   15. Perform variable volume system verification to assure the system and it's components track with changes from full flow to minimum flow.

B. A systematic listing of the above testing and verification shall be included in the final TAB report.

1.10 REPORTS

A. The activities described in this section shall culminate in a report to be provided in quadruplicate (4) individually bound to the RCM. 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.

d. Manufacturer.
e. Entering air DB temperature, design and actual.
f. Entering air WB temperature, design and actual.
g. Leaving air DB temperature, design and actual.
h. Leaving air WB temperature, design and actual.
i. Water pressure flow, design and actual.
j. Water pressure drop, design and actual.
k. Entering water temperature, design and actual.
l. Leaving water temperature, design and actual.
m. 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.
    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 23 05 93

SECTION 23 07 00 - HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 WORK INCLUDED

A. This Section specifies the general requirements for furnishing and installing insulation. These requirements apply to all other Mechanical Division sections specifying insulation.

B. All the ductwork and piping in pump rooms, mechanical rooms and equipment rooms including areas without ceilings is to be considered as exposed piping or ductwork. This also includes penthouses.

1.3 RELATED WORK

A. Internal insulation for air units is specified in the sections on air handling units. The units do not require external insulation.

B. Insulation. Refer to specific sections on individual insulation types.

C. Division 9, Painting.

1.4 FIRE HAZARD RATING

A. All equipment, duct and piping insulation used on the project must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50 as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements.

1.5 QUALITY ASSURANCE:

A. Applicator shall be a company specializing in insulation application with minimum 5 years' experience.

B. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Owner. Use materials indicated for the completed Work. Mockups shall include piping insulation, ductwork insulation and equipment insulation.

1.6 SUBMITTALS

A. Product Data. Submit product data on each insulation type, adhesive and finish to be used in the work. Include manufacturer's installation instructions, list of materials and thickness for equipment scheduled.

B. Samples. Make an application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with the work.

C. Shop Drawings: Show details for the following:
1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Attachment and covering of heat tracing inside insulation.
3. Insulation application at pipe expansion joints for each type of insulation.
4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Removable insulation at piping specialties, equipment connections, and access panels.
6. Application of field-applied jackets.
7. Application at linkages of control devices.
8. Field application for each equipment type.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are listed under individual specification sections.

2.2 INSULATION

A. Insulate in accordance with appropriate specification section.

PART 3 - EXECUTION

3.1 COMMON INSULATION REQUIREMENTS

A. All materials shall be delivered to the site shall be dry, undamaged and maintained in good condition throughout the progress of the project.

B. Insulation shall not be installed until all testing and inspection of pipe, duct, vessel, etc. has been completed and approved by Engineer/Owner's representative.

C. Insulate valves, fittings, flanges and special items in accordance with appropriate specification section.

D. Replace insulation damaged by either moisture or other means. Insulation which has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also replace any damage caused by the condensation.

E. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

F. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

G. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

H. Install insulation with longitudinal seams at top and bottom of horizontal runs.

I. Install multiple layers of insulation with longitudinal and end seams staggered.

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

K. Keep insulation materials dry during application and finishing.

L. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

M. Install insulation with least number of joints practical.

N. Where vapor barrier is indicated, seal joints, duct wrap seams, vapor retarder (ASJ) film seams and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier coating/mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier coating/mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

O. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

3.2 ACCESSORIES

A. Installation of accessories such as jacketing, bands, adhesives, insulation shields, coatings, finishes, etc. is specified under individual specification sections.

3.3 PAINTING OF INSULATION

A. Where indicated on the architectural construction documents, paint ductwork or piping in exposed areas, not including mechanical and equipment rooms. Do not paint insulation located in return air plenums.

A. FSK Jacket. Prior to painting, wipe clean insulation with FSK jacket with a mild cleaning solution that will not leave a residue and allow to dry completely. Paint FSK jacket with oil based or solvent based paint in accordance with manufacturer’s recommendations and as required in Specification 09 90 00.

B. ASJ Jacket. Prior to painting, dry wipe clean insulation with ASJ jacket to remove dust and loose dirt. Paint ASJ jacket with water based (latex) paint in accordance with manufacturer’s recommendations and as required in Specification 09 90 00.

END OF SECTION 23 07 00

SECTION 23 07 13 - EXTERNAL DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. This Section provides for furnishing and the installation of external insulation on concealed and exposed ductwork, including single wall supply ductwork, outside air ductwork, and relief and return air duct work in non air conditioned spaces and other miscellaneous ductwork. It also includes insulating the tops of all supply diffusers.

B. All the ductwork exposed to view in public spaces, in mechanical and pump rooms, crawl space and equipment rooms including all areas without ceilings is to be considered as exposed ductwork.

C. Consider space above ceilings air conditioned if floor above is air-conditioned or if the space is a return air plenum. Consider exterior vertical chases and vertical chases leading to spaces not air-conditioned as un-air conditioned spaces.

D. No lined ductwork is allowed on the project unless specifically noted on drawings.

1.3 RELATED WORK

A. Section 23 07 00, Insulation - General.

B. Section 23 31 13, Ductwork.

1.4 REFERENCES STANDARDS

A. ASTM C 411 - Temperature Range.

B. ASTM C 553 - Mineral Fiber Blanket and Felt Insulation.

C. ASTM C 612 - Mineral Fiber Block and Board Thermal Insulation.

D. ASTM C 1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts

E. ASTM E 96 Procedure A - Jacket Vapor Transmission.

F. ASTM E 119 – Standard Method of Fire Test of Building Construction and Materials.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fiberglass:
   1. CertainTeed.

2. JohnsManville.
3. Owens-Corning.
4. Knauf Insulation.

B. Ceramic Fiber[Engineer to delete if project does not require fire rated ductwork insulation]
1. A.P. Green
2. Premier
3. 3M
4. Thermal Ceramics
5. FyreWrap
6. CertainTeed

C. Flexible Elastomeric[Engineer to delete if project contains no exterior ductwork]
1. Armacell

2.2 INSULATION

A. Type D1, Flexible Glass Fiber Insulation: Provide flexible glass fiber insulation with factory-applied, reinforced foil scrim kraft (FSK) facing vapor barrier, 1.0- pound per cubic foot density. A “K” factor of 0.27 at 75°F mean is required. Shall comply with ASTM C553 and C1290.

B. Type D2, Semi-Rigid Glass Fiber Insulation: Provide semi-rigid glass fiber insulation adhered to UL labeled, reinforced foil scrim kraft (FSK) facing vapor barrier on the outside surface, 2.5 pound per cubic foot density. A K factor of 0.24 at 75°F mean is required.

C. Type D3, Rigid Glass Fiber Insulation: Provide rigid board glass fiber duct insulation with integral, UL labeled, reinforced foil scrim kraft (FSK) facing vapor barrier on the outside surface, minimum density of 6 pounds per cubic foot. A “K” factor of 0.22 at 75°F mean is required.

2.3 COATINGS AND ADHESIVES

A. Glass Fiber Insulation
1. Coating. Foster 30-80 or Childers CP-38 vapor barrier coating. Permeance shall be 0.013 perms or less as tested by ASTM E96/ASTM F1249. Coating must comply with MIL-C-19565C, Type II and be QPL listed.
2. Adhesive. Fosters 85-60 or Childers CP-127 adhesive. Product must comply with ASTM C916 and ASTM E84 25/50 requirements.

B. Reinforcing Mesh. Fiberglass or polyester, 10 strands by 10 strands per square inch. Similar to Foster Mast A Fab or Childers Chil Glas #10.

C. Outdoor Insulation[Engineer to delete if project does not require exterior ductwork]
1. Foster 30-90 or Childers CP-35. White
2. Adhesive. Armaflex 520 or Low VOC Spray Adhesive.

D. Crawlspace Ductwork Insulation[Engineer to delete if project does not require crawlspace ductwork]
1. Coating. Childers Encacel X or Foster Monalar 60-90.
2. Adhesive. Same as for Glass Fiber Insulation..

PART 3 - EXECUTION

3.1 GENERAL

A. Do not apply insulation until ductwork has been tested.

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

C. Where trapeze hangers are used, provide strip of non-compressible insulation between ductwork and hanger.

3.2 FIRE SAFETY REQUIREMENTS

A. Do not extend duct coverings through walls or floors required to be fire stopped or required to have fire resistance rating. Interrupt duct coverings in the immediate vicinity of heat sources such as electric resistance or fuel-burning heaters.

3.3 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air ductwork.
2. Indoor, exposed supply and outdoor air ductwork.

B. Air Devices:
1. Supply Diffuser.
2. Uninsulated Plenums on Slot Diffusers and Linear Bar Grilles.

C. Items Not Insulated:
1. Indoor, concealed return air ductwork (in chases, above ceilings, except as noted above).
2. Indoor, exposed return air ductwork (in chases, mechanical rooms except as noted above).
3. Flexible connectors.
4. Double wall ductwork.

D. Definitions
1. Oval ductwork shall be insulated the same as round ductwork.
2. Outside air duct shall be considered ductwork (or plenum) from louver or intake hood to air handling unit.
3. Pretreated outside air shall be insulated the same as supply ductwork.

3.4 DUCTWORK INSULATION APPLICATION AND THICKNESS SCHEDULE

A. Provide insulation with minimum thickness and installed “R” valves in accordance with ASHRAE Standard 90.1-2013 Tables 6.8 2A & B, but not less than thickness specified in this specification and as required to prevent condensation:

Ductwork System	Application	Insulation Type	Insulation Thickness
Supply & Outside Air – Rectangular/Round (Hot, Cold, Combination)	Concealed Ductwork	D1	2”
Supply & Outside Air – Rectangular (Hot, Cold, Combination)	Exposed Ductwork	D3	2”
Supply & Outside Air – Round (Hot, Cold, Combination)	Exposed Ductwork	D2	2”
Air Devices	Where Scheduled	D1	1"

3.5 TYPE D1, FLEXIBLE GLASS FIBER INSULATION

A. Insulation shall be wrapped, in accordance with manufacturer's recommendations, on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2 inches.

B. Adhere insulation to ductwork with 4 inch wide strips of adhesive at 8 inches on center. In addition, secure insulation to the bottom of rectangular horizontal ductwork and on vertical ductwork over 24 inches wide by the use of mechanical fasteners at no more than 18 inches on center. Weld stick clips to duct work to secure insulation. Stick clips material shall match the material of the ductwork to which they are welded. Adhesive applied stick pins are not acceptable.

C. On circumferential joints, the 2 inch flange on the facing shall be stapled with outward clinching steel staples on 2 inch centers, and taped with a minimum 3-inch-wide strip of reinforcing mesh and vapor barrier coating. Cover all seams, joints, pin penetrations and other breaks with two coats of vapor barrier coating reinforced with reinforcing mesh. Coating shall completely cover and conceal mesh.

3.6 TYPE D2, SEMI-RIGID GLASS FIBER INSULATION

A. All exposed ductwork in public areas and mechanical rooms shall be wrapped in accordance with manufacturer's recommendations. Firmly butt all joints together and seal longitudinal laps of factory-applied vapor barrier jacket with adhesive. Cover butt joints with a 4 inch wide strip of factory-supplied vapor barrier jacket facing adhered with adhesive. Cover all seams, joints, pin penetrations and other breaks with two coats of vapor barrier coating and reinforcing mesh.

3.7 TYPE D3, RIGID GLASS FIBER INSULATION

A. Exposed ductwork shall be covered with rigid board insulation in accordance with manufacturer's recommendations.

B. Fill and point up all joints, perforations and exposed edges with two coats of vapor barrier coating reinforced with reinforcing mesh. Coating shall completely cover and conceal mesh.

C. Securely fasten insulation to metal surface with adhesive and mechanical fasteners on 12 inch centers.

D. Sheet metal screws and discs or other approved fasteners may be used. In addition, secure insulation to the bottom of rectangular horizontal ductwork and on vertical ductwork over 24 inches wide by the use of mechanical fasteners at no more than 18 inches on center. Weld stick clips to duct work to secure insulation. Adhesive applied stick pins are not acceptable.

3.8 STANDING SEAMS

A. Insulate standing seams and stiffeners which protrude through insulation with 3-pound density, 1-1/2 inch thick, faced duct insulation, flexible blanket or rigid insulation to match duct insulation. As a vapor seal on exposed edges, use glass cloth with vapor barrier coating. Insulation should not prevent adjustment of damper operators.

3.9 AIR DEVICES

A. Insulate backside of diffusers and uninsulated plenums on slot diffusers as indicated in application schedule.

B. All edges of insulation should be taped to diffuser backpan with pressure-sensitive aluminum foil tapes listed and labeled under UL 181A, Part I.

3.10 TRANSFER DUCTS

A. Line return air transfer ducts with 1/2 inch dual density type acoustical insulation. Coat exposed edges of insulation with sealant.

3.11 HEATING COILS

A. Install insulation on terminal box heating coil casings same as specified for adjacent ductwork.

END OF SECTION 23 07 13

SECTION 23 07 16 - EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 WORK INCLUDED

A. This Section provides for furnishing and installing insulation for both high and low temperature vessels and equipment.

B. High temperature installations include hot water storage tanks and heaters, converters, heat exchangers, expansion tanks, air eliminators and other vessels containing liquids or gases above 85°F.

C. Low temperature installations include chilled water pumps, heat exchangers, expansion tanks, air eliminators, chilled water storage (buffer) tanks and other vessels containing liquids and gases below 60°F.

1.3 RELATED WORK

A. Section 23 07 00, Insulation - General.

1.4 SUBMITTALS

A. Provide Submittals in accordance with Section 23 07 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fiberglass (Type E1)
   1. Knauff.
   2. Owens-Corning.
   3. Johns Manville.

B. Flexible Elastomeric (Type E2)
   1. Armacell
   2. K-Flex USA.

2.2 INSULATION

A. Type E1, Semi-Rigid Glass Fiber Insulation: Provide semi-rigid glass fiber insulation adhered to UL labeled, reinforced foil scrim kraft (FSK) facing vapor barrier on the outside surface, 2.5 pound per cubic foot density. A K factor of 0.24 at 75°F mean is required.

B. Type E2, Flexible Elastomeric insulation: Provide flexible elastomeric insulation complying with ASTM C534, Type 1 for tubular materials. Insulation shall have a maximum “K” factor of 0.25 Btu-in./h-ft2- °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.

2.3 CEMENT AND COATINGS

A. High Temperature:
1. Cement. Provide Ryder One Coat cement to seal insulation for high temperature vessels.
2. Coating. Furnish Childers CP-50AHV2 or Foster 30-36 lagging adhesive/coating to provide a finish coat and to secure glass cloth for high temperature vessels.

B. Low Temperature:
1. Adhesive: Furnish Armaflex 520 BLV Low VOC Adhesive, Foster 30-36 AF or Childers CP-137 AF, Foster 85-75 or Childers CP-82 to seal longitudinal labs and to adhere butt joint covers.
2. Finish: Furnish Armaflex WB or Foster 30-64 water based latex enamel finish.

C. Reinforcing Mesh:
1. Reinforcing Mesh: Fiberglass or polyester. 10 strands by 10 strands per square inch. Similar to Foster Mast A Fab or Childers Chil Glas #10.

PART 3 - EXECUTION

3.1 GENERAL

A. Pressure test all piping prior to insulating equipment.

B. Clean surfaces prior to installation and remove all dirt.

3.2 EQUIPMENT INSULATION APPLICATION AND THICKNESS SCHEDULE

Service	Application	Insulation Type	Insulation Thickness-Inches
Air Separators, Expansion Tanks	Hot Water System	E1	1-1/2
Air Separators, Expansion Tanks, Storage (Buffer) Tanks	Chilled Water System	E2	1-1/2
Chilled Water Pump	Chilled Water System	E2	1
Heat Exchangers	Hot Water System	E1	1-1/2
Heat Exchangers	Chilled Water System	E2	1-1/2

3.3 TYPE E1, SEMI-RIGID GLASS FIBER INSULATION

A. Lay insulation blocks with edges tightly butted. Secure the blocks in place with wire or stainless steel bands wrapped on 9-inch centers. After insulation is secure, stretch 1-inch hexagonal galvanized wire mesh over the blocks and wire securely with edges of mesh tied together.

B. Apply cement in two coats to a total thickness of 1/2 inch. After cement is dry, prime with 50% diluted lagging adhesive and apply a final finish lagging adhesive/coating with reinforcing per manufacturer's instructions.

3.4 TYPE E2, FLEXIBLE ELASTOMERIC INSULATION

A. Adhere sheet insulation to clean, oil-free metal surfaces by compression fit method and full coverage of adhesive. Seal butt joints with same adhesive. Where two layers are used, stagger joints.

B. Apply finish to cover insulation.

C. Pumps.
1. The pump must be started up with vibration testing completed prior to insulating.
2. Clean pump prior to installation and remove all dirt. Carefully measure and sheets for direct application on chilled water pumps. Apply adhesive to pump and to back side of insulation. Allow adhesive to dry to touch but remain tacky before joining surfaces. Spread butt seams and apply adhesive to both butt edges. Align carefully and join butt edges. Refer to manufacturer's instructions for further information and details.
3. Provide removable insulation (friction fit) for accessible areas of pump. Ensure pump shaft is insulated on opposite side of motor. Insulation shall not be applied directly to moving surfaces.
4. Apply a finish to the cover as specified above.
5. Install equipment identification nameplate and "spare" manufacturer's pump performance nameplate on pump inertia base with corrosion resistant fasteners.

END OF SECTION 23 07 16

SECTION 23 07 19 - PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. Section includes:
   1. Piping insulation for Chilled and Heating Water Piping within building envelope, other than Crawl Spaces and wet areas.
   2. Primary and Secondary chilled water piping shall be considered chilled water piping in these specifications.
   3. Furnishing and installation of insulation.
   4. Jackets and accessories.

1.3 REFERENCES

A. ANSI/ASTM C 195 - Mineral Fiber Thermal Insulation Cement.

B. ANSI/ASTM- C 547 - Mineral Fiber Preformed Pipe Insulation.

C. ANSI/ASTM C 552 - Cellular Glass Block and Pipe Thermal Insulation.

D. ASTM B 209 - Aluminum and Aluminum-alloy Sheet and Plate.

E. ASTM C 449 - Mineral Fiber Hydraulic-setting Thermal Insulating and Finishing Cement.

1.4 QUALITY ASSURANCE

A. Applicator. Company specializing in piping insulation application with five years minimum experience.

B. Materials. UL/ULC Classified per UL 723 or Flame spread/fuel contributed smoke developed rating of 25/50 in accordance with ASTM E84.

1.5 SUBMITTALS

A. Refer to Specification 23 07 00.

B. Submit product data on insulating materials, including manufacturer's safety and installation instructions.

C. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Fiberglass
      a. Owens-Corning.
      b. JohnsManville.
      c. Knauff Insulation
   2. Flexible Elastomeric
      a. Armacell; AP Armaflex.
      b. RBX Corporation.
   3. Cellular Glass
      a. Owens-Corning.

2.2 INSULATION

A. Type P1: Furnish fiberglass insulation with factory applied, all service reinforced vapor barrier (ASJ) jacket having integral laminated aluminum vapor barrier and self sealing labs. Jacketing shall have a maximum water vapor permeance of 0.02 perms. Insulation shall be in accordance with ANSI/ASTM C 547 with a "K" factor of 0.23 BTU-in/hr-ft2-°F at 75°F. Insulation shall be certified by Greenguard Gold. Insulation shall be rated for continuous use on pipe convenying services up to 850 degrees Fahrenheit.

B. Type P2. Furnish closed-cell expanded rubber materials complying with ASTM C534, Type 1 for tubular materials. Insulation shall have a maximum “K” factor of 0.27 Btu-in./h-ft2- ºF at a 75ºF mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.

C. Type P3: Cellular Glass One Insulation with a “K” factor of 0.29 BTU-In/Hr.-degree F at 75ºF manufactured by Pittsburgh Corning Corporation and fabricated by a Pittsburgh Corning Corporation-approved fabricator. Water vapor permeability shall be 0.00 perm-in.The insulation shall comply with ASTM C 552 Type II, furnished in half sections up to 36 inches long or segments 18 inches long.

2.3 INSULATION SHIELDS AND SADDLES

A. Field Fabricated:
   1. Use high compression strength Cellular Glass blocks (HLB 1600) that will support the bearing area at hangers and supports.
   2. Further support insulation at hangers and supports with a shield of galvanized metal extending not less than 2 inches on either side of the support bearing area, covering at least half of the pipe circumference, and conforming to the schedule below.
   3. When pipe is guided at top and bottom, metal shields should cover the whole pipe circumference.
   4. Adhere metal shield to insulation so that metal will not slide with respect to insulation. Furnish vapor barrier and sealant where used on low temperature service (below 100ºF).

Pipe Diameter	Insulated Section Length in Inches	Minimum U.S. Standard Gauge of Metal Shield
2 1/2” and smaller	14	16
3” to 4”	14	16
6” to 12”	24	14
14” and larger	24	12

   5. At Contractor's option, factory-made insulation shields may be provided as made by Anvil Fig 168, equivalent by Pipe Shields, Inc., or equal. Insulation should extend at least 1 inch beyond metal. Select proper shield for service and pipe span.
   6. For Type P2 insulation, factory-made insulation shields such as Armafix IPH may be used at Contractor’s option.

B. Saddles: Fit piping 2 inches through 10 inches operating at high temperatures with Anvil Figure 161 through 164 protection saddles, or similar saddles of proper design for specified insulation thickness. Fit pipe sizes over 10 inches with Anvil Figure 163A through 165A or similar saddle as required by insulation thickness specified.

C. All shields are to be secured by 2 stainless steel bands, 1/2 inch wide by 0.015 inch thick with matching seals

2.4 JACKETS

A. PVC Jackets: Provide molded or mitered covers for flanges, valves and fittings similar to Schuller Zeston 2000.

B. Canvas or Glass Jackets and Lagging Adhesive/Coating: UL listed treated cotton fabric, 6 ounce/square yard or low odor glass cloth, Foster 30-36 AF; Childers CP-137 AF, or approved equal. Coatings shall meet ASTM D 5590 with 0 growth rating.

C. Cellular Glass. Provide aluminum jacketing meeting requirements of this section. Underground Piping: Provide Pittwrap CW Plus 50 mil thick self-sealing, modified bituminous membrane on piping operating below 140°F. Provide Pittwrap 125 mil thick bituminous resin reinforced with a woven, glass fabric, an integral aluminum foil layer and a protective plastic fill coating on piping operating above 140°F. Jacketing shall provide a complete encapsulation of all insulation including end flanges and reducers.

2.5 BANDING – CELLULAR GLASS

A. Aluminum Steel bands, 1/2 inch wide by 0.0015 inch thick with matching seals.

B. Reinforced tape for insulation, 3/4 inch with fiber reinforcement, Scotch Brand No. 880 by 3M, or equal.

2.6 SEALANT, ADHESIVE AND FINISH

A. Fiberglass - High Temperature (Above 100ºF):
1. Lap Adhesive. Same as low temperature.
2. Finish: Furnish Childers CP-10/11 or Foster 46-50 weather barrier mastic with reinforcing mesh.
3. Cement: Furnish Ryder One Coat on insulated fittings, flanges and valves.
4. Primer and Finish. Furnish Childers CP-50A MV1 diluted 50% with water to prime cement prior to applying coating.
5. Lagging Adhesive: Used in conjunction with canvas or glass lagging cloth to protect equipment/piping indoors. Foster 30-36 AF; Childers CP-137 AF, or approved equal. Coatings shall meet ASTM D 5590 with 0 growth rating.

B. Flexible Elastomeric
1. Adhesive: Furnish Armaflex 520 BLV Low VOC Adhesive, Foster 85-75, or Childers CP-82 to seal longitudinal labs and to adhere butt joint covers.
2. Finish: Furnish Armaflex WB or Foster 30-64 water based latex enamel finish.

C. Cellular Glass:
1. Sealant: Pittseal 444N Sealant by Pittsburgh Corning Corperation.
2. Primer: Foster 60-26 or other rust-inhibitive primer.

D. Reinforcing Mesh: Fiberglass or polyester. 10 strands by 10 strands per square inch. Similar to Foster Mast A Fab or Childers Chil Glas #10

2.7 FITTINGS

A. Provide pre-molded fittings and elbows molded in two matching half sections of same insulation thickness as adjoining piping. As an alternative, provide mitered sections of insulation equivalent in thickness and composition to that installed on straight pipe runs. No insert or blanket insulation allowed.

B. Cellular Glass. Provide Cellular Glass One pre-molded insulation at flanges, valves, and fittings. Provide fiberglass blanket insulation to fill small voids around flanges and valves as required.

2.8 PRIMER

A. Polyguard RG-CHW for surface temperatures less than 130F, RG-2400 LT for piping with surface temperatures between 130F and 250F. Application thickness shall be 25 mils.

B. Global Encasement Rust Inhibition Primer. Application thickness shall be minimum 3 mils (dry)

C. Sherwin Williams Pro-Cryl Universal Acrylic Primer. Application thickness shall be minimum 3 mils (dry).

2.9 ALUMINUM JACKET

A. Piping. Furnish for finishing interior insulated pipe, a prefabricated jacket of ASTM B209 aluminum, 0.020 inch thick, with factory-applied 2-mil moisture barrier.

B. Valves, Fittings and Flanges. Provide complete coverage of all valves, fittings and flanges, provide aluminum covers, 0.020 inch thick, ASTM B209 aluminum.

C. Straps and Seals. Furnish 1 inch x 0.010 inch, ASTM B209 aluminum strapping and seals for applying aluminum jacket and covers to provide completely weather tight covering of all insulation including caps, flanges and end of lines.

D. Metal Jacketing Sealant: Furnish 1/8” bead of Foster 95-44 or Childers CP-76 underneath all metal jacketing laps to prevent water entry on outdoor applications.

2.10 STAINLESS STEEL JACKET

A. Piping. Provide for finishing exterior insulated pipe, a prefabricated jacket of Type 304 stainless steel, 0.016 inch thick, with factory-applied 2-mil moisture barrier. Childers Strap-on or equal.

B. Valves, Fittings and Flanges. Provide complete coverage of all valves, fittings and flanges. Provide formed stainless steel covers, 0.016 inch thick, Type 304 stainless steel.

C. Straps and Seals. Provide 3/4” x 0.020”, Type 304 stainless steel strapping and seals for applying stainless steel jacket and covers to provide completely weather tight covering of all insulation including caps, flanges and end of lines.

2.11 REUSABLE JACKET FOR STEAM SPECIALTIES

A. Provide reusable one-piece asbestos free removable insulation covers for all valves and piping specialties such as strainers, filters, heat exchanger and condensate return units. The covers shall be constructed out of chemical resistant silicone coated fiberglass with a minimum of 11# density fiberglass mat and Kevlar thread & seam closure. The covers shall be capable of withstanding 500°F similar to Jacket provided by Spence.

PART 3 - EXECUTION

3.1 PIPE

A. Pressure testing of piping systems shall be complete prior to application of insulation.

B. Prior to insulating piping,
   1. Remove all oil, grease, cutting oils, dirt and other contaminants. Use suitable solvents, steam cleaning with detergent, or fresh water wash with detergent. Follow with thorough fresh water rinse.
   2. Provide primer coat on all chilled and steel piping in accordance with manufacturer's recommendations, to include field welds and over factory applied paint/coating, in total compliance with mechanical identification section and compatible with and approved by the insulation manufacturer. Painting must be completed and approved prior to installation of insulation. Ductile iron piping shall have asphaltic coating on the exterior of the pipe.

C. Butt insulation joints firmly together. Seal longitudinal laps and butt strips with sealant.

D. Type P2.
   1. Provide finish as specified on all insulation.

E. Type P3 Cellular Glass

F. Insulation shall be applied to piping with all joints tightly fitted to eliminate voids. For systems operating at or below 55°F, all joints must be sealed full-depth with sealant. Sealant shall not be used to fill voids or cracks.

G. Insulation sections shall be secured with stainless steel bands. Two strips of reinforced tape may be used in place of bands or wire if exterior bands are used with jacketing. The tape shall overlap itself by 50 percent.

H. Piping in Crawl Space or Outside of the Building Envelope: Aluminum jacketing shall be applied with all laps positioned to shed water and seams filled with silicone sealant. All laps shall be a minimum of 2 inches. Aluminum jacketing shall be secured using bands and seals as specified. Band spacing shall be two bands equally spaced per section of insulation. This will usually mean 9 inches or 12 inches on center.

I. Insulate valves, flanges, and fittings in a manner like that for piping using materials in Part 2.

3.2 VALVES, FLANGES AND FITTINGS

A. Low Temperature:
   1. Insulate all valves, flanges and fittings with molded fitting covers secured with wire. Thickness of insulation shall be equal to that adjoining piping.
   2. Finish with two coats vapor barrier coating reinforced with reinforcing mesh. The application shall provide a minimum dry film thickness of 37 mils.

B. High Temperature:
   1. Omit insulation at screwed unions and at valves smaller than 1-1/2 inches.
   2. On concealed (other than mechanical and pump rooms) piping, insulate fittings and valves 2-1/2 inches IPS and larger, with pre-molded fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with mastic reinforced with reinforcing mesh.
   3. On concealed piping, insulate fittings and valves 2 inches IPS and smaller with pre-molded fitting covers with a thickness equal to or greater than adjoining straight pipe. Finish with mastic reinforced with reinforcing mesh.

4. In exposed (mechanical, pump and equipment rooms) area, insulate all fittings, flanges and valves with pre-molded fitting covers. Thickness of insulation shall be equal to that of adjoining pipe. Finish with mastic reinforced with reinforcing mesh.
5. Omit insulation on heating hot water flexible pump connectors or expansion joints.

3.3 CONTROL VALVE COVERS - LOW TEMPERATURE SERVICE ONLY

A. Fabricate special covers, complete with troweled-on vapor seal, shaped to accommodate the valve stem. Insulation thickness shall be same thickness as adjoining pipe.

B. Seal covers to valve insulation proper with adhesive so that the seal may be broken with a knife blade without damage to either part. Arrange so that cover can be removed and replaced as necessary for operation of the valve. Finish valve cover with two coats of vapor barrier coating and reinforcing mesh.

3.4 SHIELDS AND HANGERS

A. When the insulation is jacketed in aluminum, install a length of 40-pound roofing felt 1/2 inch longer than the insulation shield between shield and jacket.

B. Where piping hangers or anchors must be in direct contact with pipe, seal off the pipe insulation on both sides of the hanger by carrying the vapor seal down to the bare pipe. Apply insulation around the hanger ring or anchor and pipe and carry vapor barrier upward and outward along the hanger rod or anchor members to a point not less than 12 inches from the adjacent pipe. Draw wire loops tight over the vapor barrier jacket, with ends of wire bent down. Take care to avoid puncturing the vapor seal. Finish insulation as specified for flanges, and seal over adjacent vapor barrier jacket.

3.5 INSTALLATION

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

B. Continue insulation with vapor barrier through penetrations.

C. In exposed piping areas, locate insulation and cover seams in least visible locations. For outdoor installations seal jacket lap with 1/8” bead of metal jacketing sealant underneath each lap to prevent infiltration of water beneath jacket. On horizontal piping place over lap at side of pipe arranged so that water will run off of jacket and not into seam lap.

D. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

E. Neatly finish insulation at supports, protrusions, and interruptions. Use 1-1/2 inch Type P2 insulation to insulate drains gauges, thermometers, and strainers.

3.6 PIPING INSULATION APPLICATION AND THICKNESS SCHEDULE[ENGINEER TO REVISE APPLICATION SCHEDULE AS REQUIRED FOR PROJECT]

A. Provide insulation with minimum thickness and conductivity values in compliance with ASHRAE standard 90.1-2013, Table 6.8.3A&B, but not less than thicknesses specified in this specification and as required to prevent condensation. Where multiple materials are listed for a single service and location, it is the Contractor’s option to choose from the allowable insulations.

Service	Location	Insulation Type	Pipe Sizes	Insulation Thickness-Inches
AHU/FCU Condensate Drains	Interior	P2	All sizes	1

Service	Location	Insulation Type	Pipe Sizes	Insulation Thickness-Inches
Heating Hot Water	Interior	P1	1-1/4” and smaller	1-1/2
Heating Hot Water	Interior	P1	1-1/2” to 4”	2
Heating Hot Water	Interior	P1	6” and larger	2-1/2
Supports, protrusions, drains, gauges, thermometers and strainers	Interior/ Exterior	P2	All Sizes	1-1/2
Flexible Pump Connector	Chilled Water	P2	All Sizes	1-1/2
Steam Condensate	Any	P1	All	3
Steam (15 psig and less)	Any	P1	All	3
Steam (16 to 120 psig)	Any	P1	1” and smaller	4
Steam (16 to 120 psig)	Any	P1	1-1/2” and greater	5
Steam (greater than 121 psig)	Any	P1	2-1/2” and smaller	5
Steam (greater than 121 psig)	Any	P1	3” and larger	5
Vent Piping	Any	P1	All	3

Service	Location	Insulation Type	Pipe Sizes	Insulation Thickness-Inches
Chilled Water	Interior	P3	4” and smaller	3
Chilled Water	Interior	P3	6” and larger	3-1/2
Heating Hot Water	Interior	P3	1” and smaller	2
Heating Hot Water	Interior	P3	1-1/2” to 4”	3
Heating Hot Water	Interior	P3	6” and larger	3-1/2
Chilled Water	Crawl Space/ Exterior	P3	4” and smaller	3
Chilled Water	Crawl Space/ Exterior	P3	6” and larger	3-1/2

Service	Location	Insulation Type	Pipe Sizes	Insulation Thickness-Inches
Heating Hot Water	Crawl Space/ Exterior	P3	4” and smaller	3
Heating Hot Water	Crawl Space/ Exterior	P3	6” and larger	3-1/2

3.7 ALUMINUM JACKET

A. Apply aluminum jacket and covers according to manufacturer’s recommendations, using aluminum strapping and metal jacketing sealant to provide completely weathertight covering. Completely encapsulate insulation on all piping, valves, flanges, reducers, etc.

B. Provide aluminum jacket for all piping within 84 inches of finished floor in air handler mechanical rooms, pump rooms, penthouses and exposed occupied spaces in the building. Do not install jacketing on AHU Condensate drains unless noted otherwise. Do not install jacketing on flexible pump connectors or expansion joints.

3.8 EXTERIOR JACKET

A. Apply stainless steel jacket and covers according to manufacturer’s recommendations. For stainless steel jacket, use stainless steel strapping and metal jacketing sealant to provide completely weathertight covering. Completely encapsulate insulation on all piping, valves, flanges, reducers, etc.

B. Provide exterior jacket for all insulated piping located outdoors.

END OF SECTION 23 07 19

SECTION 23 09 23 - DIRECT DIGITAL CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions and Supplementary General Conditions for the State of Texas Building Construction Contracts”, and Division 01 sections apply to the work of this Section.
   1. Where the term "Owner's Designated Representative" is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Development, 301 University Boulevard, Galveston, Texas 77555-1116. Phone (409) 772-3500, Fax (409) 772-5199.

1.3 RELATED SECTIONS

A. 23 05 19 – Meters and Gauges for HVAC Piping

B. 23 21 00 – Hydronic Piping and Fittings

C. 23 33 00 – Air Duct Accessories

D. Division 26

E. Division 27

1.4 REFERENCED STANDARDS

A. ASHRAE Standard 135 Latest Edition: BACnet® – A Data Communication Protocol for Building Automation and Control Networks

B. UL 916 – Energy Management Equipment

C. NFPA 70 – National Electric Code

1.5 SYSTEM DESCRIPTION

A. A complete automatic Building Management System (BMS) using field-programmable micro-processor based units. System shall communicate with the existing BMS. Contractor shall interface all new field controllers and devices and provide all necessary programming to establish communication with the existing Operator Stations on campus. Communication shall be established in one of two acceptable ways, by either extending existing field communications trunks to new field controllers or by tying in new open protocol controllers utilizing the existing Campus-wide Ethernet LAN via an OPC client/server data path to the Operator Stations. The Contractor shall be responsible for verifying and establishing new controls databases on the existing Operator Stations and provide for a Human/Machine interface to the new equipment including generating graphics compatible with existing, manual override for start/stops, manual override for setpoint resets, schedule changes, and displaying values of all binary and analog field points.

1.6 SUBMITTALS

A. Submit under provisions of Division 01.

B. Shop Drawings:
1. Trunk cable schematic showing programmable control unit locations, and trunk data conductors.
2. List of connected data points, including connected control unit and input device.
3. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
5. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring and pneumatic details.
6. Descriptive data and sequence of operation of operating, user, and application software.

C. Product Data: Provide data for each system component and software module. Markup datasheet to easily reference the intended component and part number being supplied.

D. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE Standard 135.

E. Samples for Initial Selection: Submit one sample of each color of thermostat and/or sensor cover with factory colors. Where applicable, match the color of existing thermostats and/or sensor covers.

F. Manufacturer's Installation Instructions: Include for all manufactured components. Markup installation instructions to easily reference the intended installation method.

1.7 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01.

B. Accurately record final location of control components, including panels, thermostats, and sensors.

C. Revise shop drawings as necessary to reflect actual installation and operating sequences.

D. Include data specified in "Submittals" in final "Record Documents" form.

E. Provide final documentation in electronic and hard copy formats.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 01.

B. Include interconnection wiring diagrams of complete field installed system with identified and numbered, system components and devices.

C. Include keyboard illustrations and step-by-step procedures indexed for each operator function.

D. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

E. Product Data: Provide data for each system component and software module. Markup datasheet to easily reference the intended component and part number supplied.

F. Manufacturer’s Installation Instructions: Include for all manufactured components. Markup installation instructions to easily reference the installation method.

G. Provide final documentation in electronic and hard copy formats.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years documented experience. Manufacturer shall have a local Branch office staffed with Factory trained engineers and system representatives fully capable of providing instruction, routine maintenance, and emergency maintenance service on all system components.

B. Installer: Company specializing in applying the work of this Section with minimum five years documented experience. Installer shall be a local Branch office of the Manufacturer with resident factory trained personnel. Branches shall be certified for ISO-9002 quality standards to assure adherence to quality standards adopted for their manufactured products.

1.10 PRE-INSTALLATION CONFERENCE

A. Convene a conference one week prior to commencing work of this Section, under provisions of Division 1.

B. Require attendance of all parties directly affecting, or responsible for coordinating with the work of this Section. Attendance shall include but not be limited to: General Contractor, Controls Contractor, HVAC Contractor, Electrical Contractor, Testing and Balancing Contractor, and Owner's Representative.

C. Controls contractor shall provide all attendees with a meeting agenda at least two working days in advance of the scheduled meeting. The agenda shall include but not be limited to the review of: overall design, major components, component locations, and coordination with other trades.

D. All BMS point names (Including BACNet device names) and applicable database names will be approved by the owner. The intent is to conform to the standard UTMB point naming and database naming convention.

E. New BMS point alarming and trending shall match existing typicals and will be approved by the owner.

1.11 COORDINATION

A. Coordinate work under provisions of Division 01.

B. Ensure installation of components is complementary to installation of similar components in other systems.

C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

D. Coordinate power requirements with Division 26 contractor.

1.12 WARRANTY

A. Provide two-year warranty under provisions of Division 01.

B. Provide two-year manufacturer's warranty for materials on all field-programmable, micro-processor-based units.

1.13 MAINTENANCE SERVICE

A. Furnish service and maintenance of energy management and control system for two years beginning on the date of acceptance of the system by the Owner.

B. Provide two complete inspections per year, one in each season, to inspect, calibrate, and adjust controls as required. Submit written inspection and service reports.

1.14 EXTRA MATERIALS

A. Submit maintenance materials under provisions of Division 01.

B. Provide to Owner two extra units of each type of sensor under provisions of Division 01 and provisions herein.

1.15 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
1. Limiting use of software to equipment provided under these specifications.
2. Limiting copying.
3. Preserving confidentiality.
4. Prohibiting transfer to a third party.

B. Contractor shall provide all registrations and agreements with software copyright holders executed on behalf of the Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Siemens Building Technologies, Inc.

B. Johnson Controls, Inc.

C. Substitutions: Under provisions of Division 01.

2.2 LOCAL OPERATOR ACCESS AND DISPLAY PANEL

A. Provide local display and adjustment panel. Panels shall be portable programmable control units. Panel shall contain a digital display and keyboard for displaying and editing the following parameters:
1. Input/output point information.
2. Controller set points.
3. Controller tuning constants.
4. Program execution times.
5. High and low limit values.
6. Limit differential.
7. Time, date, year.

2.3 OPERATOR STATION

A. Unless otherwise required in this specification, the Operator Stations and printers already exist on campus. New control system shall communicate through the campus LAN to the existing Operator Stations.

B. Description:
1. Provide one Operator Interface as described herein. Locate as shown on plans or as indicated by Owner's Agent. Operator PC shall be able to access all operator-level information in the system through the use of a standard, commercially available web browser. Access for a remote desktop shall also be made possible. The Operator Interface shall reside on the same peer-to-peer network as the building controllers.
2. The Operator Interface shall connect via Ethernet to a local area network and be able to serve controller information to users connected via the LAN or via telephone through standard web browser software.

C. Hardware:
   1. Operator Interface PC shall have all hardware, peripherals, cables, interfaces, etc. necessary to optimally run the operating system and BMS software.
   2. PC shall be of speed, performance, capacity, etc., that is considered current technology and is commercially available at the time of the installation of the system. At a minimum include: 19" Monitor capable of displaying at 1024x768 resolution or better, Inkjet or Laser printer, 2.0 times the minimum system memory and hard drive capacity as recommended for the operating system, CD/DVD read and write drive, multi-button optical or laser mouse with scroll wheel.
   3. Software: Contractor shall provide all required software including the database. Provide the latest professional version of Microsoft Windows operating system. Provide a non-proprietary internet browser interface with capabilities as described herein.

D. Graphical User Interface (GUI): Provide a comprehensive GUI using a collection of graphically-oriented pages accessed via standard web browser software or Remote Desktop session. The GUI shall be constructed to operate like a single application and shall provide a complete and intuitive point-and-click operator interface for access to system data.
   1. Graphics shall have the ability to show animations of equipment such as fans/pumps rotating, dampers operating, etc. Provide a complete clip-art library of standard HVAC equipment (chillers, air-handling units, pumps, etc.).
      a. Graphics have a nested or "Drill Down" structure beginning at the Campus Map level down to individual components.
      b. Graphics shall include detailed floor drawings with device (ie, Air terminals, thermostats, discrete devices) locations clearly and accurately displayed.
   2. Custom Graphics: Custom graphic files may be created with the use of a graphics generation package. Graphics may be downloaded to the Web server to use as graphical backgrounds for Dynamic data sent to a Web browser.
   3. GUI pages shall be grouped in a logical manner.
   4. The system shall provide a search function to allow users to search for GUI pages or groups of pages by name or partial name.
   5. The system shall provide the necessary means to add, remove, and manage GUI pages.
   6. The system shall provide summary tables by equipment type per site. Room or space summary tables shall provide names, space temperatures, set points, and variance from set point. Provide a means to sort columns of data viewed by ascending or descending value for any chosen data type.
   7. An operator shall be able to access a tabular listing of the system's most recent alarms and acknowledge, print, delete, and link to trouble areas. Provide the ability to reset diagnostic messages and perform control overrides.
   8. The system default setting shall be to display data in Imperial/English units. The user shall have the option to select the display of data in SI/Metric units.

E. Security: The system shall support state-of-the-art encryption between server and GUI and comply with all current UTMB IS Security policies.
   1. Server security shall accommodate a minimum of 1000 individually password-protected users. Each user shall be assigned a user name, password, and security level. User names and passwords shall be case sensitive and able to have up to 32 characters. User security shall be set up through the web browser as an administrative function. Each user will be assigned to a security level. Security levels shall be hierarchical in nature (i.e., the higher security levels have all rights of lower levels). There shall be at least four (4) user security levels corresponding to user roles.
   2. A system administrator shall be able to define the data view and edit capabilities for each security level. Additions to the server database shall be structured in the same manner as existing access control groups with the approval of the owner.
   3. Users shall be required to enter their user name and password to use the system. Users shall be automatically logged off of the system after a specified period of inactivity.
   4. System Applications and Software: The central server shall serve operator interface web pages and provide off-line storage of system information. Provide the following applications within the system.

5. Automatic System Database Save and Restore. The central server shall store on the hard disk backup tables of data including trends, alarms, custom settings and user profiles. This data shall be backed up once per day. This database shall be updated whenever a change is made in the system. The storage of this data shall be automatic and not require operator intervention.
6. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to archive the database manually at any time.
7. System Configuration. The central server shall serve web pages as the interface for configuring the operator-level functions of the system. A user with proper security shall be able to configure the system to allow for future changes or additions.
8. On-Line Help and Training. Provide a context sensitive, on line help system to assist the operator in operation and editing of the system. On-line help shall be available for all system functions and shall provide the relevant data for that particular screen. Additional help shall be available through the use of hypertext links onscreen.
9. System Diagnostics. The system shall automatically monitor the operation of all workstations, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
10. Alarm Management - The central server shall provide the following alarm handling functions:
    a. Receiving alarms from each building panel.
    b. The central server shall store specified alarms in an alarm log database.
    c. Displaying an alarm log.
    d. Forward alarms to email, pager, cell phone as specified by the user.
    e. Alarm sorting and/or filtering by alarm and/or site attribute.
    f. Store alarm data in a standard format accessible to a user-specified peer database/server.
    g. Storing and purging the alarm log.
    h. Provide a means of acknowledging and deleting alarms from the viewable alarm log(s).
    i. Provide a logical and printer-friendly format for printing alarm logs.
11. Alarm and Event Log. The operator shall be able to view all logged system alarms and events from any location in the system. An operator with the proper security level may acknowledge and clear alarms. All alarms shall be archived to the hard disk on the central server.
12. Trend Logs. The operator shall be able to define a trend log for any data in the system. This definition shall include interval, start-time, and stop-time. Change of Value (COV) trending shall also be possible to obtain from the system. Trend intervals of 1, 5, 15, 30, and 60 minutes as well as user-defined intervals shall be selectable. The system operator shall be able to determine how many samples are stored in each trend. Trend data shall be sampled and stored on the Building Controller panel, then harvested and be archived on the central server hard disk. Additionally, provide the capability to sample directly from the building controller database to the central server. Trend data shall be able to be viewed and printed from the operator interface web pages. Trends shall be viewable in both a text-based and graphical format. Trends shall also be storable in a tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages, and be exportable to a file for use in other software tools, available in a non-proprietary file format to be used by another database.
13. Dynamic Graphical Trending. The system shall have the ability to display collected data in a graphical chart. Trend viewing capabilities shall include the ability to show up to 5 points on a chart. Each data point trend line shall be an individual color. Trend data shall be able to be stored indefinitely on the central server, based on server storage capacity and data archiving practices.
14. Object and Property Status and Control. Provide a method for the operator to view, and edit (if applicable) the status of any object and property in the system.
15. Data Collection. Provide a data collection module to acquire historical data for access by the GUI. Historical data shall be categorized as follows:
    a. Consumable Data: KHW, BTU, GPM, etc., acquired in either analog or digital pulse form.
    b. Runtime Data: Information on time and operation of equipment based on equipment status.
    c. History Data: Trend log data on status of equipment or values such as an analog sensor. History data collection shall be initiated from either a specified time function or an event. Provide enough software capacity to accomplish the required data collection function for the total system as specified. The data collection process shall not require the BMS PC to be online. Additional Data Collection modules may be added at any time to meet increased system requirements. The system shall allow the operator the capability of configuring each additional module.

16. Reports and Logs. Operator shall be able to select, modify, create, and print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
17. Standard Reports. Furnish the following standard system reports. Reports shall be organized based upon the selected equipment.
    a. Alarm Summary Report of current alarms.
    b. List of equipment and associated alarm conditions.
    c. List of configured alarm actions such as pop-up, notify by email, etc.
    d. Table of operating schedules for each equipment.
    e. Summary of all operating schedules.
    f. Summary of all security actions taken through user interface.
    g. List of equipment commissioning checkout status.
18. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, organize the data, and present results in tabular or graphical format. Reports shall be launched from the operator interface.

F. Operator Interface Applications Editors. The GUI shall support dedicated screens for the editing of control system applications. The application programs shall be executed at the appropriate controller panels.

G. Scheduling. An editor for an enterprise-wide scheduling application shall be provided. Provide a method by which a system operator can make permanent changes to one or many building schedules without the need to repeat any steps. The system shall be able to provide temporary changes to one or more schedules at one or more building locations. The scheduling application shall have the following features:
1. Scheduling by system type, building area, zone, groups of zones, individually controlled equipment and groups of individually controlled equipment.
2. Schedules may be entered for up to nine years in advance.
3. Schedules shall automatically adjust for leap year and Daylight Savings Time.
4. Schedules shall be self-deleting when effective dates have passed.

H. Optimum Start/Stop. The scheduling application shall provide and support an optimal start algorithm. This algorithm shall calculate the thermal characteristics of a zone and start the equipment prior to occupancy to achieve the desired space temperature at the specified occupancy time. The algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less than and greater than 24 hours. Provide the ability to modify the algorithm based on outdoor air temperature. Provide an early start limit in minutes to prevent the system from starting before an operator determined time limit.

I. Timed Local Override. A standard application shall be utilized to enable/disable temperature control when a user selects on/cancel at the zone sensor, workstation, or the operator display. The amount of time that the override takes precedence shall be defined by the operator from the workstation. The system shall allow the operator to define a maximum number of overrides allowed in a given time period.

J. Day/Night Setback. The system shall allow the space temperature to drift within an adjustable, user-defined temperature range when the building or zones are in unoccupied mode. The heating/cooling shall be activated if the space temperature leaves the setback range and shall remain active until the space temperature reaches the setback range.

K. Staggered Start/Stop. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started and the time delay between starts shall be user-selectable. This application shall also prevent all major controlled equipment from simultaneously stopping during normal shut down. The order in which equipment (or groups of equipment) is stopped and the time delay between stops shall be user-selectable.

L. Demand Limiting. The demand limiting program shall monitor building power consumption from signals generated by a pulse generator (provided by others) mounted at the building power meter, or from a watt transducer or current transformer attached to the building feeder lines. The system shall be capable of handling no less than six separate time of day KW demand billing rate periods. The system shall be capable of measuring electrical usage from multiple meters serving one building and each piece of equipment being controlled on the LAN shall be programmable to respond to the peak demand information from its respective meter.
1. The demand limiting program shall be based on a predictive sliding window algorithm. The sliding window interval shall be operator selectable in increments of one minute, up to 60 minutes. The operator shall be able to establish the kilowatt threshold for a minimum of three adjustable demand levels.
2. Control system shall be capable of demand limiting by resetting HVAC system set points to reduce load while maintaining a widened band of comfort control in the space. The system shall allow the operator to set the individual equipment temperature set points for each operator defined demand level. If these reset set points are not satisfied, the set point shall be revised for the different established demand levels.
3. The system shall have failed meter protection, such that when a KW pulse is not received from the utility within an operator adjustable time period, an alarm will be generated. The system software will automatically default to a predetermined fail-safe shed level.
4. Information Archiving. The system shall have the ability to archive demand and usage information for use at a later time. System shall permit the operator access to this information on a current day, month-to-date, and a year-to-date basis. Input capability shall be provided for an end-of-billing period indication.

M. Maintenance Management. The system shall monitor equipment status and generate maintenance messages based upon user designated run time, starts, and/or calendar date limits.

N. Online Help. Operator Interface shall have a context-sensitive online help tool to provide help with operating and editing the system.

2.4 CONTROL UNITS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.

B. Provide the following functions:
1. Mathematical: Absolute value, calculate, square root, power, sign, average, totalize.
2. Logic: OR, AND, compare negate.
3. Fixed Formula: High and low select, span, rate, ramp, enthalpy, wet bulb, dew point, relative humidity, humidity ratio, filter differential pressure.
4. Data Manipulation: Store, file and set.
5. Control Routines: Proportional, integral, lead lag, hysteresis correction and incremental control.
6. Energy Management: Duty cycling, load shed, optimal run time, economizer, holiday and daylight savings time correction.

C. Provide self-test procedure for checking digital display and computer. Display advisories for maintenance, performance, or software problems. Identify variables as reliable or unreliable. Variables identified as unreliable will flash when displayed and calculation will use default.

D. Indicate alarms and deviations. Alarm scan shows alarms and identification. Continue alarm indication until acknowledged and alarm condition is corrected.

E. BACnet Compliance: Control units shall be compatible with BACnet.

2.5 BUILDING SYSTEMS INTEGRATION

A. Protocol Translator Module (PTM): The BMS System shall establish a seamless interconnection with other building, electrical and/or mechanical subsystems as well as other manufacturers control systems using a Protocol Translator as specified below and related equipment sections of the specification. These systems shall be controlled, monitored and graphically programmed with the same Graphical Programming Language (GPL) used for all other control modules.
   1. System Information. All system information specified in the I/O Point Summary and related documents shall be available to the BMS server.
   2. OEM Cooperation. Full cooperation by the Original Equipment Manufacturer (OEM) in this open protocol effort shall be a requirement for bidding this project. OEM manufacturers shall bid BACnet® compliant devices. OEM manufacturers that utilize other protocols shall include the cost of a PTM in their bid.
   3. Necessary Equipment Included Price. If the equipment manufacturer does not have this capability, they shall contact the authorized representative of the BMS for assistance and shall include in their equipment price any necessary equipment obtained from the BMS manufacturer to comply with this section.
   4. PTM Specification:
      a. The PTM shall be a microprocessor based communication device designed to provide seamless, two-way translation between two or more standard or non-standard protocols.
      b. The PTM shall be available for a variety of Data Link\Physical Layer configurations including PTP (point-to-point) via EIA-232, MS/TP via EIA-485 and Ethernet.
      c. In addition to BACnet®, the PTM shall also support other protocols including Modbus, J-Bus and other protocols as specified herein for electrical/mechanical subsystems.
      d. The PTM shall have at least three communication ports. One shall be for communication between native BACnet® controllers residing on the controller network. The other two ports shall have the ability to be configured for different protocols.
      e. The PTM shall provide full custom programmability of the data flowing between the networks using the same graphical programming as specified herein. The system shall have the ability to create custom building control strategies using global data between networks.

2.6 INPUT/OUTPUT SENSORS

A. Temperature:
   1. Resistance temperature detectors (RTD's) with resistance tolerance of plus or minus 0.1 percent at 70 degrees F, interchangeability less than plus or minus 0.2 percent, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air, 1800 ohm or 10,000 ohm thermistor sensors are also acceptable.
   2. Use insertion elements in ducts not affected by temperature stratification or smaller than nine square feet. Use averaging elements where larger or where prone to stratification. Sensor length as recommended by manufacturer for given installation conditions.
   3. Insertion elements for liquids shall be with brass socket with minimum insertion length of 2-1/2 inches (60 mm). Chilled water and condenser water sensors shall have an accuracy of ±0.25º F at calibration point. Hot water temperature sensors shall have an accuracy of ±0.75º F at calibration point.
   4. Provide room sensors with locking mechanism (physical or software; intent is to restrict access to local adjustment). Unless otherwise noted, public areas (ie, Rest rooms, corridors, hallways, etc) shall use Flush Mount Room Temperature sensors of Stainless Steel or white blank cover plate construction without local display or adjustments. All room sensors shall be locally labeled with it's point name for easy identification. Room sensors shall have an accuracy of ±1.0ºF at calibration point.

5. Provide outside air sensors with watertight inlet fitting and shielding from direct sunlight. OA sensors shall have an accuracy of ±0.5ºF at calibration point.

B. Humidity Sensors:
1. Elements: Accurate within ±2 percent 10-90%RH @ 25ºC with linear output.
2. Room Sensors: With locking mechanism (physical or software; intent is to restrict access to local adjustment), range of 0 - 100 percent relative humidity.
3. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 - 100 percent relative humidity.

C. Pressure Sensors:
1. Differential Pressure and Pressure Sensors: Sensors shall have a 4-20mA output proportional signal with provisions for field checking. Sensors shall withstand up to 150% of rated working pressure without damaging the device. Accuracy shall be ±2% of full scale.
2. Water Differential Pressure Switches: Pressure switches shall have a repetitive accuracy of ±2% of range and withstand up to 150% of rated pressure. Sensors shall be diaphragm or bourbon tube design. Switch operation shall be adjustable over the operating pressure range. The switch shall have an application rated Form C, snap-acting, self-wiping contact of platinum alloy, silver alloy, or gold plating.
3. High static limit switch: Switches shall be diaphragm operated with 3-1/2" diaphragm to actuate a single pole double throw snap switch. Motion of the diaphragm shall be transmitted to the switch button by means of a direct mechanical linkage. It should include a 1.4 – 5.5" WG range pressure switch with manual reset snap switch.
4. Static pressure sensor: Provide a differential pressure transmitter with a 4-20mA output to the BMS. It shall operate on the capacitance principle and be capable of sensing very low positive, negative or differential pressures. Sensor shall be accurate within ±1% of range. Range shall be from 0.1 to 5.0 inches WG over a temperature range of 32 to 125ºF and humidity range of 20 – 90% RH; additional sensor ranges may be necessary to accommodate the system being monitored or controlled.

D. Flow Switches: Flow Switches shall be either paddle or differential pressure type and have a repetitive accuracy of ±1% of their operating range.
1. Paddle Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum). Adjustable sensitivity with NEMA 1 Type enclosure unless otherwise specified.
2. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 Type enclosure, with scale range and differential suitable for intended application, or as specified.

E. Water Flow Meters:
1. Turbine Meter: Provide inline turbine type flow meter with bronze or stainless steel body, plastic turbine (stainless steel above 150 deg. F), and sensor and indicator as appropriate for the application for which it is installed. Flow meter shall be rated for minimum working pressure and temperature as appropriate for the application for which it is installed. Accuracy shall be ±1.5% or better with at least 1% repeatability.
2. Vortex Shedding Meter. Provide inline vortex shedding type flow meter with stainless steel body, stainless steel shredder bar, and sensor and indicator as appropriate for the application in which it is installed. Flow meter shall be rated for minimum working pressure and temperature as appropriate for the application for which it is installed. Accuracy shall be ±1.5% or better.

F. BTU Meters:
1. BTU Meter: Provide inline turbine type flow meter with bronze or stainless steel body, plastic turbine, (stainless steel above 150 deg. F). and sensor and indicator as appropriate for the application for which it is installed. Flow meter shall be rated for minimum working pressure and temperature as appropriate for the application for which it is installed. Accuracy shall be ±1.5% or better with at least 1% repeatability. Flow meter shall be similar to Onicon F-3500 or equivalent] [Water flow sensors shall be inline magnetic flowmeter flow tubes similar to Rosemont 8705. Each sensor shall be sized specifically for the pipe in which it is to be installed. Sensor shall have ±0.5% accuracy from 1 to 30 feet/second, with Class 150 carbon steel flanges, exterior painted with polyurethane, grounding electrode, Teflon (PTFE) lining, and Type 316L stainless steel electrodes. Contractor shall furnish remote mounted magnetic flowmeter transmitters, similar to Rosemount Model 8712E, with 115Vac/1ph/60hz power supply, NEMA 4X enclosure, 4 – 20 ma output, battery-backup totalizer, and local operator interface]. Temperature sensors shall be matched for accuracy within ±1%. Power shall be 24 VAC and be supplied by Division 23. Meter shall communicate with the server via Modbus or BACNet protocols.

G. Equipment Operation Sensors:
1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0.1 to 5.0 inches WG (0 to 1250 Pa); additional sensor ranges may be necessary to accommodate the system being monitored or controlled.
2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 PSI (50 to 400 kPa).
3. Status Inputs Where Differential Pressure Sensing is Impractical: Current sensitive relay with current transformers, adjustable and set to 175 percent of rated motor current.
4. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
5. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
6. Water-Flow Switches: Bellows-actuated or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

H. Watt-hour Transducers shall have an accuracy of ±0.25% for KW and KWH outputs from full lag to full lead power factor. Input ranges for KW and KWH transducers shall be selectable without requiring the changing of current or potential transformers and shall communicate with the server via Modbus or BACNet or BMS specific protocols.

I. Digital to Pneumatic Transducers: Convert plus or minus 12 vdc pulse width modulation outputs and/or continuous proportional current or voltage to 0 to 20 psi (0 to 138 kPa).

J. Voltage-to-Digital Alarm Relays shall monitor status of equipment safeties and overloads and shall be sized and connected so as not to impede the function of the monitored contacts. Switch shall have self-wiping, snap-acting Form C contacts rated for the application.

K. Damper Position Indication: Potentiometer mounted in handbox enclosure with adjustable crankarm assembly connected to damper to transmit 0 - 100 percent damper travel.

L. Photocells shall have transmitters for 4-20mA output signal. Sensor shall be mounted in a waterproof enclosure. Unit shall be calibrated for 4mA at greater than 100 foot-candles and 20mA at less than 0.1 foot-candles.

M. Airflow Measuring Devices:
1. Airflow/temperature measurement device (ATMD). Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor nodes contained in one or more probe assemblies per measurement location. Provide transmitter with appropriate communications interface with the Building Control System. Sensor probe shall be constructed of aluminum alloy or Stainless Steel with Stainless Steel mounting brackets. Sensor shall utilize bead-in-glass thermistor probes. Airflow sensing shall be accurate within ±2% over a temperature range of -20°F to 120°F.
2. Air Monitoring Station with multi-point, self-averaging Pitot traverse and aluminum “honeycomb” air straightener section in one assembly (Honeycomb air straightener section shall have access doors installed before and after per Section “23 33 00 – 3.3 A. Access Doors” for cleaning of Honeycomb). Aluminum **or** stainless steel frame with mounting flanges on both sides. Unit shall be capable of operating over a temperature range of -20°F to 120°F and an airflow velocity range of 400 to 5,000 FPM with an accuracy of 2% of total flow and a pressure drop of no more than .085” WC at 2000 FPM. AMS model submitted shall require owner review and approval.

N. Motorized Dampers:
1. Control dampers shall be AMCA-rated opposed [parallel] blade design and rated for leakage less than 10 CFM/SF of damper area at a differential pressure of 4"WC. Modulating dampers shall have linear flow output characteristics.
2. Frame shall be 16 gauge galvanized steel, or 1/8” extruded aluminum with reinforced corner bracing.
3. Damper blades shall be a maximum of 8" wide and a maximum of 48” long. Applications requiring longer dampers shall have multiple sections with multiple linkages to prevent binding.
4. Blade material shall be galvanized steel, not less than 16 GA, formed for extra strength. Secure blades to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
5. Dampers used for outside air intake shall have frames, blades, and other internal parts exposed to outside air constructed of 316 stainless steel.
6. Edge seals shall be inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless steel side seals rated for leakage of less than 10 CFM/SF of damper area at a differential pressure of 4”WC when damper is held by a torque of 50 IN-LB.

O. Damper Actuators:
1. Provide UL-listed electronic damper actuators designed for a minimum of 60,000 full stroke cycles at the actuator’s rated torque.
2. Actuators shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
3. All rotary spring return actuators shall be capable of both clockwise and counter clockwise spring return operation. Linear actuators shall spring return to the retracted position.
4. Proportional actuators shall accept a 0-10 VDC or 0-20 mA control signal and provide a 2-10 VDC or 4-20 mA operating range.
5. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.
6. Modulating damper operators shall be sized with sufficient reserve power to provide smooth modulating action.

P. Valve Actuators:
1. Provide UL-listed electronic valve actuators designed for a minimum of 60,000 full stroke cycles at the actuator’s rated torque.
2. Actuators shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
3. Proportional valve actuators shall accept a 0-10 VDC or 0-20 mA control signal and provide a 2-10 VDC or 4-20 mA operating range.

4. Rotary spring return actuators shall be capable of both clockwise and counter clockwise spring return operation. Linear actuators shall spring return to the retracted position
5. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the valve when the actuator is not powered. Spring return actuators with more than 60 in-lb. torque capacity shall have a manual crank for this purpose.

Q. Control Valves:
1. Pressure ratings shall be125 psig or 1.25 times the maximum system operating pressure.
2. 2" and smaller:
   a. ANSI class 250, spring loaded, Teflon packing. Two-way valves shall have replaceable composition disc or stainless steel ball and shall be quick acting for two-position service unless otherwise indicated.
   b. Screwed.
   c. Bodies and internal parts shall be bronze, cast brass, stainless steel or other approved corrosion-resistant metal as required for the application.
3. 2-1/2" and larger:
   a. ANSI class 125, guided plug, Teflon packing.
   b. Flanged.
   c. Bodies shall be cast iron or cast steel.
   d. Seats and parts exposed to fluid shall be bronze, stainless steel or other approved corrosion resistant metal as required for the application.
4. Three-way valves: linear throttling plugs allowing total flow through valve to remain constant regardless of position.
5. Sizes shall be by the control system manufacturer based on the following minimum criteria:
   a. Valves for two-position service shall be line size unless indicated otherwise.
   b. Valves for modulating service shall have a pressure drop equal to twice the pressure drop through the coil/exchanger, 50% of the pressure difference between supply and return mains, or 5 PSI, whichever is greater.
   c. Valves for three-way modulating service shall have a Pressure drop equal to twice the pressure drop through the coil/exchanger load, 5 PSI maximum.
   d. Relief and bypass valves shall be sized according to pressure available and/or flow required.

R. Steam System Globe Valves:
1. Pressure ratings shall be125 psig or 1.25 times the maximum system operating pressure.
2. 2” and smaller:
   a. ANSI Class 250.
   b. Screwed.
   c. Body shall be bronze.
   d. Trim shall be bronze with a stainless steel rising stem, renewable composition disc, and backseating capacity repackable under pressure.
3. 2-1/2” and larger:
   a. ANSI Class 125.
   b. Flanged.
   c. Body shall be cast iron.
   d. Trim shall be bronze with stainless steel rising stem, plug type disc, and renewable seat and disc.
4. Sizes shall be by the control system manufacturer based on the following minimum criteria:
   a. Two position service valves shall be sized for 20% of inlet pressure.
   b. Modulating service valves for 15 PSI and lower shall be sized for 80% of inlet pressure.
   c. Modulating service valves for 16-50 PSI shall be sized for 50% of inlet pressure.
   d. Modulating service valves for >50 PSI shall be sized for the given pressure and application.
5. Control valves for steam service shall be equal percentage type unless otherwise indicated.

S. Gas Detection Equipment:
1. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of -4 to 122ºF; with 2 factory-calibrated alarm levels at 50 and 100PPM. Maximum response time to 100 PPM CO calibration gas shall be two minutes.
2. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors suitable over a temperature range of 32 to 130ºF and calibrated for 0 to 2 percent, with continuous or averaged reading 4-20 mA output, for wall mounting.
3. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing suitable over a temperature range of 4 to 122ºF and calibrated for 0 to 5 percent with continuous or averaged reading 4-20 mA output, for wall mounting.
4. Nitrogen Dioxide Sensor and Transmitter: Single detectors using electro-chemical sensors suitable over a temperature range of 25 to 104ºF and calibrated for 0-20 PPM with continuous or averaged reading 4-20 mA output, a 2-year minimum life, for wall mounting.
5. Storage Tank Level Sensor. Pulse radar transmitter that provides a continuous level measurement up to 98 feet with a 4-20 mA signal output and is configurable via an integral push button display module. The antenna and mount shall be 316L stainless steel. The sensor shall have auto-temperature compensation and fail-safe diagnostics. The sensor shall be housed in an IP67 aluminum enclosure with polycarbonate window.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install electrical work in accordance with Division 26. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

C. Each Programmable Control Unit shall be provided a 120V AC, 15 amp dedicated emergency power circuit provided by Division 26. Mission critical PCU’s shall have appropriately sized UPS’s to ride out a power event while emergency power is being restored.
1. 120 V AC Circuits shall be the responsibility of and coordinated with Division 26 and shown on Division 26 Drawings.
2. Each PCU unit will include a local copy of its wiring diagram as well as pertinent sequences of operations.

D. Each Air Terminal Unit shall be provided a 120V AC, circuit provided by Division 26.
1. 120 V AC Circuits shall be the responsibility of and coordinated with Division 26 and shown on Division 26 Drawings.
2. The number of ATU’s per circuit shall not exceed the 120 V circuits 15 Amp rating.
3. Each ATU unit will include a local copy of its wiring diagram as well as pertinent sequences of operations.

E.

F. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Generally, install devices 48 inches above the floor in alignment with light switches.
1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

G. Install raceways, boxes, and cabinets according to Division 26 Section "Raceways, Conduit and Boxes."

H. Install building wire and cable according to Division 26 Section " Cable, Wire, and Connectors."
1. All input-output, communications, and low voltage control wiring shall have each end labeled with the appropriate identification information, i.e. point name and termination location info, etc.

I. Data communications (Ethernet) shall be the responsibility of and coordinated with Division 27
   1. In addition to any data connections required for each PCU, a spare data connection shall be provided by Division 27 within 15 feet of the PCU for technician use.

J. Connect manual-reset limit controls independently of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

K. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.2 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Division 01

B. Start-up, calibrate, and adjust systems. Allow sufficient time for start-up, calibration, and adjusting prior to placing control systems in permanent operation.

C. Provide basic operator training for four persons as designated by the Owner. Include a minimum of 24 hours dedicated instructor time. Training shall consist of instruction in the operation of the BMS including but not limited to: Logging in and navigation through all parts and pages of the graphical user interface, Sequences of control (viewing, creating and adjusting), Set points (viewing, adjusting), Alarm capabilities and management, Trending capabilities (viewing, creating, editing, reporting, and storing data), Scheduling (viewing, creating, and editing) Troubleshooting communication errors, Troubleshooting hardware errors, other capabilities as designated by the Owner’s Agent.

D. Provide each attendee with a bound set of printed training materials to be used during training and to become property of the Owner.

E. Provide service engineer to instruct Owner's representative in the operation of systems and equipment for a period of three working days.

F. Provide Owner with video recordings on DVD of all training sessions. DVD shall have a sequentially indexed menu for easy, individual access to each session/topic.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Test each point through its full operating range to verify that safety and operating control set points are as required.
   4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   5. Test each system for compliance with sequences of operation.
   6. Test software and hardware interlocks.

B. DDC VERIFICATION:
   1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
   2. Check instruments for proper location and accessibility.
   3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
   4. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
   5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
   6. Check temperature instruments and material and length of sensing elements.
   7. Check control valves. Verify that they are installed in the correct orientation.

8. Check DDC system as follows:
   a. Verify that DDC controller power supply is from emergency power supply, if applicable.
   b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
   c. Verify that spare I/O capacity has been provided.
   d. Verify that DDC controllers are protected from power supply surges.

C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 ADJUSTING

A. Calibrating and Adjusting:
   1. Calibrate instruments.
   2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   4. Control System Inputs and Outputs:
      a. Check analog inputs at 0, 50, and 100 percent of span.
      b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
      c. Check digital inputs using jumper wire.
      d. Check digital outputs using ohmmeter to test for contact making or breaking.
      e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
   5. Flow:
      a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
      b. Manually operate flow switches to verify that they make or break contact.
   6. Pressure:
      a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
      b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
   7. Temperature:
      a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
      b. Calibrate temperature switches to make or break contacts.
   8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
   9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
   10. Provide diagnostic and test instruments for calibration and adjustment of system.
   11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

3.5 DEMONSTRATION

A. Provide systems demonstration under provisions of Division 01.

3.6 INPUT/OUTPUT SCHEDULE

A. Contractor shall provide a complete points list/matrix describing all system inputs, outputs, and functions as necessary to accomplish specified sequences of control.

END OF SECTION 23 09 23

SECTION 23 09 23.1 - ENERGY METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components for the purpose of metering energy.

B. Refer to the Construction Documents for Sequences of Operations for HVAC Controls, for requirements that relate to this Section.

C. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner’s operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to division 1 for detailed commissioning requirements.

1.3 WORK INCLUDED

A. Provide an energy metering system for the entire building. The system shall be connected to the building’s Direct Digital Control (DDC) System.

B. The BAS system must be compatible with the existing campus controls system. Provide metering of primary building utilities which include chilled water, heating hot water, domestic cold water, domestic hot water, steam, irrigation water utilizing a panel separate from the building DDC and electrical metering system and metering software with indication and totalization capabilities

C. The bidding and Contract Requirements and General Requirements apply to this work.

D. Furnish and install all components but not limited to all temperature, pressure, and flow sensors, transmitters, relays, switches, wire, and all metering panels. Also furnish all controls, operators, power supplies, control valves, air and water flow measuring stations, transducers and wiring to connect components. Submit for approval, appropriate product data cut-sheets for all material/components intended for use prior to beginning work. Where BAS is used in specifications and drawings, it is understood to be same as DDC.

E. The Contractor shall provide energy metering panels (separate from building DDC) complete with all microprocessors, software, terminal strips, transducers, relays, and regulated power supply with battery backup.

F.

G. Industrial instrumentation supplied shall be standard catalog products of Rosemount, Honeywell, Bristol, Foxboro, Leeds and Northrup, Taylor or Brown. All coordination and execution of work pertaining to the installation, service, and guarantee, under this Section of the specifications, shall be the sole responsibility of the BAS Contractor.

H. All controls to be installed, calibrated and adjusted by trained instrument technicians in the full-time employ of the BAS Subcontractor & low voltage electrical subcontractor.

I. Submit engineering/wiring drawings and receive approval prior to beginning work. These drawings shall be submitted in a timely manner to provide sufficient time to review drawings so as not to hold up the project.

J. The energy metering panels will be located as shown on the drawings. All meter wiring will be brought back to the metering panel(s). The energy metering panels shall be provided with a UPS to allow operation of the panels during switchover to emergency power. The UPS shall provide a minimum of 500 va, be similar to an Invensys Powerware 120, and be installed in a NEMA 1 hinged, lockable cabinet.

K. Division 26 shall provide power to a duplex receptacle inside each panel. Power shall be provided from a breakered, 20 amp dedicated circuit on emergency power having an insulated ground wire from the power panel ground buss wired to the duplex receptacle.

L. The Metering System will perform all Sequence of Operations as required by the Design Engineer. Furnish and install a network communications between the metering panel and the owners network for utilizing metering data.

M. Remote Notification Paging System:
1. The BAS system shall be configured to send out text messages to numeric pagers, alphanumeric pagers, phones (via text to speech technology), SMS (Simple Messaging Service, text messaging) Devices, and email accounts based on a point's alarm condition. This includes alarms for both the building MEP systems and the laboratory controls alarms as specified in the points list on the mechanical drawings.
2. There shall be no limit to the number of points that can be configured for remote notification of alarm conditions and no limit on the number of remote devices which can receive messages from the system.
3. On a per point basis, system shall be configurable to send messages to an individual or group and shall be configurable to send different messages to different remote devices based on alarm message priority level.
4. Remote devices may be scheduled as to when they receive messages from the system to account for operators' work schedules.
5. System must be configurable to send messages to an escalation list so that if the first device does not respond, the message is sent on to the next device after a configurable time has elapsed.
6. Message detail shall be configurable on a per user basis.
7. During a "flood" of alarms, remote notification messages shall have the ability to optimize several alarms into an individual remote notification message.
8. BAS System/Workstation shall have the ability to send manual messages allowing an operator to type in a message to be sent immediately.
9. BAS System/Workstation shall have a feature to send a heartbeat message to periodically notify users that they have communication with the system.
10. The Contractor shall have a meeting with the owner prior to substantial completion to identify which users shall receive which alarms and what type of alarm they are to receive. All alarms must be programmed prior to substantial completion.

N. Provide graphics for all new work compatible with existing campus front end system.

O. All exposed wiring shall be in conduit (1/2" minimum), as per Division 26 Sections. Concealed wiring shall be plenum rated. All active Ethernet switches, hubs, and routers shall be Contractor-provided and installed. The conduit/wiring system required for the Energy Management System shall be a complete, separate, independent system. Conduit sharing with other unrelated electrical systems is not permitted

P. The metering panel will require sensor wiring from the panel to temperature sensors located in the primary supply and return piping on the Chilled Water, Heating Hot Water, and Domestic Hot Water, to be included as part of the BAS Contractor's responsibilities. Provide all wiring from the flow meters to the metering panel. This metering panel will require a dedicated 110 volt, 20 amp, single phase standby electric circuit source installed by Division 26. This metering panel will require a category 6 Ethernet cable installed by Division 27. A meeting between the owner and the BAS contractor will be held as early as possible, prior to installation, to review the installation and finalize panel and wiring locations. The metering system will require start-up by the metering controls vendor.

Q. The BAS contractor will be responsible for the connection from the Energy Management System to the campus.

1.4 RELATED WORK

A. All work of this Division shall be coordinated and provided by the single Building Automation System (BAS) Contractor (Also known as DDC Contractor).

B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections for details.

C. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

D. If the BAS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

E. Section 01 91 13, Commissioning

1.5 SUBMITTALS

A. General.
1. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance, prior to installation.
2. All product data in the submittal shall reference the paragraph number in the specification for the corresponding equipment.
3. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BAS work.
4. Owner & A/E Submittal Review
   a. Two weeks after submittal has been issued the Contractor, Owner and A/E will have a meeting to review and discuss A/E and Owner's comments. The submittal will be returned approximately one week after the metering meeting.

B. Product Data: For each control device specified.

C. Shop Drawings:
1. Schematic flow diagrams & graphic display.
2. Power, signal, and control wiring diagrams.
3. Details of control panel faces.
4. Metering System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
5. Metering System Software: Schematic diagrams, written descriptions, and points list.
6. Sequences of operation.

7. Software and firmware operational documentation.
8. Samples of Graphic Display screen types and associated menus.
9. Field quality-control test reports.
10. Operation and maintenance data.

1.6 RECORD DOCUMENTATION

A. Operation and Maintenance Manuals:
   1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BAS provided:
      a. Table of contents.
      b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
      c. Manufacturer's product data sheets or catalog pages for all products including software.
      d. Archive copy of all site-specific databases and sequences.
      e. Metering network diagrams.
      f. Interfaces to all third-party products and work by other trades.
   2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.
   3. Submit list of all alarm points indicating alarm, user being alarmed and type of alarm.

1.7 ENERGY MANAGEMENT SYSTEM WIRING

A. All wiring and conduit shall be installed in accordance with related Specification Section Division 26, Electrical.

B. The conduit/wiring system required for the BAS specification Input/Output summary:
   1. Digital Input (D.I.) wiring (Class 2) may be run in a common conduit with Digital Output (D.O.) wiring (Class1) where local codes permit.
   2. Analog Input (A.I.), Analog Output (A.O.), Digital Input (D.I.), and Network Communications Trunk (N.C.T.) wiring may be run in a common conduit.
   3. Digital Output (D.O.) wiring run in a common conduit with Analog Input (A.I.), Analog Output (A.0.), or Network Communications Trunk (N.C.T.) is not permitted under any circumstances.
   4. AC line power to DDC panel shall be #12 THHN.
   5. Digital Output (D.O.) wiring shall be #14 THHN.
   6. Digital Input (D.I.), Analog Input 4-20 mA (A.I.), and Analog Output (A.0.) wiring shall be #20 TSP (twisted shielded stranded pair with drain wire).
   7. Analog Input/Thermistor/or voltage types (A.I.) wiring shall be #20 TSP (twisted shielded stranded pair with drain wire).

C. Field devices requiring a 4-20 mA DC input signal shall be non-ground referenced.

D. All wiring in mechanical rooms, electrical rooms, inaccessible areas, or located in areas exposed to occupant view shall be run in conduit. Plenum rated wiring shall be acceptable for installation in concealed, accessible locations. Conduit fill limit shall not exceed 40% in any portion of the conduit system.

E. In order to facilitate maintenance, where multiple sensors or devices are connected to a common raceway or conduit, each sensor or device shall be individually connected to a common (non-sensor or device) junction box, which shall then be attached to the common conduit. Under no circumstances shall sensor or device wiring or tubing be routed through any other sensor or device's specific enclosure or junction box.

F. All wiring shall be labeled at both ends and at any spliced joint in between. Wire and tubing shall be tagged using a system similar to the Panduit P1 Self Laminating System that utilizes a thermal transfer (or equivalent) printer with a minimum font size of Arial 10. In addition to tagging at field device end and at spliced joints, a tag shall be placed 6 inches after entering each panel. Identification and tag information shall be included in engineering/wiring submittal which must be submitted for Owner approval prior to beginning work. Tag information shall coincide with equipment/point information as written in the specification input/output summary

1.8 SYSTEM VERIFICATION--PROCEDURE TO BE FOLLOWED

A. Provide minimum 2 week written notice for all inspections.

B. Upon completion of all external sensor mounting, terminations, and wiring into and out of the metering panel(s), the Owner shall inspect and approve this work. The BAS Subcontractor shall make his Representative(s) available and coordinate with the Owner during this inspection process. At the successful conclusion of this inspection, contractor shall provide a written report stating all work is complete. BAS Subcontractor, General Contractor and Owner's Rep shall sign. This should be filed with Project Commissioning/ Startup documents.

C. Following completion of the work and the DDC panel and metering Panel tie-in, a performance test shall be conducted by the Owner in the presence of the BAS Contractor and his appropriate Subcontractors.

D. The BAS Contractor shall be present for the testing of proper operation of each and every physical system point to which the Contractor has provided devices, wiring, in order to verify the equipment and installation provided by them (their portion of the work), i.e., when the Owner commands a point, the Contractor verifies in the field that the commanded point operates properly. At the successful conclusion of this inspection, contractor shall provide a written report stating all work is complete, calibrated and functioning properly per the specified sequences of operation. An electronic and paper copy of which will be provided to the owner for signature by the BAS Subcontractor, General Contractor and Owner's Representative. This should be filed with Project Commissioning/Startup documents. A representative of the BAS Contractor that can revise control sequences shall be available on site as necessary to make changes during the system verification.

E. Upon conclusion of final checkout and acceptance, the Contractor's responsibility reverts to warranty of materials and installation herein specified. System shall be warranted for a period of two (2) years.

F. The Contractor shall coordinate and include the Commissioning Agent as required for the above activities. Commissioning agent will coordinate ant witness functional performance test procedures. Refer to 01 91 13 for additional details.

1.9 COORDINATION OF EFFORT

A. It is the responsibility of the Contractor to schedule and coordinate with the installer of all furnished equipment.

B. It is the Contractor's responsibility to schedule the accomplishment of these activities to allow for nominal system checkout, performance tests and balancing within the contract performance period.

1.10 QUALITY ASSURANCE

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

1.11 SYSTEM GRAPHICS

A. Provide a cover page for the project to include graphic links including, but not limited to:
   1. Gas Meters
   2. Electrical Meters
   3. Domestic Water Flow meters
   4. Irrigation Flow Meters
   5. Hydronic Flow meters
   6. Hydronic Temperature sensors
   7. Steam Flow meters
   8. Steam Pressure

B. Other
   1. Refer to construction documents for other systems that require graphics.
   2. Graphics shall include feedback on all devices including actual values.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION

A. The Energy Metering System shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BAS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other Owner provided networks.

B. The Building Metering System shall consist of the following:
   1. Standalone Network Automation Engine(s).
   2. Application Controller
   3. Input/Output Module(s).
   4. Distributed User Interface(s).
   5. Network processing, data storage and communications equipment.
   6. Sensors and meters
   7. Other components required for a complete and working metering system.

C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices.

D. System architectural design shall eliminate dependence upon any single device for control execution:
   1. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
   2. The System shall maintain all settings and overrides through a system reboot.

E. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

F. Acceptable Manufacturers:
   1. Johnson Controls
   2. Siemens Building Technologies
   3. Substitutions under Division 01

G. Integration with Existing Johnson Controls or Siemens BAS:
   1. The BAS Contractor for this new project shall provide the following:
      a. The BAS contractor shall provide all necessary connectivity licenses within the cost of the bid. Licenses shall allow specified BAS point information to be broadcast out of the BAS expansion to the existing Johnson Controls or Siemens BAS.

2.2 ACCEPTABLE CONTRACTORS

A. Mechanical contractor shall not serve as BAS contractor. Acceptable BAS contractors, provided they comply with these specifications, are:
   1. Siemens Building Technologies, Inc. (branch office)
   2. Johnson Controls, Inc. (branch office)
   3. Substitutions under Division 01.

2.3 FIELD DEVICES

A. Temperature Sensors: Platinum Resistance Temperature Detector, 0°F to 400°F range, 100 ohms at 0°C, 316 stainless steel sheath, single element, ¼ inch diameter sheath. For water sensing provide 316 stainless steel thermowells. Use 304 stainless steel extension fitting to extend assemblies through insulating materials. Provide spring-loaded sensors to ensure good surface contact in thermowells. Provide matched sensor/transmitter assemblies, NIST certified to be accurate to within ±0.1 degrees F from 20 degrees F to 70degrees F for chilled water monitoring, accuracy of + / - 0.5 degrees F from 30 degrees F to 250 degrees F for condenser water, hot water, or domestic water monitoring, and accuracy of + / - 0.5 degrees F from 20 degrees F to 120 degrees F for all other temperature monitoring. Install on chilled water lines such that condensation does not collect in connection head. Duct temperature sensors shall be averaging type. Water sensors shall be provided with a separable stainless steel well. Outside air wall mounted sensors shall be provided with a sun shield. Accuracy of transmitter shall be unaffected by wiring distances up to 700 feet. Siemens Building Technologies, Johnson Controls, Minco, or Hy-Cal only. Immersion sensors for piping shall be Dwyer Series TTE explosion-proof RTD temperature transmitter with fully configurable ranges and display options or equal by Rosemount.

B. Water Flow Sensors: Water flow sensors shall be furnished by BAS, Rosemount series 8705 Magnetic flowmeter flow tubes. Each sensor shall be sized specifically for the pipe in which it is to be installed. Sensor shall have ±0.5% accuracy from 1 to 30 feet/second, with Class 150 carbon steel flanges, exterior painted with polyurethane, grounding electrode, Teflon (PTFE) lining, and Type 316L stainless steel electrodes. Contractor shall furnish Rosemount Model 8712 C remote mounted magnetic flowmeter transmitters, with 115Vac/1ph/60hz power supply, NEMA 4X enclosure, 4 – 20 ma output, battery-backup totalizer, and local operator interface.

C. Steam flow mass flow meter: Provide steam flow measuring station, Rosemount series 405 Orifice, or equal by EMCO or ABB. Each sensor shall be sized specifically for the pipe in which it is to be installed. Orifice body shall be single cast Type 316 stainless steel, with 300# flange. Provide Durion 8500 fiber gaskets. ATC shall provide orifice mounted transmitter, 1.5% accurate, with 8:1 turndown, 4-20mA output. Unit shall operate on 4-20mA power supply.

D. Temperature Transmitters: Temperature transmitters shall be designed for 4-20 mA DC output for Platinum RTD millivolt input sensor (as specified above). Accuracy shall be the same as specified for the temperature sensors. Stability shall be ±0.2% of calibrated span for 6 months. Transmitter shall be a part of the temperature sensor assembly and shall be in a moisture-proof housing with a moisture-proof seal between the sensor and transmitter. Immersion sensors for piping shall be Dwyer Series TTE explosion-proof RTD temperature transmitter with fully configurable ranges and display options or equal by Rosemount.

E. Flow Transmitters: Flow transmitters shall provide a 4-20 mA DC signal output proportional to flow. Accuracy of ±0.25% of calibrated span. Temperature Limits: -40°F to +220°F. Stability of ±0.25% of upper range limit for 6 months. Range of transmitter shall match flow conditions. Flow transmitter shall be Rosemont only.

F. Pressure Transmitters: Transmitters for water pressure shall provide a 4-20 mA DC signal output directly proportional to pressure. Device shall be constructed with corrosive resistant stainless steel wetted parts and have a die-cast aluminum enclosure specifically designed for NEMA4/IP65 service. Accuracy of ±0.5% of calibrated span. Span not over 200% of sensed pressure. Stability ±0.5% of upper range limit for 6 months. Stainless steel diaphragm, viton 0-rings. Temperature limits: -20°F to 220°F. Rosemount, Setra, or Bristol, only.

2.4 SUPERVISORY CONTROLLERS

A. The Supervisory Controller shall be a fully user-programmable, supervisory controller. The Supervisory Controller shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Supervisory Controllers.

B. Processor – The supervisory controllers shall be microprocessor-based with a minimum word size of 32 bits. It shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. Supervisory Controller size and capability shall be sufficient to fully meet the requirements of this Specification.

C. Memory – Each Supervisory Controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

D. Hardware Real Time Clock – The Supervisory Controller shall include an integrated, hardware-based, real-time clock.

E. The Supervisory Controller shall include troubleshooting LED indicators to identify the following conditions:
1. Power - On/Off
2. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
3. Ethernet Connection Speed – 10 Mbps/100 Mbps/1000 Mbps
4. FC Bus – Normal Communications/No Field Communications
5. Peer Communication – Data Traffic between Supervisory Control Devices
6. Run –Running/in Startup/Shutting Down/Software Not Running
7. Bat Fault – Battery Defective, Data Protection Battery Not Installed
8. 24 VAC – 24 VAC Present/Loss Of 24VAC
9. Fault – General Fault

F. Communications Ports – The Supervisory Controller shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
1. Minimum (1) USB port
2. Minimum (1) URS-232 serial data communication port
3. Minimum (1) RS-485 port
4. One (1) Ethernet port

2.5 APPLICATION CONTROLLERS

A. Based on the Building Automation System selected for the project, the following products are acceptable. If the project has selected Siemens as the Building Automation System (BAS) then the acceptable application controllers must be the Siemens product, if the project has selected the Johnson Metasys System as the BAS, then the acceptable application controllers must be the Johnson Metasys product. In all cases the acceptable application controllers must use BACnet™ as the native communication protocol between controllers, control panel, and front-end software.

B. Acceptable Products:
1. Siemens Apogee: PXC and programmable TEC line of controllers.
2. Johnson Metasys: Field Equipment Controllers

2.6 GENERAL - APPLICATION CONTROLLERS

A. Definition: An Application Controller, for this specification, could be an AAC (Advanced Application Controller), an ASC (Application Specific Controller), or and Terminal Equipment Controller (TEC). These would be used on Primary Equipment and Terminal Equipment, respectively.

B. Each Application Controller must be capable of standalone direct digital operation utilizing its own processor, non-volatile flash memory, input/output, minimum 8 bit A to D conversion, and include voltage transient and lightning protection devices. Firmware revisions to the module must be able to be made from the local workstation, portable operator terminals or from remote locations over modems or LANs.

C. The Application Controllers for Primary Equipment shall be expandable to the specified I/O point requirements. Each controller shall accommodate multiple I/O Expander Modules via a designated expansion I/O bus port. The controller, in conjunction with the expansion modules, shall act as one application controller.

D. All point data, algorithms and application software within the controllers shall be custom programmable.

E. Each Application Controller shall execute application programs, calculations, and commands via a microcomputer resident in the controller. All operating parameters for application programs residing in each controller shall be stored in read/write-able nonvolatile flash memory within the controller and will be able to upload/download to/from the Operator Workstation.

F. Each Application Controller shall be configured on the workstation/server software as a BACnet™ device. All of the points shall be configured as BACnet objects. Each controller shall include self-test diagnostics which allow the controller to automatically relay to the system supervisory engine(s) any malfunctions or alarm conditions that exceed desired parameters as determined by programming input.

G. Each Application Controller should be capable of scheduling, either by using an on-board real-time clock or by receiving the time from the system supervisory engine(s).

H. Each Application Controller shall contain both software and firmware to perform full DDC PID control loops.

I. Each Application Controller shall contain a port for the interface of maintenance personnel's portable computer. All network interrogation shall be possible through this port.

J. If being installed outdoors, the Application Controllers shall be capable of being mounted directly in or on the equipment located outdoors. The Application Controllers shall be capable of proper operation in an ambient temperature environment of -20 degrees F to + 150 degrees F.

K. Input-Output Processing:
   1. Digital outputs shall be relays or triacs, 24VAC or VDC minimum. Each output shall be configurable as normally open or normally closed.
   2. Universal inputs shall be capable of, 0-20mA, dry contact, and 0-5VDC, 2-10VDC or 0-10VDC.
   3. Analog output shall be electronic, voltage mode 0-10VDC, 2-10VDC or current mode 4-20mA.
   4. Enhanced Zone Sensor Input shall provide one thermistor input, one local set point adjustment, one timed local override switch, and an occupancy indicator.
   5. All programming sequences shall be stored in non-volatile memory. All programming tools shall be provided as part of the system. Provide documentation of all programming including configuration files.

L. Each Application Controller shall execute application programs, calculations, and commands via a microcomputer resident in the Application Controller. All operating parameters for application programs residing in each Application Controller shall be stored in read/write-able nonvolatile flash memory within the controller. Firmware revisions, application programs and program modifications to the controller shall be capable of being performed over the Wide Area Network (WAN).

M. Each Application Controller shall be able to support various types of zone temperature sensors, such as temperature sensor only, temperature sensor with built-in local override switch, with set point adjustment switch.

N. Each Application Controller for VAV application shall have a built-in air flow transducer for accurate air flow measurement in order to provide the Pressure Independent VAV operation.

O. Each Application Controller for VAV applications shall have an integral direct coupled electronic actuator. If the actuator is not integral to the controller, the controller/actuator assembly shall be factory tested and approved for the intended use. The actuator shall provide on-off/floating point control with a minimum of 35 in-lb of torque. The assembly shall mount directly to the damper operating shaft with a universal V-Bolt clamp assembly. The actuator shall not require any limit switches, and shall be electronically protected against overload. When reaching the damper or actuator end position, the actuator shall automatically stop. The gears shall be manually disengaged with a button on the assembly cover. The position of the actuator shall be indicated by a visual pointer. The assembly shall have an anti-rotational strap.

P. Each Application Controller shall have LED indication for visual status of communication and power.

Q. Astronomical Time: Astronomic capability shall allow the system to calculate sunrise and sunset times based on geographical location, and incorporate Daylight Savings Time, for dusk-to-dawn control or dusk-to-time control. This is required in any Application Controller with I/O for the Exterior lighting circuit(s). The Application Controller may receive this value from the Global Building Controller and fail to a “safe” position (ie., lights fail on) upon a loss of communication from the Global Building Controller.

R. In the event of a loss of communication, the Application Controller shall control from a standalone algorithm which maintains the assigned space temperature until communication is restored.

S. UPS: Uninterruptible Power Supply(s) is(are) required for any Application Controller (on primary or terminal equipment) that monitors or serves emergency and/or critical equipment, locations or points.

T. All Application Controller level objects shall be exposed as BACnet Objects.

U. Primary Equipment shall be controlled using one Application Controller when possible. A single controller with adequate Input/Output and resource capacity shall be used for a single piece of equipment as opposed to using two or more smaller controllers to house the programs for one piece of equipment.

V. Each Application Controller for Primary Equipment shall contain the following as Spare I/O:
1. Minimum of: (3) Spare Universal Inputs (or 2-DIs and 1-AI), (1) Spare AO, and (2) Spare DOs.
2. In addition to the Minimum, the Application Controller shall have 10% Spare I/O, of each type; UI (or DI and AI), AO and DO.

PART 3 - EXECUTION

3.1 GENERAL

A. All metering panels shall be connected to emergency power system.

3.2 LAMINATED SEQUENCE OF OPERATION

A. For each metering device provide a laminated sequence of operation, including control schematic, to be mounted on the wall in the mechanical rooms or at location as indicated by Owner.

3.3 INPUT/OUTPUT SUMMARY

A. The I/O Summary on the drawings is provided as a list of the minimum points required by this contract for connection to the Energy Automation system. Furnish all devices, wiring, tubing, etc., necessary to serve and transmit to the DDC panels. Any points not shown on the I/O Summary yet required to accomplish the sequence of operation shall be provided under this contract at no additional cost to the Owner.

3.4 INSTALLATION

A. Verify location of exposed control sensors with Drawings and room details before installation.

B. Contractor shall install labels and nameplates to identify control components according to Section 23 05 53, Identification for HVAC Piping and Equipment.

C. Contractor shall install hydronic instrument wells, valves, and other accessories according to Section 23 21 13, Hydronic Piping.

D. Install electronic and fiber-optic cables as applicable according to Division 27.

3.5 FIELD QUALITY CONTROL

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

B. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
3. Test each point through its full operating range to verify sensor capability.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.

C. Sensor Verification:
1. Verify that instruments are installed before calibration or testing.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check for proper lengths of straight run up and downstream of meters.
5. Check instrument tubing for proper fittings, slope, material, and support.
6. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
7. Check temperature instruments and material and length of sensing elements.
8. Check metering system as follows:
    a. Verify that metering controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that metering controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain energy metering instrumentation and controls. Refer to Division 01 Section, Demonstration and Training.

B. Training of the Owner’s operation and maintenance personnel is required in cooperation with the Owner's Representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 01 91 13, General Commissioning, for contractor training requirements.

END OF SECTION 23 09 23.1

SECTION 23 20 00 - HVAC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. This Section provides furnishing and installing the following hydronic pumps:
   1. Base mounted horizontal split case pumps

1.3 RELATED WORK

A. Section 23 00 00, Mechanical General Provisions.

B. Section 23 05 13, Common Motor Requirements for HVAC Equipment.

C. Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment.

D. Section 23 05 53, Identification for HVAC Piping and Equipment.

E. Section 23 07 16, Equipment Insulation.

F. Section 23 21 16, Hydronic Specialties.

G. Section 23 21 00, Hydronic Piping and Fittings.

H. Section 26 29 23, Variable Frequency Drives.

1.4 REFERENCES

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

1.5 PUMP SELECTION REQUIREMENTS

A. Select pumps conservatively for scheduled conditions. Furnish pumps which have reasonably high efficiencies, with peak efficiency at or near rated conditions. Select pumps that will operate stably at 15-foot suction lift despite substantial reduction in head or substantial increase in delivery.

B. Provide motor-driven pumps of the type and speed scheduled. Select pumps that are not overloaded throughout the entire range of pump operation. Provide pump connection sizes as scheduled.

C. If the pumps proposed are not considered suitable, submit manufacturer's data on other pumps, for review.

D. Unless otherwise indicated the maximum pump selections shall be limited to 60 HZ.

1.6 SUBMITTALS

A. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Clearly indicate which equipment and options are to be provided

B. Indicate pump's operating point on curves. Include NPSH curve when applicable.

C. Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

D. Submit information on electric motors per requirements and indicating compliance with Section 23 05 13. Motor data must be submitted with pump submittal. No exceptions.

E. Submit manufacturer’s installation instructions under provisions of Section 23 00 10.

F. Provide a letter of certification from pump manufacturer that unit was manufactured and factory assembled by pump manufacturer.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 10.

B. Include installation instructions, assembly views, lubrication instructions and replacement parts list.

C. Include copy of approved submittal, vibration test results and certified pump curve with final balancing point indicated.

D. Include letter of certification stating that pump was factory assembled by pump manufacturer.

1.8 EXTRA PARTS

A. Provide one extra set of mechanical seals for each pump.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products meeting all requirements of this specification section of the following manufacturers are acceptable
   1. Armstrong Pumps
   2. Aurora
   3. Bell & Gossett
   4. Patterson Pumps
   5. Taco
   6. Grundfos/Paco

2.2 BASE MOUNTED HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS

A. General. Provide factory assembled and tested base mounted, single stage double suction split-case pump with double-volute design to allow servicing of impeller and bearing assembly without disturbing piping connections. Pumps shall be rated for a minimum of 175-psi working pressure.

B. Casing. Casing shall be cast iron with suction and discharge flanges and mounting feet cast integral with the lower half casing. Provide tapped openings for vent and drain, and gauge tappings at the suction and discharge nozzles, all equipped with petcocks. Flanges shall be of [125][250] ANSI Standard. Suction and Discharge shall be on a common centerline in both the horizontal and vertical planes. Casing for pumps 3 inches x 4 inches and larger must accommodate an impeller 5 percent greater in diameter than the impeller actually selected to meet specified performance. Upper half of casing shall be designed to provide for complete removal of bearing, seals and impeller without disturbing connection piping. Upper casing shall be dowel aligned to the lower casing.

C. Impellers. Furnish an enclosed, cast bronze impeller, keyed and locked to the shaft, statically and hydraulically balanced.

D. Wearing Rings. Provide bronze, renewable wearing rings on all pumps 1-1/2 inches and larger. Casing Rings shall be installed with an anti-rotation device.

E. Shaft. Furnish a stainless steel shaft, turned and ground to accurate dimension, of ample size to prevent deflection and key slotted as required.

F. Bearings. Provide antifriction type bearings, grease lubricated, with lubrication fittings, having a 250,000 hour life (AFBMA B_{10}) under maximum condition of load. Bearings shall be protected by separate oil seals and shall be replaceable without disturbing the system piping and regreaseable with removal of the bearings from the bearing housing.

G. Base Plate. Mount the pump assembly and motor on common base plate constructed of structural steel or fabricated steel channel with fully enclosed sides and ends, and securely welded cross members. Base plate shall ensure rigid and true alignment of pump and motor shafts. Grouting area shall be fully opened. As an option, the pump may be install on C-Channel steel base with the open ends temporarily closed for grouting. The base plate shall include a built-in drain pan with tapped drain opening. For chilled water pumps, extend steel base to receive all drip from suction and discharge flanges.

H. Mechanical Seals. The liquid cavity shall be sealed off at the pump shaft by an internally or externally flushed mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225°F. A replaceable bronze shaft sleeve shall completely cover the wetted area under the seal. Seal boxes shall be equipped with heavy, cast, one-piece, O-ring sealed glands.

I. Couplings. Provide a flexible mechanical coupling rated for the full rated horsepower of the driving motor at motor speed, capable of absorbing torsional vibration. Coupling shall be shielded by an OSHA approved metal or HDPE coupler guard securely fastened to the base. Coupling shall be manufactured by Wood, Sure Flex or equal.

J. Name Plates. Nameplates and other data plates shall be stainless steel, suitably secured to the pump. Provide one spare stainless steel performance nameplate with each pump that is insulated and field install on pump base.

K. Test run VFD pumps with motor at all speeds prior to shipping to ensure that pump assembly will not experience unacceptable levels of vibration during operation.

2.3 MOTORS

A. Motors for base mounted pumps shall be mounted with pump on baseplate at pump manufacturer's plant and shipped as one unit.

B. Pump and motor shall be factory aligned, and shall be realigned by the Contractor after installation.

C. Motors shall be 1800 rpm except as otherwise scheduled ODP (for indoor application). Equipment manufacturers shall certify in the submittal data that the motors furnished with the pumps are compatible with the variable frequency drives (include manufacturer and Model number) to be installed on this project. If motors are incompatible with VFDs, pump manufacturer shall provide and install new motors at no change in contract price. Refer to Section 23 05 13 for additional motor requirements. Provide Aegis shaft grounding ring for pumps driven by VFDs where required in Specification 23 05 13.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install according to manufacturer's printed recommendations and pipe as shown on drawings. Install pumps with access (minimum 2'-6") for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. The Contractor shall level each pump and grout each pump base.

D. Route drain from drip pan to nearest floor drain.

E. Stored pumps shall have shafts rotated at least once a month.

F. Name Plates: Install spare nameplate as required in Part 2 of this Specification.

3.2 ALIGNMENT

A. Lubricate pumps prior to start-up. Provide manufacturer's factory representative certification for alignment of the pumps. Factory technician shall inspect pump installation after grouting is complete and certify pump alignment is in accordance with manufacturer's instructions and that the installations comply with the manufacturer's warranty requirements.

B. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

C. Comply with pump and coupling manufacturers' written instructions.

D. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.3 CONNECTIONS

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

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

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install strainer, check valve, isolation valves, pipe supports and other devices as shown on the detail.

F. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

G. Connect wiring according to Section 26 05 19, Insulated Conductors.

3.4 VIBRATION TESTING

A. 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 the Owner and include report in the O&M Manual

END OF SECTION 23 20 00

SECTION 23 21 00 - HYDRONIC PIPING AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Condensate-drain piping.
   4. Safety-valve-inlet and -outlet piping.

B. Related Specifications
   1. Section 23 05 19, Meters and Gauges, for HVAC Piping.
   2. Section 23 05 23, General Duty Valves for HVAC Piping
   3. Section 23 20 00, Hydronic Pumps
   4. Section 23 05 29, Hangers and Supports
   5. Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment
   6. Section 23 21 16, Hydronic Specialties

1.3 SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe
   2. Fittings and accessories

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Cleaning/Flushing Plan: This must be submitted and approved prior to any piping being installed. Plan, including all steps to be taken to ensure the piping installation will be cleaned properly prior to: service, circulation through equipment, or connection to another system. This shall include, but not be limited to:
   1. A step by step explication of the process.
   2. Drawing(s) indicating flow (gpm) values required to meet the minimum velocity in each pipe.
   3. Drawing(s) indicating the phase(s) in which the system will be cleaned as required to ensure the minimum velocity will be maintained in each section of piping. It is expected that multiple phases will be required to achieve the minimum velocities in all of the piping safely.
   4. Drawing(s) indicating locations of the required temporary connections, valves, strainers, and bypasses.
   5. Cutsheet of the temporary pump to be used during flushing.
   6. Water treatment and pipe cleaning chemicals.

D. Field quality-control test reports.

E. Submit certification of welder's qualifications to perform the required welding operations.

F. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

B. Provide domestic manufactured piping and fittings.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect piping, valves, fittings, etc. before installation in accordance with manufacturer's written instructions.

B. Piping shall be shipped from the factory with capped ends and stored on supports off the ground with ends covered at all times to prevent nesting of insects, birds, and other animals. Any pipe found to be without end-caps or not raised off of the ground should be cleaned by the contractor prior to installation.

C. Protect piping from accumulation of dirt and debris in and around piping/components.

1.6 OPERATION AND MAINTENANCE DATA

A. Operation and maintenance manuals shall include the following information:
1. The approved submittal with all approved items present (not a partial resubmittal)
2. Chemicals used in cleaning, flushing, inhibiting, and final water treatment.
3. Water quality test reports from the cleaning process.

PART 2 - PRODUCTS

2.1 STEEL PIPING AND FITTINGS

A. 2 inches and less in diameter. ASTM A 53, Grade B, standard-weight seamless or electric-resistance welded black steel pipe with standard-weight malleable iron threaded fittings, satisfying ASTM B16.3 and ASTM A 197

B. 2-1/2 inches to 10 inches in diameter. ASTM A 53, Grade B, standard-weight seamless or electric-resistance welded black steel pipe with standard-weight seamless steel welded fittings, satisfying ASTM A 234, Grade WPA or WPB, ANSI B16.9.

C. For pipe 12 inches and larger in diameter, provide standard-weight pipe meeting the requirements of ASTM A53 or A106 Grade B seamless or ERW black steel pipe with standard-weight seamless black steel welding fittings satisfying ASTM A 234 grade WPA or WPB, ANSI B16.9.
1. For piping over 24 inches at the contractors option provide standard-weight ASTM 139 Spiral Weld black steel pipe with standard-weight seamless steel welded fittings, satisfying ASTM A 234, Grade WPA or WPB, ANSI B16.9.

2.2 COPPER PIPING AND FITTINGS

A. ASTM B88, hard drawn Type L seamless copper tube with wrought copper fittings, ASTM B16.22.

2.3 JOINTS

A. Screwed (Steel Piping, 2" and smaller):
1. Make screwed joints using machine-cut ANSI taper pipe threads.
2. Apply suitable joint compound, such as Teflon tape to the male threads only.
3. Ream pipe to full inside diameter after cutting. All-thread nipples are not permitted.

B. Dissimilar Metals: Make joints between copper and steel pipe and equipment along with steel pipe and ductile iron pipe using insulating unions.
1. Provide insulating unions as manufactured by Crane, EPCO Sales, Inc. or approved equivalent.

C. Solder Joints (Copper Piping):
1. Prior to making joints, cut pipe square and ream to full diameter. Clean exterior of pipe and socket. Apply thin coat of suitable fluxing compound to both pipe and socket, and fit parts together immediately.
2. Heat assembled joint only as required to cause the solder to flow. Run the joint full, slightly beaded on the outside, and wipe to remove excess solder.
3. Utilize lead free solder. Use silver brazing alloy or Sil-Fos on refrigerant piping and on underground piping.

D. Welded (Steel Piping, 2-1/2" and larger):
1. Make welded joints as recommended by the standards of the American Welding Society.
2. Ensure complete penetration of deposited metal with base metal.
3. Provide filler metal suitable for use with base metal.
4. Keep inside of fittings free from globules of weld metal.
5. Do not use mitered joints.
6. Use standard weld elbow fittings for changes of direction or cut a standard elbow for odd angles.

E. Flanged:
1. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Align bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64 inch per foot inclination of the flange face from true alignment.
2. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Otherwise, use raised-face flanges.
3. Install proper gaskets, suitable for intended service and factory cut to proper dimensions. Red rubber gaskets are not acceptable. Garlock gaskets or EPDM shall be used. Apply non-stick clean surface lubricant coating to both sides of gaskets.
4. Use ANSI nuts and bolts, galvanized or black to match flange material. Use galvanized steel nuts and bolts underground, coated with tow coats of coal tar enamel. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets. Use anti-seize compound on all bolts above and below grade. Bolt threads not to protrude more than 2 threads past nut.
5. Use carbon steel flanges conforming to ANSI B16.5 with materials conforming to ASTM A 105, Grade II or ASTM A 108, Grade II. Use welding neck type flanges at all fittings and on all pipe.
6. Flanges for ductile iron pipe are specified in sections using that pipe.
7. Keep flange covers on equipment and shop-fabricated piping until ready to install in system.

2.4 [GROOVED FITTINGS

A. Acceptable Manufacturers: Victaulic Company of America

B. Where allowed in application table in Part 3 of this specification, Victaulic press type fittings are allowed for piping 2 inches and smaller.

C. Where allowed in application table in Part 3 of this specification, Victaulic grooved mechanical couplings are allowed for piping 2-1/2 inches and larger.

D. Press Type Fittings:
1. At Contractors option, ½" through 2" ASTM A312, Type 304/304L, Sch. 10S, pipe, dimensions conforming to ANSI/ASME B36.19M-1985.for chilled and heating hot water systems as indicated in the application table in Part 3.
2. Vic-Press 304™: ASTM A-312 stainless steel housings with ASTM A-276 and A-312 outlets and austenitic stainless steel plain or grooved ends, type 304, complete with synthetic rubber Grade "E" EPDM for applicable services to +250 Deg F. System shall be rated to 500 psi unless noted otherwise.
a. Flange Adapters: ANSI Class 150 flange adapter, Van Stone type with stainless steel back-up flange and Vic-Press™ ends. Rated for services to 275 psi. Victaulic Style P565.
1) Unions: Threaded union, 304/304L stainless steel, with Vic-Press™ ends. Victaulic Style P584.

E. Grooved Mechanical Couplings:
1. At Contractors option, roll or cut groove couplings, pipe, and fittings may be used in lieu of weld, flange or screwed joints for chill water, hot water and condenser water systems where indicated in the application table in Part 3.
2. All grooved end fittings shall be domestic made ductile iron conforming to ASTM A536; wrought steel conforming to ASTM A234. Grooved ends shall conform with AWWA C606. Adjoining couplings shall consist of two ductile iron housing segments, pressure-responsive gasket, and zinc-electroplated steel bolts and nuts. Factory-fabricated fittings from steel pipe are not allowed. Branch connections must meet the requirements of steel piping called out in this specification, regardless if it is factory-fabricated or field-fabricated.
a. 2" through 12": Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket rated to +250 deg F
1) Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style 107.
2) Flexible Type: For use in locations where vibration attenuation and stress relief are required. Three flexible couplings may be used in lieu of a flexible connector. The couplings shall be placed in close proximity to the source of the vibration. Victaulic Installation-Ready Style 177. Where Style 177 is not available in the pipe size required, use a Style 77 coupling.
b. 14" through 60": Victaulic AGS series with lead-in chamfer on housing key and wide width FlushSeal® gasket.
1) Rigid Type: Housing key shall fill the wedge shaped AGS groove and provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style W07.
2) Flexible Type: Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement. Victaulic Style W77.
c. Flange Adapter: Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 741 / W741.
3. In applicable locations and applications, Use Victaulic 177 flexible type couplings on expansion loops in accordance with the latest Victaulic recommendations for expansion compensation.

F. Unions are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as unions and disconnect points.)]

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8 inch maximum thickness unless thickness or specific material is indicated.
a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

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

D. Gasket Material: Thickness, material, and type suitable for fluid to be handled, and working temperatures and pressures.

2.6 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Unions(for connecting to equipment where OEM connection provided is plastic):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Charlotte Pipe and Foundry Company.
b. IPEX Inc.
c. KBi.
d. NIBCO INC.
2. MSS SP-107, CPVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

2.7 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Hart Industries International, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180°F.

D. Dielectric Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Calpico, Inc.
b. Lochinvar Corporation.
2. Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225°F.

2.8 UNIONS

A. Use 150-pound standard (300-pound WOG) malleable iron, ground joint unions with bronze seat. Provide flanged union joints on piping larger than 2-1/2 inches.

2.9 BRANCH CONNECTIONS

A. For Pipe 2 inches and smaller, use threaded fittings for steel pipe. For threaded piping, use straight size of reducing tee.

B. For 2-1/2 Inches through 20 inches. For welded piping, when branch size is the same as and one size smaller than header size, use welding tee. Use Weldolet when branch is two or more sizes smaller than header. For threaded branch connections, use thread-o-let welded to header.

C. For piping 20 inches and larger. Provide welding tee for branch connections half the size of the main or larger. For branches smaller than half the size of the header size, use Weld-O-Let or Thread-O-Let fittings.

2.10 GASKETS

A. Provide gaskets between flanges of all flanged joints. Inside diameter of gaskets shall conform to nominal pipe size. Gaskets shall be ring type between raised face flanges and full face between flat face flanges with punched bolt holes and pipe opening.

B. Gaskets shall be cut from 1/8 inch thick non-metallic, non-asbestos gasket material suitable for operating temperatures from -150°F to +750°F. Garlock or equal. For pipe smaller than 6 inches, use 1/16 inch thick gasket.

2.11 FLOOR AND CEILING PLATES

A. Provide chrome-plated floor and ceiling plates around pipes exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Size plates to fit pipe or insulation and securely lock in place.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

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

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

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

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

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

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the top of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

N. Install valves according to the appropriate section.

O. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

P. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

Q. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

R. Identify piping as specified in the above referenced specification section.

S. Support piping adequately to maintain line and grade, with due provision for expansion and contraction.

T. Use only long radius elbows on steel and copper piping unless a short radius elbow is specifically shown on the drawings.

U. Slope condensate drain piping at a minimum 1/8 inch per foot in the direction of flow.

3.2 WELDING

A. Weld and fabricate piping in accordance with ANSI Standard B31.9, latest edition, Code for Pressure Piping. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.

B. 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.

C. 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.

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

E. Remove dirt, scale and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.

3.3 OFFSETS AND FITTINGS

A. Because of the small scale of drawings, the indication of all offsets and fittings is not possible. Carefully investigate the structural and finish conditions affecting the work and take such steps as may be required to meet such conditions.

B. Install all piping close to walls, ceilings and columns so piping will occupy the minimum space. Provide proper space for covering and removal of pipe, special clearances, and for offsets and fittings.

C. Install piping as to not obstruct any equipment or architectural access doors.

3.4 ISOLATION VALVES

A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections at each floor and at branch takeoffs serving equipment, and at other locations as indicated and required for isolation of piping or equipment.

B. At air handling units, where multicoil (stacked) arrangement is used, provide each supply and return line to and from each stacked coil section with a union, pressure gauge and thermometer well and a balancing valve (with memory stop) for balancing, and valves for isolation of each coil. Refer to mechanical details for additional requirements.

3.5 DRAIN VALVES AND VENTS

A. Install drain valves at all low points and at base of all risers of water piping systems so that these systems can be entirely drained.

B. Install 2 inch drain for 2 -inch pipes and larger.

C. Install a line size drain valve for pipes smaller than 2 inches.

D. Provide hose adapter and cap on all drain lines.

E. Provide automatic vents with isolation valves or manual vents at locations as indicated on Drawings and all high points in piping systems.

3.6 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

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

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

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

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to the above referenced specification section. Refer to drawings for additional requirements.

3.8 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

A. Provide service connections to items of equipment furnished by others:
   1. Detailed shop drawings of equipment shall be furnished indicated the exact number and location of rough-in points.
   2. Such final shop drawings may indicate adjustments in total number and exact location of rough-in points, and in equipment dimensions.
   3. Making adjustments to field conditions is considered a part of the work required.

B. Roughing-In:
   1. When roughing-in, extend service piping to various items of equipment.
   2. Temporarily terminate at proper points as indicated on detailed equipment shop drawings or as directed.
   3. Do not use contract drawings accompanying specifications for rough-in locations but for pipe sizing and general routing.

C. Stop Valves:
   1. Provide stop valves for each service at rough-in locations, except for drains.
   2. Stop valve locations are subject to approval, and in all cases must be accessible from the same room in which the furniture or equipment is located.

3.9 CLEANING OF PIPING SYSTEMS

A. Cleaning of piping system must be performed by the mechanical contractor. Cleaning chemicals, procedure, water testing, reporting, and consultation must be provided by a qualified water treatment company specializing in this type of work. Qualified water treatment vendor will have the following features.
   Operating in the business of industrial water treatment for minimum 5 years.
   1. Certified to the ISO 9000 quality standard.
   2. Manufacture and deliver their own products.
   3. Provide technical specialist(s) for onsite water testing, reporting, and consultation.
   4. Have the ability to perform offsite analytical laboratory work and reporting if necessary.

B. Acceptable vendors should include, but not be limited to the following companies:
   1. ChemCal, Inc.
   2. GE Water & Process Technologies
   3. Nalco Company

C. Minimum velocity of 10 feet per second for steel piping must be maintained in the pipes during flushing period.
   1. Do not use building pumps for circulating water.
   2. Provide temporary pumps as required to achieve minimum velocities.
   3. Remove flow meters from building piping during flushing operation.
   4. Provide means (instrumentation) during flushing period to prove to the Owner that the minimum velocities are maintained in the pipes.
   5. For copper piping, maintain the flushing velocity between 3 (min) and 5 (max) feet per second. Limit temperature of water inside piping to a maximum 140°F.

D. Submit a detailed plan for the Engineer’s and Owner's review and approval describing in full detail the individual steps associated with this process before any piping is installed.
   1. Refer to Submittal section above for further requirements.

E. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the systems in service. Provide temporary connections and valves as required for cleaning, purging and circulating. Provide temporary relief valves to protect the piping system if recommended by the pipe cleaning subcontractor.

F. Install temporary strainers in front of pumps, tanks, water still, solenoid valves, control valves, and other equipment where permanent strainers are not indicated. Keep these strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blowoff valve.

G. Provide bypasses at the following equipment as close as feasibly possible to the equipment (no more than 10 feet total of piping at each piece of equipment) and isolate equipment as required (temporary blind flanges or similar):
1. Hydronic coils
2. Chillers
3. Cooling Towers
4. Water Boilers

H. Chemicals shall remove mill scale, oil, and greases as well as passivate surfaces with a protective oxide film. NOTE: All residuals of the cleaning and passivating chemicals must be totally blown-down prior to system startup.
1. Alkaline cleaner/penetrant/dispersant chemical. This product must be in liquid form and capable of removing mill scale, oils, greases, debris, and byproducts of construction. It shall be fed at the vendor's recommended dosage rate based on the volumes of the systems treated.
2. Passivating chemical. This product must be in liquid poly-phosphate form and capable of laying down a protective oxide film on metal surfaces after treatment with the cleaning chemical. It shall be fed at the vendor's recommended dosage rate based on the volumes of the systems treated.
3. Antifoam chemical. This product must be in liquid form and capable of controlling or eliminating foam in water systems.

I. Chemical for inhibiting and controlling corrosion and deposits must be added immediately after the chemical cleaning and passivating procedure.
1. Closed loop corrosion inhibitor chemical. This product must be in liquid form and impart the following active ingredients at the following dosages when fed in the Chilled Water Loop water: 1) nitrite (as NO2) = 400-800 ppm, 2) borate = 200-400 ppm, 3) azole = 20-60 ppm. This product must impart the following active ingredients at the following dosages when fed in Heating Hot Water Loop water: 1) nitrite (as NO2) = 800-1200 ppm, 2) borate = 400-600 ppm, 3) azole = 40-80 ppm.

J. Circulate chemical cleaner and passivator in closed loop water piping systems to remove mill scale, grease, oil, and silt.
1. Flush and drain loops to remove debris prior to using chemicals.
2. Fill loops and add chemical cleaner and passivator at the dosage rates recommended by the water treatment vendor based on system volume.
3. Add antifoam at the dosage rates recommended by the water treatment vendor.
4. Circulate water for 24-72 hours.
5. Drain and flush system.
6. Dispose of circulated water with chemical residuals as per local code requirements.
7. Refill and immediately charge with the proper corrosion inhibitor – based on the type of piping system – to the recommended level.
8. Match chemicals presently used in other systems used by Owner if possible.
9. Submit all chemicals to Owner and Engineer prior to cleaning for approval.
10. Match chemicals presently used in other systems used by Owner.
11. Provide report comparing make-up water quality to the water circulated in the pipe after cleaning chemicals are removed. Report shall include the following at a minimum:
    a. Conductivity
    b. Ph
    c. phosphate
    d. Iron

K. Special requirements, if any, are specified in the appropriate Sections for each type of piping.

L. After systems have been flushed and cleaned; as required by specifications, provide written certification from the cleaning contractor that the systems are clean and ready for use. This shall include the water quality report comparing the make-up water to the water circulated in the piping after removal of chemicals to verify pipe condition.

3.10 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure, minimum 150 psig. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:
1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.11 PIPING APPLICATION SCHEDULE

A. Provide piping and fittings meeting the requirements of Part 2 as identified in the table below:

Service	Pipe Sizes	Pipe Material
Chilled Water Piping	2” and smaller	Copper [Steel]
Chilled Water Piping	2-1/2” and larger	Steel

Service	Pipe Sizes	Pipe Material
Heating Hot Water Piping	2” and smaller	Copper [Steel]
Heating Hot Water Piping	2-1/2” and larger	Steel
Condensate Piping	All	Copper, Galvanized Steel
Condenser Water Piping	All	Steel
Makeup-Water Piping	All	Copper, Steel
Blowdown-Drain Piping	All	Steel
Air-vent Piping	All	Copper, Steel
Safety-valve inlet and outlet piping	All	Same as for piping system for which it is installed

END OF SECTION 23 21 00

SECTION 23 21 16 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. This Section includes hydronic specialties, including the following:
   1. Air Vents.
   2. Air/Dirt Separator
   3. Expansion Tank
   4. Shot Feeder/Filter
   5. Pressure Reducing Valve

B. Related Specifications
   1. Section 23 05 19, Meters and Gages for HVAC Piping
   2. Section 23 21 00, Hydronic Piping and Fittings.

1.3 SUBMITTALS

A. Product Data:
   1. Submit Shop Drawings and product data, including component sizes, rough-in requirements, service sizes, and finishes.
   2. Submit manufacturer's installation instructions

1.4 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by the same manufacturer throughout

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment, etc. before installation in accordance with manufacturer’s written instructions.

1.6 OPERATION AND MAINTENANCE DATA

A. Operation and maintenance manuals shall include the following information:
   1. The approved submittal with all approved items present (not a partial resubmittal)
   2. Shot Feeder/Filter. Include instructions and assembly views for installation of new filter media. Provide minimum two spare sets of filter media for each shot feeder/filter at completion of project (not including the one installed at substantial completion).

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.2 MANUFACTURERS

A. Expansion Tanks: Bell & Gossett, Taco, C. Adamson, Woods.

B. Automatic Air Vents: Armstrong, APCO, Bell & Gossett,

C. Air/Dirt Separators: Spirotherm, Thrush

D. Water Relief Valves: Keckley, Watts, Bell & Gossett

E. Shot Feeder/Filter: Harmsco, Wingert, Neptune

F. Water Pressure Reducing Valve: Taco, Watts, Zurn

2.3 EXPANSION TANKS (BLADDER TYPE):

A. Construction: Provide captive air expansion tank with a replaceable bladder, flanged connections to replace bladder, steel skirt for vertical mounting, rated at 150 psi working pressure and constructed per ASME Section VIII. Bladder shall be able to accept the full volume of the expansion tank and shall be removable and replaceable.

B. Provide gate valve and pressure gage at remote air connection coupling to register air pressure inside bladder chamber.

C. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow preventer, test cocks, strainer, vacuum breaker, and valve by-pass.

2.4 AUTOMATIC AIR VENTS

A. Furnish and install cast iron body fixed pivot ball automatic float-type air vents at high points of all hydronic systems and where shown on drawings. Vent body shall be cast iron, with stainless steel float, and stainless steel seat, valve and lever. Vent shall be rated for a minimum of 125 psi, 250 degrees F.

2.5 AIR/DIRT SEPARATORS

A. Furnish and install as shown on the drawings and schedule a full flow coalescing type combination air eliminator and dirt separator, with two equal chambers above and below the inlet/outlet nozzles.

B. Each separator unit shall be fabricated steel rated for 150 psig design pressure and 270 Deg. F. operating temperature. The separator shall provide non-turbulent non-centrifugal flow thru the unit at rated GPM with less than 1 foot of water pressure drop with a velocity not to exceed 4 feet per second through the unit at the specified GPM and CV rating.

C. The air/dirt separator shall remove 100% free air, 100% entrained air, and 99.6% dissolved air at rated GPM. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes.

D. Unit shall include internal elements for removal of air and dirt. The elements must consist of a copper core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed.

E. Each unit is to have a separate air and venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral float actuated air vent that is guaranteed not to leak. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

F. The air vent shall have a 2” npt connection for testing and remote venting. Contractor shall pipe to nearest floor drain.

G. Separators to be provided with flanged port on bottom of unit to allow removal of internal components.

2.6 WATER RELIEF VALVES

A. Pressure relief valves installed for the protection of the water circulating circuits shall be single seated diaphragm and spring type valve with screwed connections, similar to Watts No. 174A.

B. 3/4 inch size of bronze construction with bronze seat, composition shut-off disc, and rubber diaphragm.

2.7 PRESSURE REDUCING VALVE

A. 10 – 30 psig: Provide a Pressure Reducing Valve with integral strainer shall be installed where indicated on the drawings. The valve shall feature a Lead Free cast copper silicon alloy body suitable for water supply pressures up to 200psi and may be adjusted from 10 – 30 psig. All parts shall be serviceable without removing the valve from the line. Provide threaded inlet connection, integral stainless steel strainer, stainless steel seat, reinforced EPDM diaphragm and EPDM valve disc.

B. 25 – 75 psig: Provide a Pressure Reducing Valve with integral strainer shall be installed where indicated on the drawings. The valve shall feature a Lead Free brass body suitable for water supply pressures up to 300psi and may be adjusted from 25 – 75 psig. Provision shall be made to permit the bypass flow of water back through the valve into the main when pressures, due to thermal expansion on the outlet side of the valve, exceed the pressure in the main supply. All parts shall be serviceable without removing the valve from the line. Provide union inlet connection, integral stainless steel strainer, gauge tapping and gauge and replaceable seat module.

2.8 SHOT FEEDER/FILTER

A. Provide shot feeder where indicated on drawings and scheduled.

B. Filter Housing. Shall consist of continuous electric welded tube body, code semi-elliptical heads, sealed filter chamber, filter, filter support device and inlet/outlet/drain and fill port. Body of shot feeder/filter shall have 5 gallon capacity and constructed of A513 tube, have three welded carbon steel legs, and for 200PSI at 200°F. Lid shall be minimum 3-1/2” in diameter and have Buna-N O-ring. Provide minimum 2 mil epoxy coating on outside of filter housing.

C. Filter Media. Shot feeder/filter feeder shall be supplied with 20 micron high temperature re-usable pleated filter, stainless steel holder and stainless steel removal handle so that personnel shall not come in contact with vessel contents.

PART 3 - EXECUTION

3.1 PREPARATION

A. Flush and clean expansion tanks prior to delivery to the Project Site and keep sealed during construction.

3.2 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer’s published recommendations.

C. Support expansion tanks from building structure in accordance with manufacturer's instructions.

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. Provide valved drain and hose connection on strainer blow down connection.

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

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

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

I. Pipe relief valve outlet to nearest floor drain.

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

K. Air Vent
1. Provide air vents at the highest points of the hydraulic piping systems and on the uppermost connections to all hydraulic coils. Provide shutoff valves to facilitate maintenance of air vents.
2. Locate all air vents and their discharge lines in accessible locations, preferably clustered.
3. For automatic air vents in above-ceiling spaces or other concealed locations, extend vent tubing to nearest drain
4. Route ½-inch discharge lines to nearest floor drain without air traps.

L. Shot Feeder/Filter
1. Shot feeder/filter shall be installed per manufacturer’s instructions and details shown on the construction documents. Provide ball valve at shot feeder/filter drain outlet and pipe to nearest floor drain. Install new filter media in shot feeder/filter at substantial completion of the project.

END OF SECTION 23 21 16

SECTION 23 22 13 - STEAM AND STEAM CONDENSATE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 WORK INCLUDED

A. Steam piping system.

B. Steam condensate piping system.

C. Boiler Feed Water Steam

1.3 RELATED WORK

A. Section 23 00 00, Mechanical General Provisions.

B. Section 23 05 29, Hangers and Supports for HVAC Piping and Equipment.

C. Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment.

D. Section 23 05 53, Identification for HVAC Piping and Equipment.

E. Section 23 07 19 Piping Insulation.

F. Section 23 22 16, Steam and Steam Condensate Specialties.

1.4 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.

E. ANSI/ASME B31.1 - Code for Power Piping.

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

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

H. ANSI/AWS D1.1 - Structural Welding Code.

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.

1.5 REGULATORY REQUIREMENTS

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

1.6 QUALITY ASSURANCE

A. Welding Materials and Procedures: Conform to ANSI/ASME SEC 9, and applicable state labor regulations.

B. Welders Certification: In accordance with ANSI/AWS D1.1.

C. All piping and fittings shall be manufactured domestically.

1.7 SUBMITTALS

A. Product Data: For each type of the following:
1. Pipe
2. Fittings and accessories

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Cleaning/Flushing Plan: This must be submitted and approved prior to any piping being installed. Plan, including all steps to be taken to ensure the piping installation will be cleaned properly prior to service, circulation through equipment, or connection to another system. This shall include but not be limited to:
1. A step by step explication of the process.
2. Drawing(s) indicating flow (gpm) values required to meet the minimum velocity in each pipe.
3. Drawing(s) indicating the phase(s) in which the system will be cleaned as required to ensure the minimum velocity will be maintained in each section of piping. It is expected that multiple phases will be required to achieve the minimum velocities in all of the piping safely.
4. Drawing(s) indicating locations of the required temporary connections, valves, strainers, and bypasses.
5. Cutsheet of the temporary pump to be used during flushing.
6. Water treatment and pipe cleaning chemicals.

D. Include welder’s certifications of compliance with ANSI/AWS D1.1.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect piping, and fittings, etc. before installation in accordance with manufacturer’s written instructions.

B. Piping shall be shipped from the factory with capped ends and stored on supports off the ground with ends covered at all times to prevent nesting of insects, birds, and other animals. Any pipe found to be without end-caps or not raised off of the ground should be cleaned by the contractor prior to installation.

C. Protect piping from accumulation of dirt and debris in and around piping/components.

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

A. Piping systems shall conform to the following requirements.
1. Piping systems designed for steam pressure below 15 psig are low pressure steam systems.
2. Piping systems designed for steam pressures from 15 psig up to and including 125 psig are medium pressure steam.
3. Piping systems designed for steam pressures from 125 psig to 250 psig are high pressure steam.

B. Condensate Return, Pumped Condensate Return Piping, Boiler Feed Water:
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).
4. Control and Isolation valves shall have flanged connections.

C. 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.)

D. High Pressure Steam Piping:
1. For pipe 2-1/2 inches and smaller in diameter, use ASTM A 53, Grade A or B, Schedule 80, seamless black steel pipe with 3000-pound, socket welding, forged steel fittings complying with ANSI B16.11. Code welded and stamped in accordance with ANSI/ASME B31.1-2012 edition.
2. For pipe 3 inches through 24 inches in diameter, use ASTM A 53, Grade A or B, seamless black steel pipe with seamless steel welding fittings conforming with ASTM A 234, Grade WPA or WPB, ANSI B16.9

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

PART 3 - EXECUTION

3.1 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.

3.2 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.

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 Section 08310.

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 09900.

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

3.3 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections. Install dielectric unions where joining dissimilar materials.

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

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

D. All high-pressure steam valves 12" and larger shall be piped with an equalizing bypass valve assembly.

3.4 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. 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). All heat exchangers (coils, boilers, shell & tube heat exchangers, etc.) shall be bypassed during the flushing/cleaning process.

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. Provide certificate from water treatment contractor of cleanliness of system.

3.5 PIPE PRESSURE TESTS

A. Test the system as specified in ANSI Code for Pressure Piping (187.5 psig minimum), and carefully check for leaks. After leaks are repaired, retest system; repeat repair and test until proved tight.

B. Pressure testing shall be performed following the completion of postweld heat treatment nondestructive examinations, and all other fabrication, assembly and erection activities required to provide the system or portions thereof subjected to the pressure test with pressure retaining capability.

C. Preparation for Testing
   1. All joints including welds not previously pressure tested shall be left uninsulated and exposed for examination during the test. By prior agreement the complete system (as approved in the submittal process) or portions thereof subject to test may be insulated prior to the test period provided an extended holding time pressurization of the system is performed to check for possible leakage through the insulation barrier.
   2. Piping systems designed for vapor or gas shall be provided with additional temporary supports if necessary, to support the weight of the test liquid.
   3. Expansion joints shall be provided with temporary restraint if required for the additional pressure load under test, or they shall be isolated during the system test.
   4. Equipment that is not to be subjected to the pressure test shall be either disconnected from the system or isolated by a blank or similar means. Valves may be used for this purpose provided that valve closure is suitable for the proposed test pressure.

D. Hydrostatic Testing
   1. Water shall normally be used as the test medium. Test water shall be clean and shall be of such quality as to minimize corrosion of the materials in the piping system.
   2. Provide high point vents and/or drains as required to fill and drain the piping system.
   3. The test equipment shall be examined before pressure is applied to ensure that it is tightly connected. All low-pressure filling lines and all other items not subject to the test pressure shall be disconnected or isolated by valves or other suitable means.
   4. The hydrostatic test pressure at any point in the piping system shall not be less than 1.5 times the design pressure but shall not exceed the maximum allowable test pressure of any nonisolated components, such as vessels, pumps, or valves. The pressure shall be continuously maintained for a minimum time of 10 minutes and may then be reduced to the design pressure and held for such time as may be necessary to conduct the examinations for leakage. Examinations for leakage shall be made of all joints and connections. The piping system shall show no visual evidence of weeping or leaking.
   5. Repairs shall be made to the piping system failing the test. The repaired system shall be retested as indicated above.

END OF SECTION 23 22 13

SECTION 23 22 16 - STEAM AND STEAM CONDENSATE SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 WORK INCLUDED

A. Steam traps.

B. Steam pressure reducing valves.

C. Steam relief valves.

D. Steam safety valve discharge elbows.

E. Drip traps.

F. Sediment strainers.

G. Condensate pump return units

H. Steam Vent Heads

I. Gauges and gauge connections.

J. Thermometer and thermometer wells.

K. Isolation Valves

L. Steam Condensate Tempering Kit

M. Steam Moisture Separators

1.3 RELATED WORK

A. Section 23 07 00, Insulation - General

B. Section 23 07 16, Equipment Insulation

C. Section 23 07 19 Piping Insulation

D. Section 23 22 13, Steam and Steam Condensate Piping.

E. Section 23 05 13, Common Motor Requirements for HVAC Equipment.

1.4 REFERENCES

A. ANSI/ASTM - Boilers and Pressure Vessels Code.

B. ASTM A105 - Forgings, Carbon Steel, for Piping Components.

C. ASTM A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

D. ASTM A216 - Steel Casings, Carbon, Suitable for Fusion Welding, for High Temperature Service.

E. ASTM A395 - Ferric Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

F. ASME B31.9 - Building Services Piping.

G. ASME B31.1 – Power Piping

1.5 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 - Building Services Piping.

B. Conform to ASME B31.1 – Power Plant Piping

1.6 QUALITY ASSURANCE

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

1.7 SUBMITTALS

A. Submit shop drawings and product data for manufactured products and assemblies required for this project.

B. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.

C. Submit schedule indicating manufacturer, model number, size, location, rated capacity, and features for each specialty.

D. Submit manufacturer's installation instructions.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

1.9 EXTRA STOCK

A. Provide two service kits for each size and type of steam trap.

PART 2 - PRODUCTS

2.1 STEAM TRAPS

A. Acceptable Manufacturers
   1. Armstrong
   2. Spirax/Sarco

B. INVERTED BUCKET TRAPS
1. 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, 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. Provides traps with bimetal air vents.

C. FLOAT AND THERMOSTATIC TRAPS
1. 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 float, stainless steel lever and valve assembly.

D. THERMOSTATIC TRAPS
1. 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.
2. Freeze proof type with cast iron body for 300 psig WSP, bronze bellows, stainless steel valve and seat, external adjustment.
3. 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.

2.2 CONDENSATE PUMPING UNITS

A. Acceptable Manufacturers
1. Domestic
2. Bell & Gossett
3. Skidmore
4. Mepco

B. Unit shall be complete with 3/16" thick steel receiver galvanized inside and outside and shall have magnesium anode protection. Each motor shall be provided with a fused safety switch and a magnetic starter providing overload and undervoltage protection. These magnetic starters shall be provided with three pole overload protection. The pump shall be bronze fitted throughout. The bearings shall be such as to protect them from dust and corrosion. Each duplex pump shall be mounted on a heavy steel mounting plate. Each unit shall have fully automatic control by a float and float switch. An alternator switch shall, furthermore, be provided as a part of this pumping device which will automatically alternate the operation of the pumps of this unit at the end of each pump operation. All accessories and auxiliaries, such as pressure gauges, water gauge glasses, etc., shall be installed complete. The electrical wiring required shall be so complete that no wiring beyond that required by the driving motor need be supplied in the field. Such units shall be tested at the factory and adjusted prior to shipment. Alternator preferably shall be mechanical type. If electrical alternator is used, it shall be Allen Bradley. Pumps shall be capable of pumping 212°F condensate at the controlled water level. Each pump shall have stainless steel shafts. Contractor shall furnish an extra set of Viton seals or provide the pump with Viton seals installed. No turbine pumps will be permitted; only centrifugal type pumps shall be provided.

C. Unit shall have the receiver a minimum 24 inches above the floor (pump suction).

D. Capacities and electrical characteristics shall be as scheduled on Drawings.

E. Provide high level alarm switch complete with transformer, bell and one set of 120 volt AC rated, normally open contacts for connection to Building Automation System.

F. Submit complete wiring diagram for this specific contract.

G. Provide a blanket removable insulation for the pumps and receiver. Refer to specification section 23 07 16.

2.3 STEAM PRESSURE REDUCING VALVES

A. Acceptable Manufacturers
1. Spirax Sarco
2. Leslie
3. Masoneilan
4. Spence Engineering

B. 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 single stage (100 to 15 psig. Station shall consist of two PRV's. Discharge pressure shall be adjustable to any value between 10 psig and 75% of the supply pressure.

C. 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.

D. Each reducing valve shall be preceded by a sediment strainer complete with a full-sized blow off valve with threaded end for hose connection.

E. Provide valves with insulating covers. Refer to section 23 07 18.

2.4 STEAM RELIEF VALVES

A. Acceptable Manufacturers
1. Crane
2. Spirax Sarco
3. Consolidated
4. Spence Engineering

B. Relief valves 2" and smaller shall be cast bronze with stainless steel spring and ball bearings and arranged for screwed connections. Provide with stainless steel whetted trimmings. The safety relief valve shall be rated for 250 psi and 400°F.

C. Relief valves 2-1/2" and larger shall be ASME Section I or VIII stamped valves. The valves shall be rated for 250 PSIG maximum pressure and 400°F temperature. The valves shall be cast iron body with stainless steel trim. The valves shall have flange connections.

D. 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.

2.5 STEAM ISOLATION VALVES

A. Acceptable Manufacturers:
1. Crane,
2. DeZurik,
3. Nibco,
4. Powell
5. Stockham

B. 2” and larger

1. Provide class 125 flange iron body gate valves with solid wedge, bolted bonnet and outside screw and yoke. The valve shall be an all steel body with steel stem and cast-iron handle.
2. Provide class 125 flange iron body gate valve with solid wedge, bolted bonnet and non-rising stem. The stem shall be steel construction and have cast iron handle.

C. Smaller than 2”
1. Provided treated class 125 bronze gate valve. Gate valve shall be [rising, non-rising] silicon bronze stem with bronze body and wedges. Valve handle shall be equipped with iron handle.

2.6 STEAM SAFETY VALVE DISCHARGE ELBOWS

A. Acceptable Manufacturers
1. Spirax Sarco
2. Grinnell

B. 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. Drip Pan elbows shall be ASTM A126C cast iron.

2.7 SEDIMENT STRAINERS

A. Acceptable Manufacturers
1. Spirax Sarco
2. Crane

B. 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.

C. 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.

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.

E. Sediment strainers in low and medium pressure steam piping systems 2" and smaller shall be arranged for screwed pipe connections. Full sized blow off valves shall be installed on all strainers in steam, condensate and hot water lines and a drain shall be installed from each valve to the nearest floor drain.

2.8 STEAM VENT HEADS

A. Acceptable Manufacturer
1. Spirax Sarco
2. Bryan Steam
3. Watson McDaniel

B. Provide vent heads for all condensate tanks, blowdown vessels, boiler feedtanks, deaerators, and storage tanks. Vent head shall be constructed out of stainless steel and be equipped with a drain connection. The vent heads shall be sized for a maximum velocity of 3,000 fpm. Provide flange connections for vent heads 3” and larger. Use NPT connection for vents smaller than 3” and drain connections.

2.9 GAUGES AND GAUGE CONNECTIONS

A. Acceptable Manufacturers
1. Ashcroft
2. Dwyer
3. Trerice,
4. Weiss
5. Weksler
6. Spirax Sarco

B. Furnish and install, where noted or indicated on the accompanying Drawings or called for elsewhere in these specifications. Pressure gauge shall be 4" in diameter dial with units marked in psi. Provide pressure gauges appropriate pressure gauges for service of use. The pressure gauges shall have the ability to operate up to 400°F.

C. Provide gauges with lever handle union shutoff cocks. All gauge connections shall be made up with brass pipe, nipples and brass screw fittings.

2.10 STEAM MOISTURE SEPARATORS

A. Acceptable Manufacturers
1. Spirax Sarco
2. Watson McDaniel
3. Armstrong

B. Steam Moisture Separators shall be carbon steel "T" style for horizontal pipe applications. The separator shall be high efficiency baffle type constructed in accordance with ASME boiler pressure code and stamped for its working pressure of 125 psig.

C. Provide upstream of steam pressure reducing station and temperature control valves.

2.11 THERMOMETER AND THERMOMETER WELLS

A. Acceptable Manufacturers
1. Ashcroft,
2. Dwyer,
3. Trerice,
4. Weiss
5. Weksler

B. Thermometer wells and thermometers shall be located where noted on the accompanying Drawings and where called for in other sections. 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.

2.12 LAMINATED BELLOWS EXPANSION JOINTS

A. Acceptable manufactures
1. Hyspan
2. Metalflex
3. Pathway

B. Provide flanged laminated expansion bellows joint designed for axial expansion. The bellows must have a minimum test pressure of 225 psig and 750°F and comply with the following:
1. Flat face carbon steel plate made from ASME A-36 plate
2. ASME A53 Grade B schedule 40 pipe
3. The bellow shall be laminated (multiply) ASTM A240 type 304 stainless steel.
4. Have flow liner made of ASTM A240 type 304 stainless steel.
5. Bellow must have a minimum five-year warranty.

C. Provide removable/reusable insulated covers as described in section 23 07 18.

2.13 STEAM CONDENSATE TEMPERING KIT

A. Acceptable Manufacturers
1. Armstrong
2. Pure Humidifier
3. Dynafluid

B. Furnish condensate drain tempering unit equipped with temperature regulating control valve. The unit shall temper the steam condensate using cold domestic water to achieve a drain discharge temperature of 140°F.

C. The unit shall consist of a stainless steel mixing chamber with a temperature sensor. The temperature sensor shall control the amount of cold water used to cool the steam condensate water.

PART 3 - EXECUTION

3.1 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, convertors, 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 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 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 23 22 16

SECTION 23 25 00 - WATER TREATMENT FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 RELATED WORK

A. Section 23 21 00 Hydronic Piping and Fittings.

1.3 SUMMARY

A. Provide complete chemical water treatment systems for the following systems:
   1. Closed loop chilled water.
   2. Closed loop heating hot water.
   3. Steam and steam condensate

B. Provide chemicals as required to control scale, corrosion, biological fouling, waterborne pathogens, and corrosion resulting from biological contamination or inhabitance of piping systems.

C. Coordinate tap and sensor locations with Drawings and the water treatment manufacturer's requirements.

D. Provide supervision of the water treatment program starting at initial start-up of the chilled water, hot water, and condenser water systems through one year from substantial completion consisting of on-the-spot analysis of all systems treated and a submittal of a written report to Owner and Engineer stating current conditions and recommendations for maintaining optimal controls. This service shall be performed monthly.

E. Provide passivation and cleaning of piping systems prior to contractor placing these systems in to operation.
   1. all chemicals
   2. written procedures for implementation by the Contractor
   3. Site visits to ensure that the contractor understands the procedures and means of introducing the chemicals
   4. follow up report and sampling of the water to ensure that the procedures were followed

1.4 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Provide initial chemical treatment for all systems on a complete water analysis prior to equipment installation.

1.5 QUALITY ASSURANCE

A. Qualified vendor will have been in continuous operation for 20-plus years, be certified to the ISO 9000 quality standard, manufacture and deliver their own products, be capable of transferring chemicals to stationary tanks, provide technical specialists as needed in addition to the routine service representative, perform borescope inspections, support an Internet database for water treatment reports and information, have personnel and expertise to install water treatment equipment, and have the ability to perform offsite analytical laboratory work and reporting.

B. Technical service representative will have a minimum of five (5) years water treatment industry experience and live within two (2) hours drive of the site being serviced and will be a Certified Water Technologist (CWT) professional.

C. Regulatory Requirements: Conform to applicable codes for addition of non-potable chemicals to building mechanical systems, and public sewage systems.

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

1.6 SUBMITTALS

A. Product Data:
1. Include rated capacities; water-pressure drops; shipping, installed, and operating weights; and furnished products listed below:
   a. Pumps.
   b. Chemical solution tanks.
   c. Agitators.
   d. Control equipment and devices.
   e. Test equipment.
   f. Chemicals.
   g. Filters.
   h. Chemical feeders.
   i. Bypass Chemical pot feeders.

B. Shop Drawings:
1. Provide a flow schematic that indicated the piping connection points, line types, sizes, and arrangement of all chemical treatment equipment
2. Provide a control schematic that indicates what variables are being measured, the measurement points, the intended setpoints, and what control devices (metering pumps, solenoids, etc) are being actuated to achieve these setpoints.

C. Record Documents:
1. Shop Drawings: Detail equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   a. Wiring Diagrams: Detail power and control wiring and differentiate between manufacturer-installed and field-installed wiring.
   b. Flow Schematics
   c. Control Schematics
2. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project Site.

3. Field Test Reports:
   a. Indicate and interpret test results for compliance with performance requirements.
   b. Provide letter after cleaning services are completed indicating analysis of system water after cleaning and treatment, date service was performed, and chemicals used.

1.7 OPERATION AND MAINTENANCE DATA:

A. For pumps, agitators, filters, system controls, and accessories to include in Operating and Maintenance Manuals.

B. Include data on equipment including spare parts lists, procedures, and treatment programs.

C. Include step by step instructions for test procedures including target concentrations.

D. Include plant logs, MSDS sheets and other system information required for maintaining system.

E. Furnish manufacturer's written instructions.

1.8 MAINTENANCE

A. Provide adequate supply of chemicals for start-up and testing period for the time system is being operated by Contractor and for a period of one year after the system has been accepted by Owner.

B. Recommend periodic testing procedure and chemical treatment schedule for facility personnel.

C. Provide qualified service representative on site at facilities to assist with initial application of chemicals and training of personnel.

D. Service representative shall make quarterly service visit to analyze chilled and hot water system water samples for nitrite and conductivity.

E. Service representative shall visit monthly to analyze condenser water system samples.

F. A service report shall be prepared for each visit showing test results and providing recommendations for continued system operations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. ChemCal, Inc.
   2. GE Water & Process Technologies
   3. Nalco Company

2.2 GENERAL

A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

B. Chemical Feed System Description:
   1. Contract documents show a bypass loop from main system headers to the water treatment room with taps for chemical injection, coupons, controllers, and blowdown valves. Water treatment vendor will make connections and install equipment using these taps. Water treatment vendor shall consult with the mechanical contractor to verify exact location and orientation for his use. Unused taps will be left in place for future use by others.

C. Performance Requirements:
1. Maintain water quality for HVAC systems that controls corrosion and build-up of scale and biological growth for maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.
2. Base chemical treatment performance requirements on the quality of water at the Project Site HVAC system equipment material and operating personnel capabilities, and the capability of personnel and guidelines of authorities having jurisdiction at the Project Site.
a. Closed System: Maintain system essentially free of scale, corrosion, and fouling to sustain the following water characteristics:
1) Conductivity: 1000-7000 mmhos.
2) Acceptable pH: Not less than 8.8.
b. Condenser Water, Medium-to-Large Cooling Tower System: Maintain system essentially free of scale, corrosion, and microbiological fouling.

2.3 CHEMICAL FEEDING EQUIPMENT

A. General: Vendor must provide, install, and support all relevant chemical feed and storage equipment necessary to treat the condenser and steam boiler water systems.

B. Chemical storage tanks with 110% containment. Tanks may come in a variety of sizes and have injection pump standpipe and vent line, as well as chemical fill point attachments.

C. Injection pump containment boxes (i.e., Integra, Stahlin) which are splash proof. Boxes shall be wall mounted above and near their related storage tank. Boxes must have sensor capable of interlocking injection pumps with leak detection.

D. Chemical injection pumps with controllable speed and stroke.

E. Storage tank level sensors which can be read by the controller.

F. Industrial grade inhibitor tag monitoring probe (i.e., similar to Turner) to ensure proper dosage of scale and corrosion inhibitor chemical (condenser program only).

G. Industrial grade corrosion monitoring probes (mild steel, copper) to monitor corrosion rates (i.e., CorrTran) (condenser program only).

H. Flow meters for bypass loop piping.

I. Chemical tubing containment from storage tank to pump box and from pump box to injection point.

J. Stainless steel chemical tubing where applicable (i.e., acid).

K. One (1) normally closed solenoid valve for condenser water bleed line.

2.4 CHEMICAL TREATEMENT CONTROLLERS

A. Vendor must provide, install, program, and support Internet-accessible water treatment controllers (i.e., eController, Hydro-Triton) for condenser water treatment control. Such control equipment must have the following features:
1. Secure, password-protected access for each facility director and their chosen operators.
2. Access to the controller from anywhere via the Internet.
3. Secure, password-protected access at controller unit keypad.
4. Daily status reports emailed to chosen recipients.
5. Seven (7) 110 volt NO/NC relays, plus one (1) for alarms.
6. Eight (8) 4-20 mA inputs.
7. At least six (6) digital inputs.

8. Ability to assign any input to any output online.
9. Output up to four (4) 4-20 mA signals.
10. Accessibility by modem or Ethernet.
11. Industrial grade pH, ORP, inhibitor tag, and conductivity sensors and housing as required per facility and system type.
12. Ability to read 4-20 MA output signals from Building Automation System proportional to the instantaneous totalized flow of condenser water makeup and blow down flows.
13. Ability to record chemical tank level sensor data.
14. Ability to feed oxidizing biocide base on ORP set point(s) and record ORP of condenser water for any given period.
15. Ability of controller to routinely send data (i.e., conductivity, ORP, pH, tank level sensor readings) electronically to the facility's water treatment Internet database system.
16. Daily, weekly, or monthly data logs emailed to chosen recipients.
17. Ability to review controller data trend charts.
18. Real-time availability of controller data.
19. Execution of controller changes (i.e., set points, dead bands, etc.) via the Internet.
20. Detailed email alarm notifications to chosen recipients.
21. UBS and Ethernet direct connect access.
22. Vendor training and in-services on use and navigation of the controller and its database system.

2.5 CHEMICAL TREATMENT TEST EQUIPMENT

A. Vendor must provide a relevant test kit and components for operator's use for operator testing. Test kit must come in a carrying case for ease of handling and contain testing procedures, log sheets, and reagent MSDSs. The vendor must provide a minimum of one (1) hour in-service to operators involved in routine testing. The vendor will replenish reagents at no charge for the one (1) year term starting at Substantial Completion.

B. If acid (pH control) is used in the condenser water program, a hand-held conductivity/pH meter (i.e., Myron L 6-P) must be included in the test kit. Otherwise, a simple conductivity meter (i.e., Myron L EP-10) must be included in the test kit.

2.6 CHEMICALS

A. Furnish chemicals recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment.

B. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.

C. Biocide: Chlorine release agents or microbiocides.

D. Closed-Loop, Water Piping Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.

2.7 OPEN-LOOP, CONDENSER WATER PIPING CHEMICALS:

A. General: Vendor must select, manufacture, deliver, and transfer to storage tank chemicals capable of inhibiting and controlling mineral scale, corrosion, microorganisms, and biological fouling (i.e., biofilm) on all water-side surfaces (i.e., cooling tower fill, basin, piping, condenser tubes) of the condenser water system.
   1. NOTE: The microbiocide program must be consistent with CTI (Cooling Technology Institute) and or AWT (Association of Water Technologies) guidelines relative to the control of condenser water pathogens such as Legionella.

B. Vendor must be able to control the condenser water at 4-6 cycles of concentration while maintaining a Ryznar Stability Index (RSI) between 4.2 and 4.8. If this cannot be accomplished naturally based on the make-up water characteristics, the use of pH control with acid is acceptable.

C. Scale and corrosion inhibitor chemical. This product must be in liquid form and impart the following active ingredients at the following dosages when fed in condenser water:
1. phosphonate = 3-7 ppm,
2. AA copolymer = 4-10 ppm
3. maleic acid (or) acrylate homopolymer = 4-10 ppm
4. azole = 2-4 ppm.
5. PTSA dye (tag)

D. Oxidizing microbiocide chemical. This product must be in the form of liquid sodium hypochlorite, chlorine dioxide, or liquid bromination. The use of oxidizer “tablets” is prohibited. This product must be fed in a manner to hold these residuals continuously using the ORP sensor feature of the controller. This product must convey the following water test results during and shortly after feeding:
1. free oxidant = 0.1-0.5 ppm,
2. total oxidant = 0.4-1.0 ppm.

E. Antifoulant/dispersant chemical. This product must be in liquid form and be fed at a rate consistent with the recommendations in its product literature a minimum of one (1) time per week during low load periods.

F. Acid (OPTIONAL). This product must be in liquid sulfuric acid form and be 95-98% active if implemented. This product is to be part of the program ONLY if pH control is necessary to operate the condenser water at the desired 4-6 cycles of concentration and 4.2-4.8 RSI. This product must be fed at a rate so as not to lower condenser water pH below 8.3 at any time. The dead band for the control of pH cannot be any more than 0.1 pH units. The pH set point will be chosen by the vendor based on make-up water characteristics, but no less than 8.3.
1. If acid is used, feedpump must be provided with a proof of flow sensor to prevent acid from being fed into a system with no water flow.

2.8 CHILLED WATER AND HEATING WATER SYSTEMS (CLOSED LOOPS)

A. Vendor to provide chemicals capable of inhibiting and controlling corrosion and deposits on all water-side surfaces of the chill and hot loop water systems. Chemical supply will be in the amount to dose the closed loops one (1) time to the recommended dosages as confirmed by test results after completion of the cleaning and passivating process.
1. Corrosion inhibitor chemical. This product must be in liquid form and impart the following active ingredients at the following dosages when fed in chilled water loop water:
   a. nitrite (as NO_2) = 400-800 ppm,
   b. borate = 200-400 ppm
   c. azole = 20-60 ppm.
2. This product must impart the following active ingredients at the following dosages when fed in Heating water loop:
   a. nitrite (as NO_2) = 800-1200 ppm
   b. borate = 400-600 ppm
   c. azole = 40-80 ppm.

2.9 PASSIVATION AND CLEANING CHEMICALS - CONDENSER WATER, CHILLED WATER AND HEATING WATER LOOPS

A. Vendor must provide chemicals for cleaning and passivating water-side surfaces prior to implementation of the regular water treatment program and HVAC system startup. Vendor must be plan and supervise the mechanical contractor's application of these chemicals in the condenser, chilled and hot water loops. Chemicals shall remove mill scale, oil, and greases as well as passivate surfaces with a protective oxide film.
   1. NOTE: All residuals of the cleaning and passivating chemicals must be totally blown-down prior to system startup.

B. Alkaline cleaner/penetrant/dispersant chemical. This product must be in liquid form and capable of removing mill scale, oils, greases, debris, and byproducts of construction. It shall be fed at the vendor's recommended dosage rate based on the volumes of the systems treated.

C. Passivating chemical. This product must be in liquid poly-phosphate form and capable of laying down a protective oxide film on metal surfaces after treatment with the cleaning chemical. It shall be fed at the vendor's recommended dosage rate based on the volumes of the systems treated.

2.10 INTERNET DATABASE SYSTEM

A. Vendor must provide, configure, and support an Internet-accessible database account for the retrieving, recording, and archiving of water treatment related information. Such a system must have the following features:
   1. Secure, password-protected access for each manager and their chosen operators.
   2. Access to the system from anywhere via the Internet.
   3. Zero software requirements (Internet browser required for user).
   4. Ability for facility operators to record routine test log data online.
   5. Ability for facility director and operators to upload pertinent digital images and PDF files.
   6. Retrieve service reports, operator logs, laboratory analysis, corrosion coupon reports, inventory, digital images, MSDSs, product data sheets, technical papers, procedures, surveys, and training information.
   7. Graphing and trending capabilities for any recorded service report and/or facility operator test data entries.
   8. Ability of database system to routinely accept data (i.e., conductivity, ORP, pH, tank level sensor readings) electronically from the facility's water treatment controller(s).
   9. Graphing and trending capabilities that compare entries of wet test data with controller sensor data.
   10. Ability to set alarm limits and assign recipients for email alarm notifications for chosen test variables of service report and/or operator log entries.
   11. Multiple security levels for various users.

PART 3 - EXECUTION

3.1 PREPARATION

A. Water Analysis:
   1. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article.

3.2 INSTALLATION

A. Vendor is responsible for the installation of the phone line required for internet access, all test points, electrical outlets for their equipment, wiring and piping other than what is indicated to be provided by the mechanical contractor on the drawings. Vendor is solely responsible for coordinating the installation of the water treatment devices. Vendor may (at his option) negotiate the installation of any materials, equipment, or utility by the Contractor.

B. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

C. All installation shall be in accordance with manufacturer's published recommendations.

D. Install treatment equipment level and plumb.

E. Add cleaning chemicals as recommended by manufacturer.

F. Connections:
1. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
2. Install piping adjacent to equipment to allow service and maintenance.
3. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.
4. Ground equipment.
5. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 TESTING

A. Engage a factory-authorized service representative to perform Start-up service.
1. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during HVAC system Start-up procedures.

B. Test chemical feed piping as follows:
1. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
2. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
3. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose Work that has been covered or concealed before it has been tested and approved.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four (4) hours. Leaks and loss in test pressure constitute defects.
5. Repair leaks and defects with new materials and retest piping until satisfactory results are obtained.
6. Prepare test reports, including required corrective action.

7. Occupancy Adjustments: Within 12 months of Substantial Completion, perform two (2) separate water analyses to prove that automatic chemical feed systems are maintaining water quality within performance requirements specified in this Section. Perform analyses at least 60 calendar days apart. Submit written reports of water analysis.

3.4 ROUTINE TECHNICAL SERVICE REQUIREMENTS

A. Service visit frequency shall be a minimum of once per week the first month and once per month after that. Technical service visit commitment shall begin with the start-up of the mechanical systems being treated and continue for one (1) year after substantial completion.

B. The technical service representative will perform the following duties during site visits:
1. Pull and test all relevant water samples. Record results and recommendations on written reports and enter results and recommendations on the customer's Internet database account.
2. Make recommendations regarding needed adjustments, repairs, and or improvements to water-related systems and water treatment equipment, and enter such recommendations on the Internet database account.
3. Discuss and review in person all findings and recommendations with the mechanical contractor and project management during routine and nonroutine service visits. Be available for such discussions via telephone and email as well.
4. Inspect water-using equipment during routine and non-routine openings. If desired, utilize videoscopes and or borescopes, as well as digital camera and visual inspection techniques. Subsequent reports and images will become available on the Internet database account.
5. Provide in-services and technical training to the mechanical contractor and or owner operators on an as needed basis. Such training may involve test procedures and interpretation, Internet database account use and navigation, water treatment equipment use and programming, treatment chemical knowledge, and or chemical handling.
6. Review operator logs on the Internet database account and or hardcopy during site visits.
7. Analyze mild steel and copper corrosion coupons (condenser program only) at least twice during the one (1) year program and enter reports on the Internet database account.
8. Make routine inventory checks of treatment chemicals and test reagents so ordering recommendations can be made and chemicals can be furnished as needed and quickly.
9. Make adjustments to the controllers, timers, and chemical pumps as needed.

3.5 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
1. Schedule two four (4) hours of training with Owner. One for equipment, one for internet data base access and management.
2. Provide at least seven calendar days advance notice.
3. Review manufacturer's safety data sheets for handling of chemicals.
4. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service.
5. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service.

END OF SECTION 23 25 00

SECTION 23 31 00 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. Perform Work required to provide and install ductwork, flexible duct, hangers, supports, sleeves, flashings, vent flues, and all necessary accessories as indicated in the Contract Documents. Provide any supplementary items necessary for proper installation

B. Section Includes:
   1. Rectangular ducts and fittings.
   2. Round ducts and fittings.
   3. Sheet metal materials.
   4. Sealants and gaskets.
   5. Hangers and supports.

C. Related Sections:
   1. Division 09 Section, Painting, for interior painting of metal ductwork exposed to view through grilles, registers, and other openings.
   2. Section 23 05 93, System Testing, Adjusting, and Balancing.
   3. Section 23 07 13, External Ductwork Insulation.
   4. Section 23 33 00, Air Duct Accessories.
   5. Section 23 34 00, Fans.
   6. Section 23 36 00 Air Terminal Units.
   7. Section 23 37 00, Air Devices.

1.3 DEFINITIONS

A. Low Pressure: Up to 2 inches w.g. positive or negative static pressure and velocity equal to 1500 fpm. Constructed and tested for +2 inches W.G.

B. Medium Pressure: Over 2 inches w.g. through 6 inches w.g. positive or negative static pressure and velocity greater than 1500 fpm. All medium pressure ductwork shall be constructed and tested for +6 inches w.g.

C. High Pressure: Over than 6 inches w.g. positive static pressure and velocity greater than 2500 fpm.

D. Duct Size. The supply return and exhaust duct sizes shown on drawings are sheet metal dimensions.

1.4 GUARANTEE

A. Guarantee all ductwork for 1 year from the date of final acceptance. The guarantee will cover workmanship, noise, chatter, whistling or vibration. Ductwork shall be free from pulsation under all conditions of operation.

1.5 CONTRACTOR COORDINATION

A. Erect all ducts in the general locations shown on the drawing(s) but conform to all structural and finish conditions of the building. Before fabricating any ductwork, Contractor to check the physical conditions at the job site and make all necessary changes in cross sections, offsets and similar items, whether they are specifically indicated on drawing(s) or not. Do not obstruct the induced air plenum opening at VAV boxes and service access spaces for VAV boxes and other equipment.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

1.6 STANDARDS AND CODES

A. Except as otherwise indicated, sheet metal ductwork material, fabrication and installation shall comply with second edition of SMACNA HVAC Construction Standards Metal and Flexible, except where indicated otherwise. All air distribution devices (such as dampers) included in this Section shall comply with the third edition of SMACNA HVAC Construction Standards Metal and Flexible.

B. In addition, construct ductwork and all air distribution devices to the following:
1. IMC International Mechanical Code
2. NFPA 90A Installation of Air Conditioning and Ventilating Systems.
3. NFPA 90B Installation of Warm Air Heating and Air Conditioning Systems
4. NFPA 96 Installation of Equipment for the Removal of Smoke and Grease Laden Vapors from Commercial Cooling Equipment.
5. NFPA 45 – Laboratory Ventilating Systems and Hood Requirements
6. SMACNA Round Industrial Duct Construction Standards
7. SMACNA The Managers' Guide for Welding

1.7 SUBMITTALS

A. Product Data
1. Submit product data for each product. Refer to Section 23 00 10.
2. Provide acoustical data on insulated flexible ductwork as indicated in Part 2.

B. Delegated-Design Submittal. Include the following for each system furnished on the project.
1. System name and type
2. Duct system design pressure.
3. Sheet metal thicknesses and materials.
4. Reinforcement details and spacing.
5. Seam and joint construction and sealing.
6. Fittings, construction and details.
7. Hangers and supports, including materials, fabrication, methods for duct and building attachment.

C. Ductwork shop drawings. Provide CAD-generated shop drawings of mechanical rooms and building ductwork drawn at a minimum scale of ¼ inch per foot. Include the following as a minimum:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory and shop fabricated duct and fittings.
3. Duct layout indicating sizes, configuration and pressure classes.
4. Elevations of top and bottom of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Reinforcement and spacing.
7. Penetrations through fire-rated and other partitions.

8. Equipment installation based on equipment being used on Project.
9. Duct accessories, including access doors and panels, fire dampers and smoke dampers.

D. Welding certificates. For duct welders including procedures and standards of acceptance

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Spiral Ductwork. Gowco, McCorvey, United McGill, Lindab (supply duct only).

B. Sheet Metal Products. McCorvey Sheet Metal Works, Gowco, United McGill, Flexmaster, Ductmate, Ward.

C. Insulated Flexible Duct. Pepertree Air Solutions, Thermaflex, Flexmaster.

2.2 APPLICATION

A. Ductwork shall be constructed in accordance with the following as a minimum. Refer to drawings for any deviations from this table.

SYSTEM	**MATERIAL**	**MINIMUM PRESSURE CLASSIFICATION** (1)
Supply Systems:		
All fan coil unit supply ductwork	Galvanized Steel	Low Pressure
Supply ductwork downstream of constant volume single and multi-zone AHUs.	Galvanized Steel	Low Pressure
Supply ductwork downstream of single zone VAV AHUs(2)	Galvanized Steel	Medium Pressure

B. Notes to Table:
1. Positive pressure unless noted otherwise in Table.
2. From air handling unit (AHU) to terminal boxes.
3. From pretreatment AHU to AHU.
4. Runout from air device to return/exhaust air trunk duct
5. Negative pressure SMACNA table.

2.3 DUCT MATERIAL AND CONSTRUCTION

A. General. Noncombustible or conforming to requirements for Class I air duct materials or UL 181. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise on Drawings. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein

B. Galvanized Steel Ducts. Constructed of G-60 coated galvanized steel meeting requirements of ASTM A 653 or ASTM A 527. Stencil coils of sheet steel throughout on 10 foot centers with gage and manufacturer's name. All materials associated with the duct system shall be galvanized steel including stiffeners, fasteners, etc.

C. Stainless Steel Ducts. Type 304 or 316L as indicated in application schedule. For round ductwork, butt-welded (solid welded) longitudinal seam only. Spiral lockseam and Spiral lockseam with standing rib is not acceptable.

D. Fasteners. Rivets, bolts or sheet metal screws.

E. Sealant.
1. Sealant shall be water based, latex UL 181B-M sealant with flame spread of 0 and smoke developed of 0. Sealants shall be similar to Foster 32-19, Childers CP-146, Hard Cast Iron Grip 601, Ductmate Pro Seal or Design Polymerics DP 1010.
2. Scrim tape shall be fiberglass open weave tape, 3 inches wide, with maximum 20/10 thread count.

F. Hangers and Supports.
1. Support ductwork with continuously threaded hanger rods of galvanized steel or 20 gauge straps as indicated in these specifications.

2.4 RECTANGULAR DUCTS AND FITTINGS GENERAL REQUIREMENTS

A. General Fabrication Requirements: Comply with SMACNA based on indicated static-pressure class unless otherwise indicated. In no case shall the ductwork be less than 26 gage for low pressure ductwork, 24 gage for medium pressure ductwork.

B. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Snaplock longitudinal seams (L2) are not acceptable.

D. Fittings:
1. Select types and fabricate according to SMACNA Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.
2. Construct bends and elbows per SMACNA Figure 2-2, “Rectangular Elbows”, Type RE1 with radius of not less than 1-1/2 times width of duct on centerline. Where not possible or where indicated on construction documents, construct Type RE2 rectangular elbows with welded-in-place double wall airfoil turning vanes (whether specifically shown on drawings or not), or short radius type RE1 radius elbows.
3. Construct tees per SMACNA Figure 2-5, “Divided Flow Branches”, Type 2, Type 3, Type 4A or 4.
4. Construct branch connections per SMACNA Figure 2-6, “Branch Connection”. Use 45 degree entry, 45 degree lead in, conical or bellmouth connections only.
5. Unless indicated on construction document details, transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence. Divergence upstream of equipment shall not exceed 30 degrees. Convergence downstream of equipment shall not exceed 45 degrees.
6. Bullhead tees are not permitted.

2.5 ROUND AND OVAL DUCTS AND FITTINGS GENERAL REQUIREMENTS

A. General Fabrication Requirements: Comply with SMACNA Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated. In no case shall the ductwork be less than 26 gage.

B. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Use flanged joints for ducts larger then 48 inches in diameter.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Utilize spiral seam or butt weld seams only. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

D. Fittings:
1. Fittings shall have a wall thickness not less than that specified for longitudinal-seam straight duct or 26 gage, whichever is more stringent.
2. Tees and Laterals: Select types and fabricate according to SMACNA Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA. Utilize 90 degree tee with oval to round tap, 45 degree lateral tap, or conical fitting only. Wye fittings may be utilized where specifically indicated on drawings and details.
3. Elbows: Construct elbows with radius of not less than 1-1/2 times width of duct on centerline. Provide minimum 5 gore elbows on all 90 deg elbows, 3 gore elbows on 45 degree elbows. Continuously welded stamped long radius elbows may be utilized on ductwork up to and including 12-inches in diameter.
4. Bullhead tees are not permitted.

2.6 INSULATED FLEXIBLE DUCTWORK

A. Use for connection to diffusers, grilles and terminal boxes as indicated in specifications and details.

B. Construct the inner liner of coated steel helix and a PE or CPE liner substantially bonded together to prevent the duct from collapsing or kinking in short radius bends. Provide fiberglass insulation providing minimum R-4.2 thermal conductance and 3 pound minimum density around inner jacket consisting of fiberglass reinforcement and aluminum foil vapor barrier outer jacket. Use duct rated at minimum working pressure of 10 inches of water positive and 1 inches of water maximum negative pressure (4-12 in I.D.), and 6 inches of water positive and 1/2 inch of water maximum negative pressure (14- 16 I.D.), Provide duct listed by U.L. at flame spread rate of not over 25 and smoke developed rate of not over 50, and complying with NFPA Standard 90A and 90B. The entire assembly shall be listed by Underwriters Laboratories under U.L. Standard 181 as a Class I flexible air duct. Supplier shall submit laboratory test results indicating acoustical performance comparable to that of "Flexmaster Type 1M-Insulated".

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Construction Standards. Use construction methods which follow the requirements outlined SMACNA publications, as well as SMACNA Balancing and Adjusting publications, unless indicated otherwise in these specifications or accompanying drawings.

B. Reinforcement. Reinforce ducts having one side equal to 25 inches or more in accordance with recommended construction practice of SMACNA.

C. Plenum Construction. Construct plenum chambers of not less than No. 20 U.S. gage metal reinforced with galvanized structural angles.

D. Cross Breaking or Beading. Cross break or bead sheet metal for rigidity, except ducts which are 12 inches or less in the longest dimension.

E. Wall and Floor Penetrations.
1. Install fire, smoke and combination fire smoke dampers in floor penetrations and in one and two-hour rated walls where indicated in drawings and in accordance with code requirements.
2. Where ducts pass through walls in exposed areas, install suitable escutcheons made of galvanized sheet metal angles as closers.

3. At all locations where ductwork passes through floors, provide watertight sleeves projecting 3 inches above finished floor and flush with bottom of floor slab. Fabricate sleeves of 1/8 inch thick steel, galvanized after fabrication. Anchor into adjacent floor slab as required.
4. Sleeves are required inside as well as outside chases.
5. Provide 24 gage sheet metal sleeves for insulated ducts penetrating gyp board walls. Seal openings between ducts and sleeves with fireproofing sealants.

F. Interior Painting. Interior painting of metal ductwork exposed to view through grilles, registers, and other openings is specified in the Section on painting. Do not install grilles, registers, or similar items until painting is complete.

G. Ductwork Openings. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

H. Ductwork Location. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities, including access to electrical and control panels.

I. Instrument Test Hole Fitting. Provide Duro Dyne Model TH-1 instrument test ports with heavy-duty zinc-plated heavy-gage cap, instant-release wing nut, neoprene expansion plug, flat neoprene mounting bracket and mounting holes. Provide fittings to air balance contractor.

J. Provide transitions at equipment and air device connections as per SMACNA standards. Where equipment requires an oval inlet and a round flex duct is routed to the equipment, provide insulated round to oval transition.

K. Install duct mounted electric and hot water coils, provided in other specification sections, if required.

L. Refer to mechanical details for information on terminal box connections, diffuser connections, fume hood connections, lab-trac equipment, etc.

3.2 SEAM AND JOINT SEALING

A. All duct systems (except welded exhaust ductwork and double wall flue) shall be sealed. Duct shall be thoroughly cleaned prior to application of sealant. All transverse joints, longitudinal seams and duct wall penetrations shall be sealed. All ductwork shall be sealed as per seal Class A of SMACNA Standards irrespective of the duct pressure classifications.

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports." Unless indicated otherwise in specifications.

B. Hanger Spacing. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing. Install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection. Do not use wire to support ductwork.

C. Horizontal Ducts Up to 40 Inches. Support horizontal ducts up to and including 40 inches in their greater dimension by means of No. 20 U.S. gage band iron hangers attached to the ducts by means of screws, rivets or clamps, and fastened to inserts with toggle bolts, beam clamps or other approved means. Use clamps to fasten hangers to reinforcing on sealed ducts.

D. Horizontal Ducts Larger Than 40 Inches. Support horizontal ducts larger than 40 inches in their greatest dimension by means of hanger rods bolted to angle iron (or equivalent unistrut) trapeze hangers. Place supports on at least 8'-0" centers according to the following:

Angle Length	Angle	Rod Diameter
4’-0”	1-1/2” x 1-1/2” x 1/8”	1/4”
6’-0”	1-1/2” x 1-1/2” x 1/8”	1/4”
8’-0”	2” x 2” x 1/8”	5/16”
10’-0”	3” x 3” x 1/8”	3/8”

The trapeze is to be placed on the exterior of non-compressible insulation between hanger and ductwork.

E. Vertical Ducts. Support ducts to ensure rigid installation. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Fig. 4-7, Fig 4-8, Fig 4-9 "Riser Supports – From Floor”. Support vertical ducts where they pass through the floor lines with 1-1/2 inches x 1-1/2 inches x 1/4 inch angles for ducts up to 60 inches. Above 60 inches, the angles must be increased in strength and sized on an individual basis considering space requirements. Support vertical duct drops more than 6 feet in length with angle iron frames attached to ducts.

F. Refer to drawings for additional hanger details and requirements. Note that not all hangers are shown on the drawings are in the BIM model. The Contractor shall coordinate all hangers with the structure and other trades.

3.4 FLEXIBLE DUCTWORK

A. Low Pressure Flexible Ductwork
1. Do not exceed 6 feet in length with any flexible duct.
2. Flexible duct shall be limited to a maximum of a single 90 degree change indirection between the duct and the neck of the air device. This does not include the final turn into the neck of the air device.
3. Support ductwork independently of lights, ceiling and piping. Provide harness at connection to ceiling diffuser as indicated on details.
4. Provide two stainless steel work clamps on inner core and seal connection with duct sealant. The insulation and outer jacket shall be slipped over inner core connection to point where insulation abuts insulation on duct or diffuser. The insulation connections shall be sealed by embedding scrim tap and sealant to form a vapor barrier.

B. Medium Pressure Flexible Ductwork
1. Refer to details for maximum length of flexible ductwork upstream of terminal box.
2. Do not use flexible ductwork for changes in direction of airflow.
3. Provide two stainless steel work clamps on inner core and seal connection with duct sealant. The insulation and outer jacket shall be slipped over inner core connection to point where insulation abuts insulation on duct or terminal box. The insulation connections shall be sealed by embedding scrim tap and sealant to form a vapor barrier.

3.5 FLASHING

A. Where ducts pass through roofs or exterior walls, provide suitable flashing to prevent rain or air currents from entering the building. Provide flashing not less than No. 26 gage 316L stainless steel or 16 ounce copper.

3.6 DUCT LINING

A. Fiberglass acoustical lining is not permitted to be installed on this project except as indicated in this specification or specifically shown on drawings.

B. Install per manufacturer's recommendations. Keep internal lining clean during construction by keeping ends of ductwork sealed during storage and construction.

3.7 TESTS

A. Allowable Leakage. Test ductwork for leaks in accordance with SMACNA before concealing or insulating as indicated below. Arrange for the Owner's Representative to witness the test.
   1. Low pressure ductwork. Test low pressure ductwork at +2 inches W.G. Maximum allowable leakage (Lmax) per 100 ft^2 of ductwork shall be equal to $C_L \times P^{0.65}$, where $C_L = 6$ for rectangular ducts and round flexible ducts, $C_L = 3$ for round/flat oval ducts, and P = 2" for low pressure ducts.
   2. Medium pressure ductwork. Test medium pressure ductwork at +6 inches W.G. Maximum allowable leakage (Lmax) per 100 ft^2 of ductwork shall be equal to $C_L \times P^{0.65}$, where $C_L = 6$ for rectangular ducts and round flexible ducts, $C_L = 3$ for round/flat oval ducts, and P = 6" for medium pressure ducts.
   3. Lab exhaust ductwork. Test laboratory exhaust ductwork at +6 inches w.g. Maximum allowable leakage is 1/2% of the total system air flow rate. Where partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
   4. Test the following ductwork:
      a. Low pressure ductwork:
         1) All ductwork served by fan coil units.

B. Equipment. Provide equipment necessary for performing tests, including rotary blower, orifice section and U-tube gage board complete with cocks and rubber tubing.

3.8 CLEANING

A. Protect all ductwork and equipment from dirt during storage, installation and prior to grille, diffuser installation with protective covering at each end. Ductwork exposed to dirt and dust due to inadequate protection will have to be removed, cleaned and reinstalled.

B. Do not operate any air handling units or fan coil units during construction without filters.

C. Provide temporary filters on return air ductwork during construction to protect ductwork from dust.

D. Provide temporary filters on exhaust grilles during construction to protect ductwork from dust.

E. Do not operate laboratory exhaust fans or kitchen exhaust fans during any drywall operation to protect ductwork, hoods and laboratory control products.

END OF SECTION 23 31 00

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. Section Includes:
   1. Fire dampers.
   2. Combination fire and smoke dampers.
   3. Smoke dampers.
   4. Volume control dampers.
   5. Duct access doors.
   6. Conical spin-in fittings and taps
   7. Duct accessory hardware.
   8. Flexible Connection
   9. Portable Roof Duct Supports
   10. Laboratory exhaust accessories

1.3 RELATED WORK

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

B. Specification 23 31 00, Ductwork

1.4 SUBMITTALS

A. Product Data: Submit product data for each product. Refer to Section 23 00 00.

B. Fire and Combination Fire/Smoke Damper. Include manufacturer’s literature to include performance data and installation requirements. Include any wiring diagrams.

C. Access Doors. Include type of material, installation guidelines, leakage rates and maximum pressure data.

D. Volume Control Dampers. Include type of material, installation guidelines, pressure drop and maximum pressure data.

E. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      b. Manual volume damper installations.
      c. Control damper installations.

d. Fire-damper and smoke-damper installations, including sleeves; and duct-mounted access doors.
e. Wiring Diagrams: For power, signal, and control wiring.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 10.

B. Fire dampers, smoke dampers and combination fire/smoke dampers.
1. Include operation and maintenance information, including recommended testing requirements.
2. Assign identification numbers (FD – Fire Damper, FSD – Fire/smoke Damper, SD – Smoke Damper) for each damper. Include table in O&M manual that indicates identification number, room location, duct system and size.

1.6 QUALITY ASSURANCE

A. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references
1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
2. AMCA 500-D, “Laboratory Method of Testing Dampers for Rating”
3. NFPA 101 - Life Safety Code.
4. SMACNA - HVAC Duct Construction Standards Metal and Flexible – Second Edition
5. UL 555 – Standard for Fire Dampers.
6. UL 555C – Standard for Ceiling Radiation Dampers.
7. UL 555S – Standard for Smoke Dampers

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fire, Smoke and Fire/Smoke Dampers. Greenheck, Pottorff, Ruskin, Nailor.

B. Flexible Connections. Ductmate, Ventfabrics Ventglass.

C. Duct Access Doors. Ductmate, DuraSystems, Flexmaster, Greenheck, Ruskin, United McGill.

D. Roof Duct Supports. Portable Pipe Hangers, MAPA Products.

E. Conical Spin-in Fittings. Flexmaster, Buckley

F. Volume Control Dampers. Flexmaster, Greenheck, Prefco, Ruskin.

2.2 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316L, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

2.3 FIRE DAMPERS (FD)

A. Quality Standards. Furnish and construct fire dampers according to NFPA 90A and UL 555 (Dynamic). Dampers must bear UL label and suitable for dynamic application. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating 165 degrees F fusible link.

B. Construct fire dampers such that damper frame material and curtain material are galvanized.

C. Use Curtain Type Fire Dampers for fire dampers where possible. Use Multiple Blade Fire Dampers for fire damper sizes that exceed manufacturer's allowable Curtain Type Fire Damper sizes, or where velocities or pressures exceed Curtain Type Fire Dampers.

D. Curtain Type Fire Dampers (Type B)
1. Damper shall be classified for dynamic closure to 2000 fpm and 4 inches w.g. static pressure.
2. Damper shall have 5" frame constructed from minimum 20 gage galvanized steel.
3. Blades shall be minimum 24 gage galvanized steel.
4. Closure springs shall be Type 301 stainless steel, constant force or spring clip type.
5. Provide Grille, Grille Access Type or Out of Wall Type of frame where indicated on drawings.

E. Multiple Blade Fire Damper
1. Dampers shall be suitable for dynamic closure to 3000 fpm and 6 inches w.g. static pressure at 90"x64" for vertical installation and 60"x48" for horizontal installation.
2. Damper shall have 5" frame constructed from minimum 16 gage galvanized steel channel and reinforced at the corners.
3. Blades shall be 6" wide airfoil type and constructed from minimum 14 gage galvanized steel.
4. Bearings shall be self-lubricating stainless steel sleeve, turning in extruded hole in frame.
5. Blade seals shall be galvanized steel for flame seal to 1,900 degrees F and mechanically attached to blade edge.
6. Linkage shall be concealed in frame.
7. Provide ½-inch diameter plated steel hex shaped axle attached to blade.
8. Pressure drop shall be a maximum of 0.07 inches w.g. at 1,500 feet per minute through 24 x 24 inch damper.

2.4 COMBINATION FIRE AND SMOKE DAMPERS (FSD)

A. Quality Standards. Furnish and construct combination fire/smoke dampers according to NFPA 90A and UL 555 (Dynamic). Dampers must bear UL label and suitable for dynamic application and a Leakage Class 1 Smoke Rating in accordance with UL 555S. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating 165 degrees F. Dampers shall have a minimum 5 year warranty.
1. Dampers shall be suitable for dynamic closure to 3000 fpm and 6 inches w.g. static pressure at 120"x96" for vertical installation and 144"x96" for horizontal installation.
2. Damper shall have 5" frame constructed from minimum 16 gage galvanized steel channel and reinforced at the corners.
3. Blades shall be 6" wide airfoil type and constructed from minimum 14 gage (equivalent) galvanized steel.
4. Bearings shall be self-lubricating stainless steel sleeve, turning in extruded hole in frame.
5. Blade seals shall be inflatable silicone fiberglass material, rated for maintaining smoke leakage at a minimum of 450°F and galvanized steel for flame seal to 1,900 degrees F. Seals shall be mechanically attached to blade edge. Provide stainless steel flexible metal compression jamb.
6. Linkage shall be concealed in frame.
7. Provide ½-inch diameter plated steel hex shaped axle attached to blade.

8. Temperature Release Device. Close in a controlled manner and lock damper during test, smoke detection, power failure, or fire conditions through actuator closure spring. At no time shall actuator disengage from damper blades. Allow damper to be automatically and remotely reset after test or power failure conditions. After exposure to high temperature or fire, inspect damper before reset to ensure proper operation. Controlled closing and locking of damper in 7 to 15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable.
9. Actuator. Provide electric 120V [24V], 60 Hz, two-position, fail close actuator. Operators shall be UL listed and labeled.
10. Pressure drop shall be a maximum of 0.07 inches w.g. at 2,000 feet per minute through 24 x 24 inch damper.

2.5 SMOKE DAMPERS (SD)

A. Quality Standards. Furnish and construct smoke dampers according to NFPA 90A and UL 555 (Dynamic). Dampers must bear UL label and suitable for dynamic application and a Leakage Class 1 Smoke Rating in accordance with UL 555S. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating 165 degrees F. Dampers shall have a minimum 5 year warranty.
1. Dampers shall be suitable for dynamic closure to 3000 fpm and 6 inches w.g. static pressure at 120”x96” for vertical installation and 144”x96” for horizontal installation.
2. Damper shall have 5” frame constructed from minimum 16 gage galvanized steel channel and reinforced at the corners.
3. Blades shall be 6” wide airfoil type and constructed from minimum 14 gage (equivalent) galvanized steel.
4. Bearings shall be self-lubricating stainless steel sleeve, turning in extruded hole in frame.
5. Blade seals shall be inflatable silicone fiberglass material, rated for maintaining smoke leakage at a minimum of 450°F. Seals shall be mechanically attached to blade edge. Provide stainless steel flexible metal compression jamb.
6. Linkage shall be concealed in frame.
7. Provide ½-inch diameter plated steel hex shaped axle attached to blade.
8. Actuator. Provide electric 120V [24V], 60 Hz, two-position, fail close actuator. Operators shall be UL listed and labeled.
9. Pressure drop shall be a maximum of 0.07 inches w.g. at 2,000 feet per minute through 24 x 24 inch damper.

2.6 VOLUME CONTROL DAMPERS

A. Provide volume dampers in round and rectangular ductwork where indicated on drawings.

B. General Fabrication Requirements:
1. Comply with SMACNA Chapter 2, "Volume Dampers" unless more stringent requirements are indicated. Provide single blade dampers on round dampers and for rectangular dampers not exceeding 36-inches in width or 12-inches in height. Provide multiblade rectangular dampers for dampers exceeding 36-inches in width or 12-inches in height or where required due to velocity or pressure requirements.
2. Refer to Specification 23 31 13 Ductwork for application table that defines Low and Medium Pressure ductwork.
3. Provide a locking hand quadrant on all dampers. Mount quadrant regulators on stand-off mounting brackets, bases, or adapters on insulated ducts.
4. For stainless steel ductwork, provide stainless steel finish to match ductwork material.
5. Shop fabricated dampers are not acceptable.

C. Round Dampers.
1. Low Pressure. Provide single blade damper with minimum 20 gage galvanized steel frame, minimum 20 gage galvanized steel blade, continuous 3/8" square plated steel axle mechanically attached to blade, and bronze or oilite bearings. Dampers shall be suitable for 1500 feet per minute velocity and a maximum pressure of 2"W.G. when closed, and a maximum pressure drop of 0.03"W.G at 1500 feet per minute through a 20-inch damper when tested in accordance with AMCA Fig. 5.3.
2. Medium Pressure. Provide single blade damper with minimum 20 gage galvanized steel frame, minimum 14 gage (equivalent) galvanized steel blade, continuous 1/2" square plated steel axle mechanically attached to blade, and bronze or oilite bearings. Dampers shall be suitable for 3000 feet per minute velocity and a maximum pressure of 4"W.G. when closed, and a maximum pressure drop of 0.06"W.G at 2000 feet per minute through a 24-inch damper when tested in accordance with AMCA Fig. 5.3.

D. Rectangular Dampers.
1. Low Pressure Single Blade Damper (Fans systems with less than 1"W.G. Static Pressure). Provide single blade damper with minimum 3-inch x 20 gage galvanized steel frame, minimum 20 gage galvanized steel blade on dampers up to 18-inches wide, 16 gage on dampers over 18-inches wide. Provide a continuous 3/8" square plated steel axle mechanically attached to blade, and synthetic flanged sleeve type bearing. Dampers shall be suitable for 1500 feet per minute velocity and a maximum pressure of 1"W.G. when closed.
2. Low Pressure Multi-Blade Damper. Provide opposed multi-blade damper with minimum 5-inch x 16 gage galvanized steel frame, minimum 16 gage triple V galvanized steel blade. Provide a continuous 1/2" square plated steel axle mechanically attached to blade and external (out of airstream) blade-to-blade linkage. Provide bronze or oilite bearings. Dampers shall be suitable for 1500 feet per minute velocity and a maximum pressure of 3"W.G. for up to a 24-inch wide damper when closed. Damper shall have a maximum pressure drop of 0.1"W.G. at 1500 feet per minute through a 24-inch x 24-inch damper.
3. Medium Pressure Damper. Provide opposed multi-blade damper with minimum 5-inch x 1-inch 16 gage galvanized steel channel frame. Blades shall be minimum 16 gage triple V galvanized steel blade. Provide a continuous 1/2" square plated steel axle mechanically attached to blade and external (out of airstream) blade-to-blade linkage. Provide bronze or oilite bearings. Dampers shall be suitable for 3000 feet per minute velocity and a maximum pressure of 5"W.G. for up to a 24-inch wide damper when closed. Damper shall have a maximum pressure drop of 0.16"W.G. at 2000 feet per minute through a 24-inch x 24-inch damper when tested in accordance with AMCA Fig. 5.3.
4. Low Pressure Drop Medium Pressure Damper. Provide opposed multi-blade damper with minimum 4-inch x 1-inch 0.125-inch thick aluminum channel frame. Blades shall be extruded aluminum airfoil type, minimum 0.125-inch thick. Provide a continuous 1/2" square plated steel axle mechanically attached to blade and linkage concealed in jamb. Provide bronze or oilite bearings. Dampers shall be suitable for 5000 feet per minute velocity and a maximum pressure of 5"W.G. for up to a 24-inch wide damper when closed. Damper shall have a maximum pressure drop of 0.1"W.G. at 2000 feet per minute through a 24-inch x 24-inch damper when tested in accordance with AMCA Fig. 5.3.

E. Splitter Dampers. Fabricate splitter dampers of minimum 16 gauge thickness sheet metal to streamline shape. Secure blade with continuous hinge or rod. Operate with minimum 1/4" diameter rod in self-aligning, universal joint action flanged bushing with set screw. Control splitter with locking quadrants on exposed externally insulated ductwork.

2.7 DUCT ACCESS DOORS

A. Square Frame Access Doors
   1. Low Pressure Ductwork
      a. Construct outer frame of minimum 22 gage roll formed galvanized steel with installation tabs. Door shall be removable double wall door constructed of 24 gage galvanized steel and insulated with 1-inch of insulation (R-4). Provide minimum 2 manually operated cam locks on access doors 16-inches and under, 4 cam locks for doors greater than 16-inches. Provide foam gasket seal between door and frame and between frame and duct.
      b. Performance. 24”x24” access door shall be suitable for up to 2”W.G. and have a maximum leakage of 0.15 CFM/sq.ft. at 1”W.G. pressure.
   2. Medium Pressure Ductwork
      a. Construct outer frame of minimum 22 gage roll formed galvanized steel with installation tabs. Door shall be removable double wall door constructed of 24 gage galvanized steel and insulated with 1-inch of insulation (R-4). Provide minimum 4 manually operated cam locks on access doors 16-inches and under, 8 cam locks for doors greater than 16-inches. Provide foam gasket seal between door and frame and between frame and duct.
      b. Performance. 24”x24” access door shall be suitable for up to 10”W.G. and have a maximum leakage of 0.15 CFM/sq.ft. at 1”W.G. pressure.

B. Round “Spin” Access Doors
   1. Construct outer frame of minimum 22 gage roll formed, double hemmed galvanized steel. Door shall be revovable double wall door constructed of 24 gage galvanized steel and insulated with 1-inch of insulation (R-4). Provide minimum 3 manually operated cam locks on access door. Provide continuous foam gasket between door and frame.

C. Grease-Laden Vapor Exhaust Ductwork Access Doors
   1. Access door shall be constructed of same material and same thickness as grease exhaust ductwork and be UL Listed.
   2. Access panels shall have a gasket or sealant that is rated for 1500ºF and shall be grease tight.
   3. Fasteners, such as bolts, weld studs, latches or wing nuts, used to secure the access panels shall be of carbon steel or stainless steel and must not penetrate the duct walls.
   4. Access doors shall be suitable for zero clearance fire rated insulation when required. Refer to Specification 23 07 13 External Duct Insulation for coordination.
   5. For factory built grease exhaust ductwork, provide access doors manufactured by the ductwork manufacturer.

D. For stainless steel ductwork, provide stainless steel finish to match ductwork material.

E. Where duct size permits, access door size shall be 18-inches in diameter or 18” x 16” for oval and rectangular doors. For duct sizes under 20-inches, provide access door 2-inches smaller than duct size. For ducts 12-inches wide, provide minimum 10” x 12”.

2.8 CONICAL SPIN-IN FITTINGS AND TAPS

A. General Construction. For stainless steel ductwork, provide stainless steel finish to match ductwork material.

B. Furnish conical spin-in fittings with quadrant dampers at all round runout ducts serving diffusers and grilles. Fabricate conical fitting of 26-gage galvanized sheet metal with 2-inch build out, continuous 3/8” square shaft, air tight nylon bushings and locking quadrant handle. Connect damper plate to shaft with a minimum 2 u-bolts on dampers 12-inches and greater.

2.9 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Drill temporary test holes for balancing in ducts as required. Cap with neoprene plugs, threaded plugs, or threaded or twist-on metal caps. Provide neat patch on external duct insulation and label as “Test Plug”.

C. Provide permanent test holes in ductwork upstream and downstream of all coils, fans, and locations as indicated on drawings. Test holes shall be factory fabricated, airtight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.10 FLEXIBLE CONNECTIONS

A. Provide air-tight flexible connections where ductwork connects to fans, air handling units and fan coil units with fabric as specified below:

Application	**Fabric**	**Coating**	**Gauge**
HVAC (Indoor)	Fiberglass	Neoprene	28
HVAC (Outdoor & Lab)	Fiberglass	Hypalon	28

B. The fabric shall be UL listed, fire retardant, waterproof and mildew resistant, crimped into metal edging strip.

2.11 ROOF DUCT SUPPORTS:

A. Engineered, portable system specifically designed for installation without the need for roof penetrations or flashings, and without causing damage to the roofing membrane. Factory fabricated to support exact duct sizes to be installed.

B. Design system using minimum 14 inch x 16 inch high density polyethylene or 14 gauge stainless steel bases.

C. Provide 1-5/8 inch or 1-7/8 inch 12 gage stainless steel structural steel framing, as required for loading conditions. Framing shall be 3-sided or tubular shape with mill finish.

D. Provide stainless steel clamps, bolts, nuts, washers, and other devices as required for a complete system.

2.12 LABORATORY EXHAUST ACCESSORIES

A. Low-Leakage Isolation Damper (Gas Tight Dampers for Type IIB2 Hoods)
1. Acceptable Manufactures
   a. NuAire
   b. Greenheck
   c. Flanders
   d. Ruskin
2. Dampers shall be a gas tight, positive seal, isolation type shall not exceed a leakage rate of 0.029 cfm/inch of circumference of blade at 10 inches water gage. The design pressure of the damper shall be 10 inch water gage. Damper housings shall be cylindrical and constructed of 10 ga., T-304 stainless steel. Blade shall consist of two 10 ga. T-304 stainless steel plates with a closed cell neoprene rubber gasket between them. Blade seal shall occur when the neoprene gasket seats against the inside of the 10 ga. housing wall. The damper shall be all weld design. All "pressure retaining" weld joints and seams shall be continuously welded" weld joints and seams requiring only intermittent welds by design shall not be continuously welded. As a minimum, all weld joints and seams shall be wire brushed and/or buffed to remove heat discoloration, burrs and sharp edges. All welding procedures, welders, and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX.
3. Flanges: Minimum of 1-1/2" wide. Factory drilled bolt holes (7/16' diameter) shall be no more than 4" apart as recommended in ERDA 76-21, "Nuclear Air Cleaning Handbook."

4. Frame: 10 ga. (min) T-304 stainless steel (unpainted).
5. Shaft & Linkage Components: All components of the blade are manufactured from 300 Series stainless steel. Shafts are 1/4" diameter (mm.) stainless steel rod with shaft seals.
6. Manual (M): Manual actuator shall be a 1/2 turn worm geared actuator with handwheel. Actuator has aluminum base and cover Rated output torque shall be 2000 inch pounds with a gear ratio of 301. Actuator shall be fully lubricated and self-locking to hold in any position.
7. Damper shall be manufactured under a quality assurance program that addresses the requirements of ANSI/ASME NQA-1, "Quality Assurance Program Requirements for Nuclear Facilities." All production welds shall be visually inspected per CSC's standard procedure number P-122, "Visual Inspection of Welds," which incorporates the workmanship acceptance criteria described in Section 4 and 5 of AWS D9 1, "Specification for Welding of Sheet Metal." The damper blade shall be tested in the ANSI/ASME N-510-1980, "Testing of Nuclear Air Cleaning Systems." Blade shall not exceed a leakage rate of 0.029 cfm/inch of circumference of blade. The complete pressure boundary (damper housing) shall be tested same as the blade, except the maximum leak rate shall be 0.005 cfm/sq.ft. of housing surface.
8. Dampers shall be equal to NuAire Model NU940.

B. C.A.T.S. E-Z Joint Connector. Provide Type 316L stainless steel round duct joint connector for connection of ductwork at lab exhaust valve as indicated in drawing details. Product shall be manufactured by Standard Sheet Metal Works. System shall consist of ½" flanged end duct connectors meeting requirements of SMACNA, and suitable up to 30"W.G. positive/negative pressure. System shall include Nitril/PVC blend gasketing.

C. Fernco Fitting. Provide Fernco coupling at fume hood connection as indicated in drawing details. Coupling shall resistant to UV and conform to ASTM D5926. Provide two stainless steel clamps for connection to ductwork. Coupling shall be suitable for temperatures between -30°F and 140°F and pressures up 4.3 psig.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

3.2 ACCESS DOORS

A. Install duct access doors on sides or bottom of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
1. Upstream and downstream of duct mounted duct coils.

2. Downstream from manual volume dampers (not spin-in fittings).
3. Downstream of control dampers.
4. Upstream of airflow measuring stations.
5. Adjacent to and close enough to fire, smoke and combination fire/smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
6. At duct mounted smoke detectors.
7. Upstream or Downstream of turning vanes.
8. In internally lined ductwork, provide access doors for duct liner inspection at 50 foot intervals and downstream of each elbow or branch fitting. Access doors are not required in return air boots.
9. Elsewhere as indicated on drawings, details or specifications.

B. Label access doors according to Section 23 05 53 - Identification for HVAC Piping and Equipment to indicate the purpose of access door.

C. Grease-Laden Vapor Exhaust Ductwork Access Doors. Provide access doors where required per NFPA96 and IMC. This includes:
1. Spaced at not more than 12-foot intervals in horizontal ductwork.
2. Every change in direction of horizontal duct.
3. Openings in vertical ducts at every floor or on the top of the vertical riser if personnel entry is possible.
4. Within 3-feet of exhaust fans with horizontal connected ductwork.

3.3 FIRE, SMOKE AND COMBINATION FIRE/SMOKE DAMPERS

A. Install dampers at locations indicated on the drawings and in accordance with manufacturer's UL approved installation instructions.

B. Install dampers square and free from racking with blades running horizontally.

C. Do not compress or stretch damper frame into duct or opening.

D. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jackshaft.

E. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

F. Provide access doors for all fire, smoke and combination fire/smoke dampers. Refer to details for additional requirements.

3.4 CONICAL SPIN-IN FITTINGS AND TAPS

A. Install conical spin-in fittings with quadrant dampers to serve diffusers as indicated on drawings.

B. After installation of spin-in fitting, seal all around connection to meet leakage class indicated in Specification 23 31 13.

3.5 VOLUME CONTROL DAMPER

A. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

B. Set dampers to fully open position before testing, adjusting, and balancing

3.6 ROOF DUCT SUPPORTS

A. Verify that roofing system is complete and that roof surfaces are smooth, flat, and ready to receive work of this Section. Verify that roof surface temperature is at minimum 60°F for proper adhesive performance.

B. Clean surfaces of roof in areas to receive portable support bases. Remove gravel from gravel surfaced roofs. Remove dirt, dust, oils, and other foreign materials. Prime roofing membrane with a primer compatible with existing components in the roofing system.

C. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all ducts, whether or not all required devices are shown. Install framing at spacing indicated, but in no case at greater than 15 ft on center. Accurately locate and align bases. Set in adhesive if required by manufacturer's installation instructions. Where applicable, replace gravel around bases. Set framing posts into bases and assemble framing structure as indicated. Use stainless steel fasteners for stainless steel framing. Install ductwork as shown on detail.

3.7 FLEXIBLE CONNECTIONS

A. Install at connections between ductwork and motor driven equipment as shown. Provide a minimum of 1 inch slack in the connections, and a minimum of 2-1/2 inches distance between the edges of the ducts and equipment. Also provide a minimum of 1 inch slack for each inch of static pressure on the fan system. Securely fasten flexible connections to equipment and to adjacent ductwork by means of sealant with sheet metal screws. Where flex ductwork is connected to oval collars in diffusers and plenums, provide a metal transition fitting from oval to round.

3.8 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Operate all volume dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke and combination fire/smoke dampers to verify full range of movement per NFPA and verify that proper heat-response device is installed.

END OF SECTION 23 33 00

SECTION 23 37 00 - AIR DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. Section includes air distribution devices including the following:
   1. Diffusers.
   2. Grilles.
   3. Registers.

1.3 COOPERATION WITH OTHER TRADES

A. Coordinate work with Division 26 Electrical Sections to ensure intended functions of lighting and air systems are achieved.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: At the request of the Owner and/or A/E team, submit each exposed product for each color and texture specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products meeting all requirements of this specification Section of the following manufacturers are acceptable:
   1. Diffusers, Grilles and Registers. Krueger, Price, Metalaire, Titus.
   2. Sound Attenuators. Commercial Acoustics, Transonics, United McGill, Price, Vibroacoustics.

2.2 DIFFUSERS

A. Square Plaque Diffuser (MARK A – E) :
   1. Provide aluminum plaque diffuser, precision formed back cone of one-piece seamless construction which incorporates a round inlet collar of sufficient length for connecting rigid or flexible duct. An inner plaque assembly shall be incorporated that drops no more than 1/4 inch below the ceiling plane to assure proper air distribution performance. The inner plaque assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near the diffuser neck.
   2. Finish shall be White Powder Coat.
   3. Provide transitions for rectangular duct connections if required.

B. Perforated (MARK F – K):
1. Provide steel frame construction with aluminum perforated face and white factory finish. Frame the diffuser face with a mitered and welded frame.
2. Face shall have no less than 51% free area.

C. Radial (Laboratory) Diffusers (MARK N – Q):
1. Air diffuser shall provide a non-aspirating radial air pattern, projecting air horizontally, vertically in a radial direction.
2. Shall be constructed of 6-inch-tall stainless-steel back pan. All pattern controllers shall be internal to the unit. The back pan shall have integral hanger tabs for securing the unit to the overhead structure.
3. The face of the diffuser shall be constructed of perforated stainless steel. Provide face hinged access to permit interior access without having to remove the back pan. Provide foam gasketing at face and back pan interface. Provide white finish.

D. Flush Faced Radial (Laboratory) Diffusers (MARK N – Q):
1. Air diffuser shall provide a flush face, non-aspirating radial air pattern, projecting air horizontally, vertically in a radial direction.
2. Shall be constructed of 6-inch-tall stainless-steel back pan. All pattern controllers shall be internal to the unit. Provide foam gasketing.
3. The face of the diffuser shall be constructed of perforated stainless steel and shall not protrude below the ceiling. Provide white finish.

2.3 DIFFUSERS - PART OF A RATED CEILING ASSEMBLY

A. Provide UL fire rated ceiling diffuser with louver face, radiation fire damper and thermal blank radiation barrier.

2.4 GRILLES

A. Supply (MARK L):
1. Use double-deflection supply grilles made of aluminum.
2. Install vertical face blades and horizontal rear blades. Provide solid, extruded aluminum blades which are individually adjustable. Space at not more than 3/4-inch centers for rear blades and 1/2-inch centers for face blades and not less than 5/8 inch deep.
3. Employ grille frames of extruded aluminum with welded and mitered corners and mounting gaskets.
4. Provide white finish on all grilles unless indicated otherwise on drawings.
5. Provide integral [steel] [aluminum] opposed blade damper with [black finish] [mill finish].

B. Return and Exhaust (MARK M):
1. For ceiling return, provide scheduled diffuser with white factory finish. Use construction and frame styles as specified for ceiling diffusers, but without pattern controllers. Use neck sizes as shown.
2. For wall return and exhaust, provide a 45-degree fixed-blade aluminum grille. Provide 3/4-inch blade spacing as scheduled, with front blades parallel to long dimension. Provide solid, extruded frames and aluminum blades which are individually adjustable on sizes larger than 24 inches x 24 inches, roll-formed aluminum blades for smaller grilles. Include mounting gaskets. Provide white finish unless noted otherwise on drawings.
3. Provide [steel] [aluminum] opposed blade damper with [black finish] [mill finish] for all air devices used for exhaust.

C. Spiral Duct Grille (MARK LL) :
1. Shall be a double deflection type with two sets of fully adjustable deflection blades, spaced ¾” on center. Grille shall be mounted on spiral ductwork without use of transitions. Grille shall be curved to match the radius of the duct.
2. Front blades shall run parallel to the short dimension.
3. Provide air-scoop adjusted via operator on the side frame for balancing.

4. Provide finish that can be painted in field.
5. Provide closed cell foam gasket attached to the border to provide a tight seal around opening of the ductwork.

D. Heavy Duty Return (MARK XX):
1. Provide a 0-degree fixed-blade 14 gauge steel grille. Provide 3/8-inch blade spacing as scheduled, with front blades parallel to long dimension. Include mounting gaskets. Provide white finish unless noted otherwise on drawings. Provide key operated opposed blade damper for all air devices.

2.5 ACCESSORIES

A. Supply Grille Extractors. Provide each supply grille with an air control device capable of positively regulating the volume of air extracted from the supply duct.
1. Select extractors similar to Price Model AE1, tight-closing in the minimum position. Include a key-operated or worm-gear adjusting mechanism to facilitate positioning from the grille opening. Where adjustment is not accessible at the grille opening, provide a control rod equipped with a locking quadrant.
2. For ductwork control, use Young regulators. Provide extractors 30 inches and longer with a support rail inside of the duct at the outboard quarter point of the extractor. Construct the support rail of angle or channel members formed of sheet metal fastened securely to the duct. Make the rails 18 inches long, except where duct width prevents the extractor from sagging when moved toward its maximum position.
3. Check extractors thoroughly for freedom of operation. If necessary, oil bearing points before installing.

B. Mounting Frames. Provide each grille or register not equipped with a removable core with a companion, all-purpose mounting frame constructed like a grille frame to facilitate installation and removal of the grille or register without marring adjacent mounting surfaces.
1. Furnish frames with 1/2-inch-thick sponge rubber gasket to prevent air leakage.
2. Provide a frame that neatly fits the grille. Mounting frames will not be required for grilles or registers mounted directly on exposed ductwork.

2.6 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 GENERAL

A. Protect all HEPA fan filter units on site from dirt, water and exposure to outside elements. Unit shall remain in dust-tight container until ready for installation in clean rooms. Protect HEPA fan filter units after installation and prior to start-up. Do not start-up fan filter units until space is deemed clean.

3.2 INSTALLATION

A. Do not install ceilings adjacent to fixtures until installation of fixtures, air supply assemblies, return-air blank-off strips and flexible duct have been properly approved. Remove and reinstall any part of the installation found incorrect.

B. Diffusers. Louvered diffuser outlets mount tight against the ceiling. Fasten outlets securely to ductwork with sheet metal screws. For perforated diffusers, attach the frame assembly by a concealed hinge assembly to an outer frame compatible with the type of ceiling on which the diffuser is installed.

C. Radial Diffusers. Install per manufacturer's recommendations and as indicated in the details. All radial diffusers to be independently hung from structure.

3.3 ADJUSTING

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

END OF SECTION 23 37 00

SECTION 23 41 00 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.3 RELATED WORK

A. Section 23 73 23, Air Handling Units

1.4 REFERENCES

A. AMCA 99 – Standards Handbook.

B. ARI 850 – Commercial and Industrial Air Filter Equipment.

C. ASHRAE 52.1 – Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter.

D. ASHRAE 52.2 – Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size.

E. ASHRAE 62 – Ventilation for Acceptable Indoor Air Quality.

F. IEST RP-CC—1 – HEPA Filters.

G. NFPA 70 – National Electrical Code.

H. SMACNA – HVAC Duct Construction Standards – Metal and Flexible.

I. UL 586 – High Efficiency, Particulate Air Filter Units.

J. UL 900 – Test Performance of Air Filter Units.

1.5 DEFINITIONS

A. IEST – Institute of Environmental Sciences and Technology.

B. MERV – Minimum Efficiency Reporting Value.

1.6 SUBMITTALS

A. Product Data: Include dimensions; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; MERV rating, efficiency and test method; fire classification; furnished specialties; and accessories for each unit indicated.

B. Shop Drawings: Include plans, elevations, sections, and details to illustrate component assemblies and attachments.
   1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
   2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
   3. Include wiring diagrams.

C. Operation and Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the specified products with minimum three years documented experience, who issues complete catalog data on total product.

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

C. Comply with ARI 850.

D. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.

E. Comply with NFPA 90A and NFPA 90B.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site in accordance with Section 23 00 10, Mechanical General Provisions.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean, dry space and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

D. Ship equipment to jobsite with not less than a prime coat of paint or as specified.

1.9 PROJECT CONDITIONS

A. Environmental Requirements: Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fans have been test run under observation.

1.10 SCHEDULING

A. Capacities and characteristics are generally shown on schedules on Drawings. Reference shall be made to schedules for such information.

B. Capacities shown are minimum capacities. Variations in capacities of scheduled equipment supplied under contract will be permitted only with written direction from Owner.

1.11 MAINTENANCE

A. Extra Materials: Provide two complete sets of filters for each unit. Tag to identify associated unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AAF International.
2. Cambridge.
3. Camfil
4. Flanders
5. Koch
6. Dwyer Instruments, Inc.

2.2 FILTERS

A. Filters shall be listed as Class 2 in accordance with UL 900 and shall be tested and reported in accordance with ASHRAE Test Standards 52.1 and 52.2. Dust spot efficiencies listed are results when tested by ASHRAE Standard 52.1. MERV and MERV-A values listed are results when tested by ASHRAE Standard 52.2. and ASHRAE Standard 52.2 Appendix J.

B. Medium Efficiency Panel Filter (Disposable, Dry Type)
1. MERV 8-A Filters:
a. Media: 0.18-inch nonwoven cotton and synthetic blend media, formed into a uniform radial pleat. Provide industry standard sizes as required for installation. The minimum media area shall be 17.3 square feet for a 24X24 filter.
b. Frame: Provide filter media in permanent removable frames with corrosion resistant welded wire grid bonded to the downstream side of the media. Media shall be fully bonded to frame to prevent air leakage.
c. Rating: Initial resistance no greater than 0.31-inches w.g. at 500 FPM face velocity. Minimum Efficiency Reporting Value shall be MERV 8, dust spot efficiency of 25-30 percent.
d. Thickness: 2-inches or 4-inches. Pre-filters shall be 2-inches unless otherwise noted on the Drawings or Specifications.

PART 3 - INSTALLATION

A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

B. Install filters in position to prevent passage of unfiltered air.

C. Coordinate filter installations with duct and air-handling unit installations.

D. Electrical wiring and connections are specified in Division 26 Electrical Sections.

END OF SECTION 23 41 00

SECTION 23 57 00 - HEAT EXCHANGERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 WORK INCLUDED

A. Shell & Tube Heat Exchangers. Perform all Work required to provide and install shell and tube heat exchangers, accessories and trim indicated by the Contract Documents with supplementary items necessary for proper installation and operation

B. Plate & Frame Heat Exchangers. Perform all Work required to provide and install plate and frame heat exchangers, accessories and trim indicated by the Contract Documents with supplementary items necessary for proper installation and operation

1.3 RELATED WORK

A. Section 23 00 00, Mechanical General Provisions

B. Section 23 07 19, Piping Insulation.

C. Section 23 07 16, Equipment Insulation.

D. Section 23 21 16, Hydronic Specialties.

E. Section 23 21 00, Hydronic Piping and Fittings

F. Section 23 22 13, Steam and Steam Condensate Piping

1.4 REFERENCES

A. ASME Section VIII

B. AHRI Standard 400 – Liquid to Liquid Heat Exchangers

1.5 REGULATORY REQUIREMENTS

A. Conform to ASME Section VIII

B. Units shall be “U” stamped to ASME code requirements. The manufacturer’s data report (form U-1) shall be available on request by owner or engineer.

1.6 QUALITY ASSURANCE

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

B. AHRI Certification: Plate heat exchanger shall be certified according to AHRI Standard 400 and listed on the AHRI Directory site (http://www.ahridirectory.org). If heat exchanger is not AHRI certified, then the manufacturer shall provide an independent third-party field performance test using mapped ratings and tolerances of AHRI Standard 400 to verify performance to specification. Any and all cost associated with correcting a non-performing heat exchanger to meet performance requirements shall be the responsibility of the supplier. Any cost associated with the field performance test shall be included in the price of the heat exchanger.

C. ASME Certification: The complete assembly shall be factory assembled and tested in accordance with ASME Code, Section VIII, Division I, and furnished with ASME Code Certification (VI Form) for design pressures as specified in this Section.

1.7 SUBMITTALS

A. Submit shop drawings and product data for manufactured products and assemblies required for this project.

B. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.

C. Submit schedule indicating manufacturer, model number, size, location, rated capacity, and features for each specialty.

D. Submit manufacturer's installation instructions.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 10.

B. Protect internals from entry of foreign material by temporary caps on flanged openings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Shell & Tube Heat Exchangers
1. Taco
2. Thrush
3. Armstrong

2.2 SHELL AND TUBE TYPE HOT WATER CONVERTER

A. Tubes. U tube type with ¾" OD minimum, 20 gage seamless copper tubes suitable for 150 psig working pressure. On double wall tube units, the inner and outer tube shall be constructed of the same material.

B. Shell. Steel pipe with threaded or flanged piping connections and necessary tapings, steel saddle and attaching U-bolts, prime coated.

C. Heads. Cast iron, rolled naval brass tube sheets, threaded or flanged for piping connections.

D. Separators: Separators shall be constructed of the same material as the tubes.

E. Water Chamber and Tube Bundle. Removable for inspection and cleaning.

F. Design. Heating fluid in shell and heated fluid in tubes.

G. Trim:
1. Shell. Pressure gage tapping with pigtail siphon and vacuum breaker.
2. Water Inlet. Thermometer well, pressure gage tapping and valved drain.
3. Water Outlet. Thermometer well for temperature regulator sensor, ASME rated pressure and temperature relief valve, thermometer well and pressure gage tapping.
4. Pressure relief valve selected for pressure and flow rate as required.

H. Saddles: Provide each unit with adjustable saddles.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

A. General

B. Shell & Tube Heat Exchangers:
1. All installation shall be in accordance with drawings and manufacturer's installation instructions.
2. Install to permit removal of tube bundle with minimum disturbance to installed equipment and piping.
3. Support vessel on welded steel channel and angle floor stand with condensate return units below set on concrete housekeeping (equipment) pad.
4. Pitch shell to completely drain.
5. Pipe relief and drain valves to nearest floor drain.
6. Provide reducers as required for connections to the equipment.

C. Heat Exchanger Trim
1. Provide thermometers, wells, and pressure gages in supply and return piping on both the hot and cold connections to the exchanger.

D. Heat Exchanger Insulation
1. Insulate heat exchanger frame and plate shroud as required to prevent condensation on cold surfaces.

END OF SECTION 23 57 00

SECTION 23 82 19 - FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including "Uniform General Conditions and Supplementary General Conditions For The State Of Texas Building Construction Contracts" and Division 01 Specification Sections, apply to the work of this Section.
   1. Where the term “Owner’s Designated Representative” is used, it shall mean a member of the project’s capital team as defined by UTMB, Facilities Design and Construction, 1302 Mechanic, Galveston, Texas 77555-1116
   2. Phone (409) 772-3500-, Fax (409) 772-5199.

1.2 SUMMARY

A. This Section specifies horizontal fan coil units for concealed overhead or exposed installation.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

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

B. Units shall be AHRI 440 certified and labeled.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IESNA 90.1 or IECC Compliance.

1.5 WARRANTY

A. Provide one (1) year manufacturer’s warranty. Include coverage of fan-coil unit and motors.

1.6 DEFINITION

A. Exposed cabinet is defined as a unit that does not have supply or return duct connections, but has integral supply and return registers.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan-Coil-Unit Filters: Install new filters at substantial completion per Part 3 of this specification. Furnish one additional spare filters for each filter installed to be used by Owner after substantial completion.
   2. Fan Belts: Furnish one spare fan belt for each belt driven unit installed

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide scheduled products by one of the following:
   1. Daikin
   2. Enviro-Tec, Inc.
   3. Greenheck
   4. International Environmental Corporation.
   5. Johnson Controls
   6. Temtrol
   7. Zehnder Rittling

2.2 DIRECT DRIVE FAN-COIL UNITS

A. Cabinet. Construct of heavy gauge galvanized steel panels. Exposed units shall be shall be finished with a heat cured anodic acrylic powder paint of the standard factory color. All units shall be insulated with 1/2-inch, 1-1/2 pound foil faced fiberglass insulation meeting NFPA 90A requirements. Insulate coil and fan sections. Seal insulation edges.

B. Access. Exposed units shall have fan and filter bottom access panel attached with quarter turn quick open fasteners for access to service.

C. Fan. Unit fan shall be a dynamically balanced, forwardly curved, DWDI centrifugal type constructed of 18 gauge zinc coated galvanized steel for corrosion resistance. The fan assembly shall be easily removable for servicing the motor and blower at, or away from the unit. Plenum unit fan assemblies shall be easily serviced through an access panel provided.

D. Motor. Motors shall be high efficiency, permanently lubricated sleeve bearing, permanent split-capacitor type with UL and CSA listed automatic reset thermal overload protection and three separate horsepower taps. Single speed motors are not acceptable.

E. Hydronic Coil. 1/2 inch copper tube, 0.016-inch tube wall thickness, with mechanically bonded aluminum fins spaced no closer than 12 fins/inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220°F. Include manual air vent and drain valve.

F. Drain Pan. Primary condensate drain pans shall be single wall, heavy gauge stainless steel for corrosion resistance, and extend under the entire cooling coil. Drain pans shall be of one-piece construction and be positively sloped for condensate removal. Drain pans on concealed models shall be field reversible for right or left hand connections. The drain pan shall be externally insulated with a fire retardant, closed cell foam insulation. The insulation shall carry no more than a 25/50 Flame Spread and Smoke Developed Rating per ASTM E-84 and UL 723 and an Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21

G. Filters. All plenum and exposed units shall be furnished with a minimum 1" pleated MERV 6 filter. Filters shall be tight fitting to prevent air bypass. Plenum unit filters shall be easily removable from the bottom of the unit without the need for tools.

H. Electrical. Units shall be furnished with single point power connection. Provide an electrical junction box with terminal strip for motor and other electrical terminations. The factory mounted terminal wiring strip consists of a multiple position screw terminal block to facilitate wiring terminations for the electric control valves and thermostats. Provide unit mounted three speed fan and disconnect switch.

I. Controls: All controls, including terminal equipment controller for fan coil unit shall be supplied by Temperature Controls Contractor to fan coil unit manufacturer for factory installation.

J. Options: Refer to FCU Schedule
1. Provide double deflection discharge grille where indicated on fan coil unit schedule.
2. Provide insulated mixing box with return and outside air connections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fan-coil units to comply with NFPA 90A.

B. Suspend fan-coil units from structure with vibration isolators as specified in Section 23 05 48, Vibration Isolation for HVAC Piping and Equipment.

C. Verify locations of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Install new filters in each fan-coil unit at Substantial Completion.

E. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

F. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Section 23 33 00, Air Duct Accessories. Comply with safety requirements in UL 1995 for duct connections.

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 82 19