DIVISION 22

PLUMBING

SECTION 22 00 10

BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Basic Plumbing Requirements specifically applicable to Divisions 22 and 23 Sections, in addition to Division 01 General Requirements.

1.3 GENERAL

A. The Contractor shall execute work specified or indicated on accompanying Drawings.

B. Contractor shall provide equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the Drawings.

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

D. Mechanical, electrical, and plumbing Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe or conduit in its exact location.

1. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions.

E. Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work.

1. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted otherwise.
2. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise note

F. When the mechanical, electrical, and plumbing Drawings do not give exact details as to the elevation of pipe, conduit and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved.

G. New construction projects will be provided with a Hierarchy Drawing or sections and elevations, which clearly show the general elevations that utilities will be routed in N-S and E-W directions.

1. The contractor shall not start work until this drawing has been provided.

H. Piping, exposed conduit, and the duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner.

1. The drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.
2. All equipment indicators shall face main traffic pathways unless noted otherwise.

1.4 DEFINITIONS

A. Concealed/Exposed: "Concealed" areas are those areas which cannot be seen by the building occupants. "Exposed" areas are all areas which are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical and electrical rooms.

1.5 RELATED REQUIREMENTS

A. Section 01 77 00 - Closeout Procedures and Submittals

B. Section 01 79 00 - Demonstration and Training

C. Section 01 91 00 - General Commissioning Requirements.

D. Section 07 18 00 - Traffic Coatings.

E. Section 07 84 00 - Firestopping.

F. Section 07 84 43 - Joint Firestopping.

G. Section 09 96 00 - High-Performance Coatings.
H. Section 22 05 53 - Plumbing Identification.
I. Section 22 07 19 - Plumbing Insulation.
J. Section 22 08 00 - Commissioning of Plumbing Systems.

1.6 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS

A. General: Refer to Division 01 for construction phasing and time increments.
B. Fees and Costs:
   1. If, during the course of the construction, a need arises to buy utilities, the Contractor shall pay all fees attendant.
   2. If City or privately owned utility piping or electrical cable needs to be extended, relocated, or terminated, the Contractor will pay all permits and construction/inspection fees associated with that particular work.
C. Work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to City controlled services. Confirm with specific project contract requirements.
   1. If inspections by City personnel are specifically required by this document, then the Contractor is responsible for any fees or permits in connection to those requirements.
D. Compliance:
   1. The Contractor shall comply in every respect with all requirements of National Fire Protection Association, local Fire Department regulations, and utility company requirements.
   2. In no case does this relieve the Contractor of the responsibility of complying with these Specifications and Drawings where specified conditions are of higher quality than the requirements of the above specified authorities.
   3. Where requirements of the Specifications and Drawings are more lenient than the requirements of the above authorities having jurisdiction, the Contractor shall make installations in compliance with the requirements of the above authorities with no extra compensation.

1.7 CONTRACT DOCUMENTS

A. Dimensional information related to new structures shall be taken from the appropriate Drawings.
   1. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.
B. The interrelation of the Specifications, the Drawings, and the schedules are as follows:
   1. Specifications determine the nature and setting of the several materials, Drawings establish the quantities, dimensions and details, and the schedules give the performance characteristics.
   2. If the Contractor requires additional clarification, request shall be made in writing, following the contractually prescribed information flow requirements.
C. Should the Drawings or Specifications conflict, the better quality, or greater size or quantity of work or materials shall be performed or furnished.

1.8 OWNER FURNISHED PRODUCTS

A. Products furnished to the site and paid for by Owner will be noted on the drawings and utilities created/connected as required.

1.9 FUTURE WORK

A. Future work will be noted on the Drawings.

1.10 ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner`s option. Accepted Alternates will be identified in Owner-Contractor Agreement.
B. Coordinate related work and modify surrounding work as required.
C. Schedule of Alternates: See "Special Conditions" and Bid Form.
D. Any Alternate Proposals are summarized in Division 01 of the Specifications.
E. The Contractor is directed to refer to all Sections of the Specifications and Drawings for this project to determine the exact extent and scope of the various Alternate Proposals as each pertains to the work of all trades.

1.11 SUBMITTALS

A. Refer to Division 01, UGC, and supplemental UGC's for specification requirements pertaining to timeliness of submission and review, quantity, and format.

B. Each specification section describes the content of the submittals and any submittals which must be approved prior to submission of others.

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

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

D. Submit Fabrication Drawings in accordance with the following:

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

E. All required Fabrication Drawings, except as noted otherwise, shall be prepared at a scale of not less than 1/4 inch = 1 foot.

1. Fabrication Drawings for ductwork, air handling units, and sections in Mechanical Rooms shall be drawn at a minimum scale of 3/8 inch = 1 foot.
2. Submit digital and pdf prints of each Fabrication Drawing to the Architect/Engineer for review.
3. Reproduction and submittal of the Construction Documents is not acceptable.
4. The Architect/Engineer will review Drawings and return one print with comments.

1.12 SUBSTITUTION OF MATERIALS AND EQUIPMENT

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

B. General:

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

C. It is not the intent of the Drawings and/or Specifications to limit products to any particular manufacturer or to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer.

1. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products.
2. When a manufacturer`s name appears in these Specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project.
3. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).
4. The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities with which substitutes must at least equal to be considered acceptable.
5. The burden of proof of equality rests with the Contractor.
6. The decision of the designer is final.

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

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

F. Acceptance of materials and equipment:
   1. This is based on the manufacturer`s published data and will be tentative subject to the submission of complete shop Drawings indicating compliance with the contract documents and that adequate and acceptable clearances for entry, servicing, and maintenance will exist.
   2. Acceptance of materials and equipment under this provision shall not be construed as authorizing any deviations from the Specifications, unless the attention of the Architect/Engineer has been directed in writing to the specific deviations.
   3. Data submitted shall not contain unrelated information unless all pertinent information is properly identified.
   4. Equipment installed on this project shall have local representation, local factory authorized service, and a local stock of repair parts.

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

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

I. Materials and Equipment Lists:
   1. Provide digital list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer.
   2. Lists shall be accompanied by digital copy sets of pictorial and descriptive data derived from the manufacturers` catalogs, sales literature, or incorporated in the Shop Drawings.
   3. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.13 MATERIALS AND WORKMANSHIP

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

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

1.14 FLAME SPREAD PROPERTIES OF MATERIALS

A. Materials and adhesives incorporated in this project shall conform to NFPA.

B. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc., specified for each system, and shall not exceed a smoke developed rating of 50.

1.15 REGULATORY REQUIREMENTS

A. The "Authority Having Jurisdiction" for Fire and Life Safety related compliance in accordance with the rules and regulations promulgated by the Texas State Fire Marshal as an Agency of the State of Texas is UT Southwestern Medical Center Office of Safety and Business Continuity.
   1. Plan reviews, installations, inspections, and approvals shall be done as a function of the Fire and Occupational Safety program under the direction of the Director of Fire and Occupational Safety (University Fire Marshal).

B. It is required that the installation shall meet the minimum standards prescribed in the currently adopted editions as identified in Section 01 41 00 - Regulatory Requirements and listed in other Specification sections. Additional requirements include but not limited to:
   1. National Fire Protection Association Standards (NFPA): Currently accepted edition.
   2. ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
   3. American Gas Association Publications (AGA): Directory of Approved Gas Appliances and Tested Accessories.
   4. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes.
   5. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these Specifications.
   6. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA): All current editions of applicable manuals and standards.
   7. Air Moving and Conditioning Association (AMCA): All current editions of applicable manuals and standards.
   8. American Society of Testing Materials (ASTM): All current editions of applicable manuals and standards.
   9. American Water Works Association (AWWA): All current editions of applicable manuals and standards.
   10. National Electrical Manufacturers` Association (NEMA): All current editions of applicable manuals and standards.
   11. International Codes, current edition or as listed elsewhere in the contract.
   12. Texas Occupational Safety Act: All applicable safety standards.
   13. Occupational Safety and Health Act (OSHA).
   14. TAS, ADA, and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards, and the requirements of the American Disabilities Act.
   15. ASME A13.1

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

D. Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur.
   1. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation.
   2. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 1 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance.
   3. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

1.16 COMMISSIONING

A. Comply with project requirements for commissioning. Refer to Section 01 91 00 - General Commissioning Requirements and associated sections.

1.17 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

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

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

C. Conformance with Agency Requirements:

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

D. Nameplates:

1. Refer to Section 22 05 53 - Plumbing Identification for requirements.
2. Each major component of equipment shall have the manufacturer`s name, address, and catalog number on a plate securely attached to the item of equipment. Industry standard attachments shall be appropriate for the sign type to the surface material, size, shape, and condition.
3. Data on nameplates shall be legible at the time of Final Inspection.

E. Prevention of Rust:

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

F. Protection from Moving Parts:

1. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.
2. Guards shall be compliant with OSHA requirements.

G. Verification of Dimensions:

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

1.18 WALL, FLOOR, AND CEILING PLATES

A. Except as otherwise noted, provide C.P. (Chrome plated) brass floor and ceiling plates around all pipes, ducts, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except underfloor and attic spaces.

1. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation.
2. Plates will not be required for piping where pipe sleeves extend 3/4-inch above finished floor.
3. Equipment rooms are classified as finished areas.
4. Round and rectangular ducts shall have closure plates (NOT chrome plated) made to fit accurately at all floor, wall and ceiling penetrations.

1.19 SLEEVES, INSERTS, AND FASTENINGS

A. General:
1. Openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, ductwork, conduit, cable trays, etc., shall be sleeved.
2. Penetrations must pass through sleeves except soil pipe installed under concrete slabs on fill.
3. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer.
   a. If a penetration is cored into an existing solid concrete or stone structure, then the installation of a sleeve will not be necessary.
4. Sleeves set in floors shall extend 4-inch above finished floor elevation and be sealed water tight to the floor.

B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4-inch, except that the minimum clearance shall accommodate a Link-seal by Garlock, an Enpro Company, closure where piping exits the building, or penetrates a wall below ground level.

C. Contractor shall be responsible for the accurate location of penetrations in the slab for pipe, duct, etc.
1. Penetrations shall be of ample size to accommodate the pipe, duct, etc. plus any specified insulation.
2. Sleeve materials shall be rigid metal of adequate strength.
3. Void between sleeve and pipe shall be filled with Nelson Flameseal Firestop or approved equal caulk or putty.

D. Sleeves:
1. Installation of sleeves in walls shall be the same as for floors.
2. Refer to the details on the project drawings.
   a. Where the details differ from these specifications, the drawings take precedence.
3. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration.
   a. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.

E. Inserts:
1. Where the construction schedule allows, suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction
2. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed.
3. Drilled anchors in concrete or masonry shall be submitted for approval.

F. Fasteners: Fastening of pipes, conduits, etc., in the building shall be as follows:
1. Wood members attached by wood screws.
2. Masonry fastening by threaded metal inserts, metal expansion screws, or toggle bolts, as appropriate.
3. Metal fastening by steel machine screws or welding (when specifically permitted or directed), or bolts.
4. Concrete fastening by suitable inserts anchored to reinforcing steel, and poured in place unless other means are indicated on the plans.
5. Power-actuated fasteners (shooting) will not be acceptable under any circumstances.
6. If it is necessary to install a method of fastening a hanger after the structure has been installed, then only clamps or drilled anchors shall be used.
7. Note: Plastic anchors or plastic expansion shields are prohibited.

G. Rat-proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be rat-proofed in a manner acceptable to the Architect/Engineer.

H. Weatherproofing: The annular space between a pipe and its sleeve in exterior walls or through floor to below grade shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound.
   1. Seal both surfaces of wall or floor.

I. Air Plenums: The space around piping, ductwork, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.

J. Fireproofing:
   1. Each mechanical, plumbing, and electrical contractor shall seal all cable trays, pipe, conduit, duct, etc., penetrations through roof, fire rated walls and floors with a foam or sealant (as described below) that will form a watertight, vermin tight barrier capable of containing smoke and fire up to 2,000 degrees F for two hours.
   2. Sealing of cable trays and conduits that extend through rated walls from ends of cable tray shall be done after conductors have been installed.
   3. Refer to fireproofing and firestopping specifications in Division 07 for product requirements.

1.20 PROJECT/SITE CONDITIONS

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

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

C. Contractor shall thoroughly familiarize themselves with the existing system(s) and bring to the attention of the Architect/Engineer any situations, which deviate from those, indicated in the Contract Documents

1.21 MANUFACTURER`S RECOMMENDATIONS

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

1.22 SPACE AND EQUIPMENT ARRANGEMENT

A. The size of mechanical, plumbing, and electrical equipment indicated on the Drawings is based on the dimensions of a particular manufacturer.
   1. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment they propose to furnish will fit in the space.
   2. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

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

C. All equipment intended for floor mounting shall be installed on housekeeping pads or above grouted baseplate that elevate the base away from damage.
   1. Housekeeping pads to be sealed to match floor waterproofing system, refer to Section 07 18 00 - Traffic Coatings.
   2. Housekeeping pad edges to be painted Safety Yellow.

1.23 LARGE APPARATUS

A. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed.

B. Following placement in the space, such apparatus shall be thoroughly, completely protected from damage as hereinafter specified.

1.24 PROTECTION

A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work.
   1. Include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage.
   2. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. Take particular care not to damage the building structure in performing work.
   1. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the building.

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

1.25 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades, subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole.

B. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job.

C. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.26 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

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

B. The Electrical Trades shall provide all interconnecting wiring for the installation of all power.

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

D. The Mechanical Trades shall provide complete wiring diagrams indicating power wiring and interlock wiring.
   1. Diagrams shall be submitted for review within thirty (30) days after the submittals for equipment have been reviewed.
   2. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control Drawings, not a series of manufacturer`s individual diagrams.
   3. After these diagrams have been reviewed, copies shall be transmitted to the Electrical Trades by the Contractor. They shall be followed in detail.
   4. See Section 23 09 23, ENERGY MANAGEMENT SYSTEM (EMS), for additional clarification.

1.27 SUPERVISION

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

B. It shall be the responsibility of each superintendent to study all Drawings and be familiarized with the work to be done by other trades.

C. Coordinate work with other trades and before material is fabricated or installed, make sure that work will not cause an interference with another trade.

D. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved.

E. Where interferences cannot be resolved without major changes to the Drawings, the matter shall be referred to the A/E for ruling.

1.28 SITE OBSERVATION

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

1.29 PRECEDENCE OF MATERIALS

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

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

1. Building lines.
2. Structural Members.
3. Soil and Drain Piping.
4. Vent Piping.
5. Supply, Return, and Outside Air Ductwork.
6. Exhaust Ductwork.
7. HVAC Water and Steam Piping.
8. Condensate Piping.
9. Fire Protection Piping.
10. Natural Gas Piping.
11. Domestic Water (Cold and Hot).
12. Refrigerant Piping.
13. Electrical Conduit.

1.30 RECORDS FOR OWNER

A. Records shall comply with Section 01 77 00 - Closeout Procedures and Submittalsand requirements of the section herein.

B. The Contractor shall maintain a set of Drawings in the Field Office for the sole purpose of recording "installed" conditions.

1. Daily note all changes made in these Drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.

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

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

D. Electronic Media Transfer:

1. AutoCAD files specific to a floor shall be provided (under formal transmittal letter) to the owner within 1 week of floor acceptance.
2. The electronic files shall have the latest changes incorporated, and represent the most accurate design issued for construction.
3. The files shall be in AutoCAD Version 2010 or higher unless UTSW PM indicates otherwise.

E. Provide digital pdf's with optical character recognition (OCR) as well as hard copy set of marked up Drawings titled "AS INSTALLED DRAWING" with title block generally located in lower right hand corner of Drawing with Company name of the installing trade Subcontractor and with a place for the date and the name of the responsible company representative.

F. In addition to the above, the Contractor shall accumulate during the progress of the job the following data, in digital format, prepared in a neat order or packet folder and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner.
   1. All warranties and guarantees and manufacturers` directions on equipment and material covered by the Contract.
   2. Two sets of operating instructions and preventative maintenance procedures for heating and cooling and other mechanical and electrical systems.
   3. Valve tag charts and diagrams specified.
   4. Approved wiring diagrams and control diagrams representing "as installed" conditions.
   5. Copies of approved Shop Drawings.
   6. Any and all other data and/or drawings required as submittals during construction.
   7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.

G. All of the above data shall be submitted to the Architect/Engineer for approval, and shall be corrected as instructed by the Architect/Engineer prior to submission of the final request for payment.

H. Refer to additional requirements in the commissioning section of Division 01.

PART 2 – PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be acceptable to the authority having jurisdiction as suitable for the use intended.

B. Furnish products listed and classified by Underwriter's Laboratory, Inc. as suitable for purpose specified and shown.

C. Unless otherwise specified materials shall be new and free from any defects.

2.2 ACCESS DOORS

A. General: This Contractor shall provide wall, floor, or ceiling access doors for unrestricted access to all concealed items of mechanical, plumbing, or electrical equipment or devices including items requiring general maintenance or access.

B. Utilize Section 08 31 13 - Access Doors and Frames for products and requirements.

C. Access doors shall be a minimum of 24 x 24 inches in size unless approved by UTSW FM in writing. Location shall provide appropriate access.

PART 3 – EXECUTION

3.1 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by them and their workers, and shall be responsible for repairing or replacing such loss or damage.
   1. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in service maintenance of all plumbing, heating, air conditioning, and ventilating services for the new and existing facilities.
   2. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall same upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, all Contractors shall remove and reinstall in locations approved by the Architect/Engineer all devices required for the operation of the various systems installed in the existing construction.
   1. This includes but is not limited to temperature controls system devices, electrical switches, relays, fixtures, piping, conduit, etc.

E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner.
   1. The Contractor shall allow the Owner two weeks in order to schedule required outages.
   2. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner.
   3. All costs of outages, including overtime charges, shall be included in the contract amount.

3.2 DEMOLITION AND RELOCATION

A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the Drawings or required by the installation of new facilities.
   1. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage.
   2. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination or otherwise disposed of as directed by the Owner.
   3. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition.
   4. The Contractor may, at their discretion, and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

B. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated.
   1. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order.
   2. All relocations shall be performed by workers skilled in the work and in accordance with standard practice of the trades involved.

C. When items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal.
   1. Items damaged in repositioning operations are the Contractor`s responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.

D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the Drawings, specified, or acceptable to the Owner.
   1. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain.
   2. Such services shall be sealed, capped, or otherwise tied off or disconnected in a safe manner acceptable to the Owner.
   3. Disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas.
   4. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as specified.

3.3 EXCAVATION, TRENCHING AND BACKFILL

A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):
   1. Any excavation and digging below 1 foot around the campus bird sanctuary must be approved by OSBC. The area of the bird sanctuary is Defined as the tree line surrounding it.
   2. The contractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the Drawings and/or required for the installation of piping, conduit, utility systems, etc.
      a. All exterior lines shall be installed with a minimum cover of 24-inches, unless otherwise indicated.
      b. Generally, more cover shall be provided if grade will permit.
      c. Excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector.
      d. All excavations shall be made only by open cut.
      e. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced.
      f. Trenches shall be not less than 12-inches wider or more than 16-inches wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6-inches nor more than 8-inches in width is provided on each side of the pipe.

g. For sewers, the maximum width of trench specified applies to the width at and below the level may be made as wide as necessary for sheeting and bracing, and the proper installation of the work.

3. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2-inches of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints.
   a. Bell holes shall be dug after the trench bottom has been graded.
   b. Where inverts are not shown, grading shall be determined by the Plumbing Code for the service intended and the size used.
   c. Bell holes for lead pipe joints shall be 12-inches in depth below the trench bottom and shall extend from a point 6-inches back of the face of the bell.
   d. Such bell holes shall be of sufficient width to provide ample room for caulking.
   e. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench.
   f. Depressions for joints other than bell and spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used.
   g. Grading for electrical duct banks and conduits shall be from building to manhole, and from a high point between manholes to each manhole.
   h. Special pipe beds shall be provided as specified hereinafter.
4. The lower 4-inches of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by workers especially skilled in this type of work.
   a. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place.
   b. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required.
   c. Where rock excavation is required, the rock shall be excavated to a minimum over depth of 6 inches below the trench depths specified.
   d. The over depth rock excavation and all excess trench excavation shall be backfilled with sand.
   e. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.
   f. Where rock excavation is required, the rock shall be excavated to a minimum over depth of 6-inches below the trench depths specified.
   g. The over depth rock excavation and all excess trench excavation shall be backfilled with sand.
   h. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.
5. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations.
   a. Any water accumulated in the excavations shall be removed by pumping or other acceptable method.
   b. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave ins.
   c. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.
6. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.
7. Excavate as required under the building in order that all piping, ductwork, etc., shall clear the ground a minimum of 12-inches for a distance of 24-inches on either side.
   a. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector.

b. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.

8. Trenches for cast iron drain, storm water and sewer lines inside the building shall be properly excavated, following, the procedures set out for exterior lines.
   a. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water.
   b. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.
9. All surplus materials removed in these trenching operations becomes the property of the contractor, and shall be disposed of at the expense of the contractor, at a legal disposal site, off of the campus.

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

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

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

3.4 INSTALLATION METHODS

A. Where to Conceal: All pipes, conduits, etc., shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.

B. Where to Expose:
   1. In mechanical rooms, janitor`s closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed.
   2. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.

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

D. Maintaining Clearance:
   1. Where limited space is available above the ceilings below concrete beams or other deep projections, pipe and conduit shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above-floor clearance.
   2. Sleeves shall be as specified.
   3. Approval shall be obtained from the Architect/Engineer for each penetration.
   4. Piping, ductwork and other installed materials should be located such to not obstruct maintenance clearance for mechanical components such as controls, filters and the like.
   5. Piping shall not create trip-hazards through floor-mounting but be routed in a manner overhead or below the floor.

E. Piping:
   1. Piping shall be identified with both color and labels as indicated in Section 22 05 53 - Plumbing Identification.
   2. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing.
   3. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch.
   4. Piping, ducts and conduits run in furred ceilings, etc., shall be similarly installed, except as otherwise shown.
   5. Conduits in furred ceilings and in other concealed spaces shall be neatly grouped and racked indicating good workmanship.
   6. All conduit and pipe openings shall be kept closed until the systems are closed with final connections.
   7. All piping not directly buried in the ground shall be considered as "interior piping".
   8. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the construction inspector so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off.
      a. The Contractor shall give as much advance notice as possible no less than 10 working days.
   9. All above-ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view.
      a. All mechanical, plumbing, and electrical work at and above the ceiling, including items supported by the ceiling grid, such as air inlets or outlets and lighting fixtures, shall be complete and installed in accordance with contract requirements, including power to lighting fixtures, fans, and other powered items.
      b. Adequate lighting shall be provided to permit thorough inspection of all above-ceiling items.
      c. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Physical Plant, Architect/Engineer, UTSW PM, and the Resident Construction Manager`s Construction Inspector Areas to be included and time of inspection shall be coordinated with the Construction Inspector.
      d. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems.
      e. The ceiling supports (tee bar or metal framing) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.
      f. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.

g. Proper accessibility to equipment may be required to be demonstrated by the commissioning agent or inspector.

3.5 CONNECTIONS FOR OTHERS

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

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

C. Shutoff Valves: In each service line connected to an item of equipment or piece of machinery, provide a shutoff valve.

D. Traps: On each drain not provided with a trap, provide a suitable trap.

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

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

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

3.6 CUTTING AND PATCHING

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

B. Methods of Cutting:

1. 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.
2. Impact type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled to exact size.

C. Restoration: All openings shall be restored to "as new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry:

1. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.
2. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation.
3. 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.

E. Plaster:

1. All mechanical work in areas containing plaster shall be completed prior to the application of the finish plaster coat.
2. Cutting of finish plaster coat will not be permitted.

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

1. Rebar placement shall be determined prior to floor coring operations.
2. Any rebar, which has been cut, shall be submitted in writing to the Architect/Engineer for evaluation.

3.7 ROOF PENETRATIONS AND FLASHING

A. Pipe, conduit and duct sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided and installed by a qualified contractor for all roof penetrations.

B. This shall be the responsibility of the General Contractor.

3.8 OPERATION PRIOR TO COMPLETION

A. When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, they may do so, providing that they properly supervises the operation, and has the Construction Inspector`s written permission to do so.

B. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.

C. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the Owner.

1. The date of acceptance and performance certification will be the same date.

D. Additional requirements for operation of equipment prior to completion found in the commissioning sections of Division 1 and Division 22 shall be followed.

3.9 CLEANING AND PAINTING

A. All equipment, piping, conduit, ductwork, grilles, insulation, etc., furnished and installed in exposed areas under Divisions 22, 23 and 26 of these Specifications and as specified shall be cleaned, prepared, and painted according to the following specification. Color of finish painting in Mechanical Rooms shall be painted in accordance with Color Schedule for machinery spaces using Sherwin Williams paint numbers, or approved equivalent.

1. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Divisions 22, 23 and 26 work.
2. UTSW Approved paint colors: Refer to Section 22 05 53 - Plumbing Identification.
3. Paint Specification: Refer to Section 09 96 00 - High-Performance Coatings.
4. Natural gas piping shall be painted in its entirety.

B. Equipment furnished by the mechanical, plumbing, and electrical subcontractors shall be delivered to the job with a suitable factory protective finish and shall be painted, after installation, with the color hereinafter specified.

C. The following materials shall not be painted:

1. Materials: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.
2. Aluminum jacketing on insulation .
3. Nameplates on equipment shall be protected during painting to prevent damage.

D. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed.

1. Such surfaces shall be carefully wiped and all cracks and corners scraped out.
2. Exposed metal work shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.

E. Painting:

1. Interior piping shall be primed before insulation installation.
2. Exterior piping shall be primed and painted to finish before insulation installation.
3. For painting purposes, the equipment and piping inside of built-up air handling units shall be painted the same as if they were within the walls of a Mechanical Room.

F. Scope of painting for Divisions 22, 23, and 26 work in areas other than those defined as "exposed" is as follows:

1. In addition to painting in mechanical rooms, electrical rooms, materials, piping, ductwork, conduit, gear, supports, foundations, equipment and appurtenances installed by the mechanical and electrical subcontractors in exposed areas shall be finish painted with two coats enamel paint of color selected by the Architect/Engineer, refer to Section 09 96 00 - High-Performance Coatings.
2. Additional areas to be defined as "exposed" for purposes of painting, are defined on the Drawings.
3. The surfaces to be finish painted shall first be prepared as follows:
    a. Electrical switchgear, disconnect switches, contactors, etc., with suitable factory applied finishes shall not be repainted; except for aesthetic reasons where located in finished areas as directed by the Architect/Engineer and in a color selected by the Architect/Engineer.
        1) Where factory applied finishes are damaged in transit, storage or installation, or before final acceptance, they shall be restored to factory fresh condition by competent refinishers using the spray process.
    b. Ferrous metal surfaces without a protective finish and not galvanized in exposed and concealed areas including chases, underfloor and above ceilings shall be painted with two (2) coats of P&L zinc chromate primer as the construction progresses to protect against deterioration.

3.10 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

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

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

C. Refer to the commissioning sections of Division 1 and Division 22 for additional start-up, testing, and acceptance requirements.

3.11 TESTS

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

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

C. The Construction Inspector shall be notified in writing at least 10 working days prior to each test and other Specification requirements requiring action on the part of the Construction Inspector.

D. All equipment shall be placed in operation and tested for proper automatic control requirements before the balancing agency starts their work.

E. Maintain Log of Tests as specified.

F. See Specifications hereinafter for additional tests and requirements.

G. All testing reports shall be submitted to UTSW Facilities Managment for review and approval.

3.12 LOG OF TESTS

A. All tests shall have pertinent data logged by the Contractor at the time of testing.
    1. Data shall include date, time, personnel, description, and extent of system tested, test conditions, test results, specified results, and other pertinent data
    2. Data shall be delivered to the Architect/Engineer and UTSW Facilities Management as specified under "Requirements for Final Acceptance" in Section 01 77 00 - Closeout Procedures and Submittals.
    3. All Test Log entries shall be legibly signed by the Project Contractor or his authorized job superintendent.

3.13 COOPERATION AND CLEANUP

A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition.

B. At the end of each day`s work, each trade shall properly store all tools, equipment and materials and shall clean his debris from the job. Upon the completion of the job, each trade shall immediately remove all of his tools, equipment, any surplus materials and all debris caused by that portion of the work.

3.14 CLOSEOUT ACTIVITIES

A. As part of project punch list requirements per Section 01 77 00 - Closeout Procedures and Submittals, include UTSW Plumbing Shop, UTSW Building Maintenance, OSBC, UTSW PM, and other associated teams for plumbing focused review.

B. Provide revised Operation and Maintenance Data including final installed components schedule, maintenance manuals, and warranty documentation to UTSW PM and to UTSW Building Maintenance.

3.15 TRAINING

A. Refer to Section 01 79 00 - Demonstration and Training as well as individual technical Sections for specific training requirements.

B. Where training is called for in other sections provide a minimum of 8 hours on site training for Owner's representatives.

C. Training shall be presented by a qualified instructor with training experience and technical knowledge of the product.

D. Submit a training agenda, proposed date, and instructor qualifications to the Owner for approval.

END OF SECTION 22 00 10

SECTION 22 00 11

MEP AUTOCAD PROCEDURES AND STANDARDS

PART 1 - GENERAL

1.1 PURPOSE

A. The purpose of this Specification is to establish standardized procedures for UTSW engineering drawings submitted as required deliverables by Contractor.

1.2 APPLICABILITY

A. This Specification applies to all MEP projects completed by any Architect/Engineering (A/E) firm with the Contractor providing as-built documents. .

B. Prior to the acceptance of project closeout drawings the responsible Contractor shall submit an electronic copy of all drawings to the UTSW Planning Department, who shall certify that the electronic drawing files comply with these standards.

C. Layers: The following layers shall be used for all mechanical, electrical, plumbing, and fire protection drawings. No other layer designations are permissible.

1. HVAC/Mechanical:
    a. M-AHUAir handler components
    b. M-CHILLERChillers and refrigeration components
    c. M-CONTROLSControl panels, sensors, wiring, and text
    d. M-DEMOMechanical components scheduled for demolition
    e. M-EQUIPUnspecified mechanical equipment
    f. M-EXHExhaust duct
    g. M-EXH-VAVExhaust VAV
    h. M-EXH-GRILLEExhaust grille
    i. M-HVTEXTHVAC duct size and CFM text
    j. M-LPDUCTAll low pressure ductwork down stream of the VAV
    k. M-PADEquipment pads
    l. M-PUMPAll pumps
    m. M-RA-DUCTReturn air ducting
    n. M-RA-GRILLEReturn air grille
    o. M-SA-COLDCold deck supply air (medium pressure)
    p. M-SA-DIFFSupply air diffusers
    q. M-SA-HOTHot deck supply air (medium pressure)
    r. M-VAVVariable air volume boxes (VAV)
    s. M-TEXTGeneral mechanical text and notes
2. ELECTRICAL:
    a. E-120V-CKTAll 120 volt circuits, panels, text, etc.
    b. E-120V-RECPAll 120 volt receptacles and plug mold only
    c. E-120V-LGHTAll 120 volt ceiling mounted lights only
    d. E-120V-LCKTAll 120 volt lighting circuits, panels, text etc.
    e. E-120V-UCLTAll 120 volt under cabinet lights, circuits, and text
    f. E-208V-RECPAll 208 volt receptacles only
    g. E-208V-CKTAll 208 volt circuits, panels, text etc.
    h. E-277V-CKTAll 277 volt circuits, panels, text etc.
    i. E-277V-LCKTAll 277 lighting circuits, panels, text, etc.
    j. E-277V-LGHTAll 277 volt ceiling mounted lights only
    k. E-480V-CKTAll 480 volt circuits, panels, text, etc.
    l. E-480V-DISCAll 480 volt disconnects only
    m. E-CTRAYAll cable tray
    n. E-DEMOElectrical components scheduled for demolition
    o. E-CONDUITAll conduit
    p. E-TEXTGeneral electrical text and notes
3. PIPING:
    a. P-AIRCompressed air piping and text

b. P-AWAcid wastes and vents piping and text
c. P-CO2-GASCarbon dioxide gas piping and text
d. P-CNSCondenser water supply and text
e. P-CNRCondenser water return and text
f. P-CRSteam condensate return and text
g. P-CWRChill water return piping and text
h. P-CWSChill water supply piping and text
i. P-DEMO Plumbing components scheduled for demolition
j. P-DIRDe-ionized water return piping and text
k. P-DISDe-ionized water supply piping and text
l. P-FUELFuel oil system piping and text
m. P-HWRHot water return piping for HVAC coils and text
n. P-HWSHot water supply piping from HVAC coils and text
o. P-LAB-HWLaboratory hot water piping and text
p. P-LAB-CWLaboratory cold water piping and text
q. P-NGASNatural gas piping and text
r. P-N2-GASNitrogen gas piping and text
s. P-N2-LIQLiquid nitrogen piping and text
t. P-SANSanitary sewer piping, vents, and text
u. P-STORMStorm sewer piping and text
v. P-STEAMSteam supply piping and text
w. P-TEXTGeneral non-specific piping text
x. P-VACVacuum piping and text
y. P-VALVEValves and text

4. FIRE PROTECTION:
   a. F-ALARMAll alert devices (audible, strobe, etc.) and text
   b. F-CO2CO2 suppression system and text
   c. F-DAMPERSmoke dampers, fire dampers, and text
   d. D-DEMOFire protection components scheduled for demolition
   e. F-HALONHalon or other type suppression system and text
   f. F-PIPINGFire protection piping and text
   g. F-PENDANTDrop ceiling sprinkler heads only
   h. F-SPRNKSprinkler heads other than drop ceiling
   i. F-TEXTGeneral non-specific fire protection text
   j. F-VALVESFire protection isolation valves and text
5. MISCELLANEOUS LAYERS:
   a. A-TEXTPaper space notes
   b. VIEWPORTView ports
   c. XREF-BASEAll drawings are to be x-reffed on this layer

D. IMPORTANT: Use only the layers above. If additional layers are needed, add a numerical value. For example: P-STEAM1, P-STEAM2…

1.3 FLOOR MASTER DRAWING DESIGNATION

A. Provide floor master drawings (if available) by e-mail or file transfer.

B. Master drawings follow the following alphanumeric designations as shown in the examples below:
   1. NA01MPBuilding “NA”, floor 1, mechanical floor plan
   2. B02PSBuilding B, floor 2, plumbing sectional views
   3. DC01ELBuilding DC, floor 1, lighting floor plan drawing

C. Master drawings have the following classifications by discipline:
   1. MPHVAC/mechanical equipment floor plan
   2. MSHVAC/mechanical equipment sectional views
   3. EPElectrical power floor plan
   4. ELElectrical lighting floor plan
   5. ETCable tray
   6. ESElectrical sectional views
   7. PPPlumbing floor plan

8. PSPlumbing sectional views
9. FPFire protection floor plan
10. FSFire protection sectional views

D. Note: the EP and EL Floor Masters are eventually combined. Maintaining separate electrical master drawings is left to A/E choice.

E. The master drawing file name shall not be used as any project master. The file shall be copied, and the file name shall be changed per Section 5.0.

1. Do not return any electronic file with a floor master designation assigned.

1.4 PROJECT MASTER DRAWING DESIGNATIONS

A. The Project Master Drawing is essentially an updated part of the Floor Master Drawing, and will eventually be blocked into the Floor Master Drawing for the building. The intent is to create a unique file that is readily identifiable and traceable.

B. Project Drawing Masters shall the following alphanumeric designations as shown in examples listed below:

1. L5R262MBldg L, floor 5, room 262, mechanical HVAC
2. NA8R410EBldg NA, floor 8, room 410, electrical
3. B2R300PBldg B, floor 2, room 300, plumbing

C. Where more than one room is being renovated, just one room number will be sufficient.

D. DO NOT PLACE CONSTRUCTION NOTES ON PROJECT MASTER DRAWINGS

E. Construction notes are unique to a particular project. Construction notes shall be placed on the presentation drawings.

F. The text size used on all project master drawings shall be 4-1/2 inches. There are no exceptions.

1.5 SETTING UP PRESENTATION DRAWINGS

A. Presentation drawings shall follow the following classifications by discipline:

1. M1.1, 1.2…HVAC/mechanical equipment demolition floor plans
2. M2.1, 2.2…New HVAC/mechanical equipment floor plans
3. M3.1, 3.2…HVAC/mechanical equipment sectional views
4. M4.1, 4.2…HVAC/mechanical equipment details
5. M5.1, 5.2…HVAC/mechanical equipment schedules
6. E1.1, 1.2…Electrical demolition floor plans
7. E2.1, 2.2…Electrical power floor plans
8. E3.1, 3.2…Electrical lighting floor plans
9. E4.1, 4.2…Electrical power and lighting details
10. E5.1, 5.2…Electrical power and lighting schedules
11. P1.1, 1.2…Plumbing demolition floor plans
12. P2.1, 2.2…New plumbing floor plans
13. P3.1, 3.2…Utility piping plans
14. P4.1, 4.2…Plumbing details
15. P5.1, 5.2…Plumbing fixture schedules
16. F1.1, 1.2…Fire protection demolition floor plans
17. F2.1, 2.2…New fire protection floor plans
18. F3.1, 3.2…Fire protection sectional views
19. F4.1, 4.2…Fire protection details
20. F5.1, 5.2…Fire protection equipment schedules

B. Presentation drawings are done in Paper Space, not Tiled Model Space.

1.6 DRAWING SCALE, FONTS, AND BLOCKS

A. Refer to UTSW Design Guidelines Section C for Submittal Requirements for all Deliverables.UTSW deals with many A/E firms; many have their own choice and size of fonts. This proves to be a significant problem in drawing reconciliation.

B. Drawing presentation shall be set up on 1/4inch scale.

C. The A/E firm SHALL NOT use custom fonts, &archsty.shx is the font that UTSW uses for all architectural and engineering drawing. The font style Simplex.shx is considered an acceptable substitute for MEP drawings.

D. Presentation drawings submitted in AutoCAD shall be set up in paper space with a viewport depicting the project area. The font style is &archsty.shx, and UTSW will provide upon request.

E. All blocks shall be created and set to layer 0 prior to inserting into a drawing The color shall be set to 'by

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 22 00 11

SECTION 22 00 13

UTSW PLUMBING DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 PURPOSE

A. This Specification establishes University of Texas Southwestern Medical Center (UTSW) requirements for plumbing projects on campus. This document address design criterion not specifically covered by the Plumbing Code (UPC), or set requirements that may exceed the minimum requirements of the Code.

1.3 APPLICABILITY

A. This standard applies to all plumbing projects designed and constructed by physical plant personnel, outside Architect/Engineering (A/E) firms, and all construction contractors. No substitutions to the standard are acceptable without the written authorization of the ENGINEER.

1.4 TERMS AND DEFINITIONS

A. CDAS – Central Data Acquisition System. CDAS is the campus-wide central monitoring station, which is located in the Physical Plant Office (P Building).

B. Dry Lab – Laboratories, which are not equipped with multiple utilities, but require a greater degree of electrical power and HVAC than an office area.

C. Engineer – UTSW Engineer

D. Gas Cylinder Room – Any room that contains carbon dioxide, nitrogen, or argon cylinders in excess of 50 Lbs. capacity.

E. Wet Lab – Any laboratory equipped with sinks, fume hoods, biological safety cabinets, or other equipment, which requires multiple utilities (such as gas, air or vacuum), and a greater degree of HVAC than a dry lab.

1.5 GENERAL PLUMBING DESIGN DRAWING CRITERIA

A. Flow diagrams shall be drawn for each piping system including but not limited to steam, heating water, chilled water, hot and cold water, distilled water, fire standpipe, oxygen, compressed air, condensing water, gas, vacuum, and refrigerant systems. Mains and major branches shall show quantities of flow with size. All valve sizes shall be indicated. Architectural room names and numbers shall be used to indicate locations.

B. HVAC plumbing and air-conditioning systems shall be drawn as separate drawings. A complete roof plan shall be included both for air-conditioning plans and plumbing plans; one plan may serve for both.

C. Floor plans for mechanical systems shall be drawn to show pipes, ducts, et on the floor in which they are installed.

D. Plumbing riser diagrams must be drawn with one for each riser on the project. The risers must show all piping from the under-floor through the roof.

1.6 PLUMBING DESIGN FOR WET LABS

A. UTSW has standardized the arrangement of horizontal plumbing utilities for laboratory counters and peninsulas. An AutoCAD detail of the horizontal plumbing chase is readily available from the ENGINEER.

B. Acid waste piping is composed of glass. No acid waste or vent pipe shall be sized smaller than 2 inches diameter. Acid waste exposed to the potential for damage shall be constructed of either high silica cast iron (Duriron) or protected with unistrut guards.

C. All de-ionized water fixtures shall be designed for recirculation, regardless of existing de-ionized water design or availability. If a return line is not available, the fitting will be capped for future.

D. All fixtures serving laboratory Millipore filtration systems shall be equipped with a positive connection, such as a compression fitting. No “tube-and-turret-barb” configurations are acceptable. The standard procedure is to provide a Hayward 1/2 inch PVC Needle valve with double female connections, stock # NV10050T. The department provides the connections to the valve.

E. Natural gas lines shall be of a welded black steel construction up to emergency shut-off valves within reach of occupants. Natural gas lines from emergency shut-off valves to lab tables or appliances may be screwed if not larger than 3/4 inch and if they are exposed.

F. The emergency gas shutoff valve shall be located as close to the room exit as possible.

G. All connections between dissimilar materials in the piping system shall be made with dielectric unions or couplings.

H. At every point where piping penetrate a floor slab, except slabs on grade, a cast-in sleeve or other waterproof curbing at least 2 inch high shall be provided.

I. Rebar shall be located prior to coring any holes.

J. Wherever possible gravity drainage to a hub or floor sink is to be used. Condensate pumps shall not be use to drain equipment.

1.7 DESIGN OF GAS PIPING IN GAS CYLINDER ROOMS AND LABORATORIES

A. All piping for vacuum and gases other than natural gas shall be ASTM B88, Type L hard drawn seamless copper pipe and tubing. Use brass mechanical connections where required. All vacuum and oxygen piping shall be dry nitrogen purged while being soldered.

B. An isolation valve shall be provided for each branch circuit. Gas turrets shall not be relied upon as isolation valves.

C. Greater than two tank installations require a manifold system and shall be hard piped. Piping for two tank installations is normally the responsibility of the Department.

1.8 LAVATORY AND MECHANICAL ROOM DESIGN CONSIDERATIONS

A. Waste lines from lavatories shall be limited to two fixtures per arm. The wastes shall discharge into a Cast Iron (C.I.) stack behind the fixture. Back to back lavatories are permitted if connected to sanitary tapped crosses. Straight tapped crosses are not permitted.

B. Floor drains shall be 4 inches in size serving 80 or more square feet. Areas less than 80 square feet shall be 3 inch diameter. Coordinate with architect to provide minimum 1 inch in 10 feet slope to room and area drains.

C. Drains serving as indirect receptors for other drain piping shall be floor sink style.

D. Clean-outs shall be shown on plans and on riser diagrams.

E. Vent pipes shall be carried up adjoining soil and waste pipe, and they shall be connected into the main stack at top and bottom. Vents may be one size smaller than the traps they serve, except that no vent shall be less than 2 inch. The size of vent lines accommodating more than one fixture shall be sized in accordance with the International Plumbing Code.

F. Specified fixtures shall conform to the requirements of UTSW Codes, Regulations, and standards, inlcluding the Texas Department of Health water saving performance standards.

1. Photoelectric activated plumbing fixtures are generally not in use at the campus, and as a result of past maintenance problems their introduction is discouraged.

1.9 ROOF DRAINS

A. Roof drain piping shall be sized in accordance with Table D-1 of the Plumbing Code. Use 4.0 inches per hour as a design rainstorm.

B. Roof drains shall be run separately from all other storm water sources to a manhole outside the building. Downstream from this manhole, the piping shall be sized sufficiently large to prevent roof drain water from impeding the proper flow from area drains. All piping 50 feet or more below the roof shall be welded construction.

C. No piping should be run in concrete floors. No piping should be buried beneath the lowest floor level with the exception of soil pipe.

1.10 MISCELLANEOUS

A. Domestic water lines shall not be run to coffee makers, unless a drain is provided or the coffee maker is immediately adjacent to a sink.

B. Drinking fountains shall be electric, wall type, surface mounted into a wall recess 30 inches wide x 14 inches deep except where ADA requirements dictate a different configuration. Do not construct fountains into the walls so that a building alteration is required in the event an exact duplicate is not available.

C. All machine room floor sinks shall be a minimum of 4 inch diameter, with acid resisting interior, and shall be connected with trap primers. Floor drains in areas above grade and over crawlspaces shall have mechanical joints for easy access.

D. Process or Laboratory Equipment shall not be directly connected to the hydronic chilled water system, including process chillers. A process cooling water loop consisting of a heat exchanger, filters, pumps, piping, and controls must be provided for service to Laboratory equipment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 22 00 13

SECTION 22 05 16

PIPING EXPANSION COMPENSATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Flexible pipe connectors.
B. Expansion joints and compensators.
C. Pipe loops, offsets, and swing joints.

1.3 RELATED REQUIREMENTS

A. Division 21 Fire Protection Sections.
B. Section 22 00 10 - Basic Plumbing Requirements.
C. Section 22 11 16 - Plumbing Piping.

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 PERFORMANCE REQUIREMENTS

A. Provide structural work and equipment required to control expansion and contraction of piping. Verify that anchors, guides, and expansion joints provided, adequately protect system.
B. Expansion Calculations:
    1. Installation Temperature: 50 degrees F.
    2. Domestic Hot Water: 140 degrees F.
    3. Safety Factor: 30 percent.

1.6 SUBMITTALS

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Product Data:
    1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
    2. Indicate maximum temperature and pressure rating, and maximum expansion compensation.
C. Design Data: Submit calculations for the sizing of expansion loops and selection of expansion joints.
D. Shop Drawings: Submit shop drawings indicating the exact location and calculated axial and lateral loads for all anchors, guides, expansion joints and loops. Provide drawings indicating the proposed method of attachment to the building structure.
E. Manufacturer's Installation Instructions: Indicate special procedures, and external controls.
F. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.7 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Maintenance Data: Include adjustment instructions.

1.9 QUALIFICATIONS

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

B. Design expansion compensating system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.

C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.11 WARRANTY

A. Provide five year warranty.

B. Warranty: Include coverage for leak free performance of packed expansion joints.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Microflex, Inc.

B. Amber Booth Company.

C. The Metroflex Company.

D. ADSCO Manufacturing Corporation.

E. Mason Industries, Inc.

F. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 EXPANSION JOINTS

A. Laminated Stainless Steel Bellows Type as manufactured by Hyspan.

1. Pressure Rating: 300 psig WOG and 500 degrees F.
2. Joint: As specified for pipe joints.
3. Size: Use pipe sized units.
4. Application: Domestic hot and cold water piping.

2.3 ACCESSORIES

A. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Construct spool pieces to exact size of flexible connection for future insertion.

C. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Provide line size flexible connectors.

D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

E. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.

F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where indicated.

3.2 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Provide inspection services by flexible pipe manufacturer's representative for final installing and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 22 05 16

SECTION 22 05 19

METERS AND GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Pressure gauges and pressure gauge connections.
B. Thermometers and thermometer wells.
C. Pressure/temperature test plugs.

1.3 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ASME B40.100 - Pressure Gauges and Gauge Attachments.
C. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers.
D. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.
E. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.4 SUBMITTALS

A. Submit under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.
B. Product Data: Include list for every meter and gauge to be provided which indicates use, operating range, total range and location.
C. Samples: Submit one of each type of instrument specified upon request by Engineer.
D. Submit manufacturer’s installation instructions.
E. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.5 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.
B. Accurately record actual locations of meters and gauges.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 - PRODUCTS

2.1 GAUGES AND GAUGE CONNECTIONS

A. Pressure Gauges and Accessories: Provide Ashcroft gauges or approved equal, complete with lever handle shut-off cocks, and pulsation piston type dampeners, or approved equal. Porous type dampeners will not be accepted. Gauges shall have stainless steel movement and 1/2 of 1 percent accuracy. Gauges shall have back connection when used on a panel; otherwise they shall have bottom connections. Gauges shall have minimum 3 inch diameter faces.
B. Pressure Gauge Connections: Provide where noted or indicated on the Drawings or called for elsewhere in the Specifications, gauge connections complete with lever handle union shutoff cocks, or approved equal. All gauge connections shall be made up with brass pipe, nipples and brass screw fittings.
C. Siphon: Brass, 1/4 inch angle or straight pattern. Model SY14b manufactured by Weiss.
D. Pressure Test Tap: 1/4 inch full port brass ball valve, 150 psig.

2.2 THERMOMETER AND THERMOMETER WELLS

A. Provide thermometers of not less than 9 inch length scale complete with brass separable sockets (wells) with extension neck to allow for insulation of piping.

1. These thermometers shall be mercury red reading type in one piece glass tubes extending from top of scale to sensor, and shall be located so that they may be easily read.
2. Field adjustable angle thermometers are acceptable.
3. Thermometers shall be Weksler Industrial Thermometers, or approved equal.

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

C. All thermometers shall be easily read from floor and readily visible from floor.

2.3 PRESSURE TEMPERATURE TEST PLUGS

A. Test Plug:

1. 1/4 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe.
2. Provide test plugs rated for 400 psig with neoprene core for temperatures up to 200 degrees F and Nordel core for temperatures up to 350 degrees F and manufactured by Fairfax or approved equal.
3. Provide extensions for plugs installed on insulated piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

1. Pressure gauges shall be provided on the suction and discharge of base mounted pumps as indicated on the Drawings.
2. Single pressure gauges shall be installed on in-line pumps as indicated on the Drawings.
3. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gage. Provide siphon on gages in steam systems. Install thread-o-lets on piping for gage installation, do not weld nipple directly to pipe.
4. Install thermometers in piping systems in thermometer wells. Enlarge pipes smaller than 2-1/2 inch for installation of -thermometer sockets.
5. Thermometer wells and thermometers shall be located where noted on the Drawings and where called for in other sections of the Specifications. Thermometer test wells only shall be installed in a vertical position in horizontal lines and at 45 degrees, in vertical lines to hold a fluid in the well.
6. Locate pressure/temperature test plugs on the inlet and outlet of each healing coil in air terminal units, unit heaters, duct healing coils, etc. Mount short nipple with 1/4 inch ball valve. Place in accessible locations.

END OF SECTION 22 05 19

SECTION 22 05 29

HANGERS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Hangers for plumbing piping.

1.3 RELATED REQUIREMENTS

A. Section 22 11 16 - Domestic Water Piping.

B. Section 22 13 16 - Storm And Sanitary Waste And Vent Piping.

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 SUBMITTALS

A. Submit product data for review in accordance with the requirements of Division 01.

B. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Anvil.

B. Carpenter and Patterson.

C. Fee and Mason.

D. B-Line.

E. Viking.

F. Reliable.

G. Michigan.

H. Anvil model numbers are used for reference.

2.2 HANGERS

A. Anvil Figure #260 MSS Type 1, clevis hangers for:

1. Non-insulated steel and galvanized piping 2 inch through 24 inch diameter.
2. Non-insulated cast iron pipe.
3. Non-insulated PVC piping.

B. Anvil Figure #260 clevis hangers with Figure 167, MSS Type 40 galvanized insulation protection shields (sized for supporting insulation having a compressive strength of 4 psi). Support piping on outside of insulation. Size hangers so that pipe insulation passes through them without interruption.

1. Domestic hot water piping above 160 degrees F. 4 inch diameter and less.
2. All other insulated piping.

C. Anvil Figure CT-69, MSS Type 10 with adjustable wrought tubing ring hanger, copper plated for:

1. Non-insulated copper tubing with no longitudinal movement.
2. Isolation of copper tubing from dissimilar material shall also be accomplished through the use of PHD Manufacturing, Model Numbers 2501 - 2514 Unistrut clamps with PVC inserts or PHD model number 143 PVC coated swivel ring hangers.

D. Anvil Figure #171, MSS Type 41 with pipe roller, Anvil Figure #167 protection saddle, MSS Type 40 galvanized insulation protection shields (sized for supporting insulation having a compressive strength of 4 psi, at 8 foot intervals). Support piping on outside of insulation. Size hangers so that pipe insulation passes through them without interruption. Use these for:

1. Domestic hot water above 160 degrees F, 6 inch diameter and larger.

E. Anvil Figure #CT-121, MSS Type 8, riser clamps (at floor penetrations) to support:
   1. Copper pipe risers.
F. Anvil Figure #261, MSS Type 8, riser clamps (at floor slab penetrations) to support:
   1. Steel pipe risers.
   2. PVC pipe risers.
G. Anvil Powerstrut Trapeze Hangers: Where three or more lines of pipe run parallel, support them with trapeze hangers.
H. Water piping supports within walls to be by Caddy, Holdrite, Sioux Chief or approved equivalent. Support vertical drops and piping at fixture supplies in wall. Hanger material to be suitable for piping material installed. Piping supports shall be installed per manufacturer's recommendations.

2.3 INSERTS

A. Concrete Insert: Anvil Figure #281, MSS Type 18, universal concrete inserts, adequately sized and correctly positioned to support full load operating systems.
B. Concrete Insert, Wedge Type: Anvil Figure #281, 1/4 inch to 7/8 inch.
C. Lightweight Concrete Insert: Anvil Figure #285.
D. Continuous Concrete Insert: Anvil Powerstrut Figure #PS-349 pre-galvanized.

2.4 EXPANSION ANCHORS

A. Hilti Kwik-bolt, zinc-plated, metal expansion anchor.
B. Anchor to meet U.L., ICBO-4627 and FM listings.

2.5 HANGER RODS

A. Provide mild steel all-thread rods with maximum loads as follows:
   1. 3/8 inch - 300 lbs
   2. 1/2 inch - 600 lbs
   3. 5/8 inch - 1,200 lbs
   4. 3/4 inch - 2,000 lbs
   5. 1 inch - 5,000 lbs

2.6 CLAMPS

A. C-Clamps: Anvil Figure #92, MSS Type 23.
   1. Use these for attaching hangers to steel beams. Do not weld hanger rods to structural steel members.
B. Malleable Beam Clamps: Anvil Figure #218, MSS Type 30: Use these for attaching hangers to bar joists. Attach clamps to top chord of bar joists only. Confirm with structural engineer for maximum loading and restrictions.

PART 3 - EXECUTION

3.1 PIPE HANGERS

A. Support pipes on specified hangers so that equipment, pumps, and fittings do not bear weight or stresses from vibration and swaying of pipe. Support pipe risers at regular intervals in pipe shafts at least once at each floor level or a maximum of 12 feet apart. Do not use perforated metal, strap iron, or band iron. Do not make offsets in hangers.
B. Maximum allowable spacing of pipe hangers is listed below. Space hangers and brackets at closer intervals where necessary to maintain levels, slopes, and drainage, or to prevent sagging or swaying of pipe.
C. Steel Pipe - Water
   1. 1/4 inch to 1-1/2 inch - 7 feet O.C.
   2. 2 inch to 2-1/2 inch - 10 feet O.C.
   3. 3 inch to 4 inch - 12 feet O.C.
   4. 5 inch and above - 14 feet O.C.
D. Steel - Vapor
   1. 1/4 inch to 1-1/2 inch - 8 feet O.C.
   2. 2 inch to 2-1/2 inch - 13 feet O.C.
   3. 3 inch and above - 15 feet O.C.
E. Copper Pipe - Water

1. 1/4 inch to 1-1/4 inch - 5 feet O.C.
2. 2 inch to 2-1/2 inch - 8 feet O.C.
3. 3 inch and above - 10 feet O.C.
4. 1-1/4 inch to 2 inch - 8 feet O.C.

F. Cast iron pipe

1. Space hangers not to exceed 5 feet on centers. Provide minimum of two hangers per section within 18 inch of joint on barrel and at change of direction and branch connection. Install hanger and supports per CISPI 301-12.

END OF SECTION 22 05 29

SECTION 22 05 53

PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Nameplates.
B. Pipe Markers.
C. Ceiling Tacks.

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 22 62 19 - Medical Gas and Vacuum Systems for supply of pipe labels for placement by this Section.

1.4 RELATED REQUIREMENTS

A. Section 22 00 10 - Basic Plumbing Requirements.
B. Section 22 07 19 - Plumbing Insulation.

1.5 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems.
B. Texas Government Code Chapter 2252.001-005 - Texas Government Code Chapter 2252.001-005.

1.6 SUBMITTALS

A. Submit under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.
B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
C. Obtain new equipment identification numbers from the Drawings or the Superintendent of Utilities.
D. Product Data: Provide manufacturers catalog literature for each product required.
E. Samples: Submit two of each type of label, tag, etc., of the approximate size specified or implied in the specification.
F. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
G. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.7 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Contractor shall make it possible for the personnel operating and maintaining the new equipment and systems in this project to readily identify the various pieces of equipment, major valves, piping, etc., by marking them.
   1. All items of equipment such as pumps, etc., shall be clearly marked using engraved nameplates as hereinafter specified.
   2. The item of equipment shall indicate the same number as shown on the Drawings. For example, pumps will be identified as 3A, 3B, 3C, etc.
   3. The equipment identification will be shown on the Drawings or provided by the Superintendent of Utilities.
   4. All piping shall be identified with pipe markers including pipe type, direction, and pipe diameter with colors to match UTSW requirements.
   5. Color coded pipe jacketing and fitting covers (to match jacketing type) shall match UTSW colors for mechanical and piping.

2.2 MECHANICAL SPACE AND PIPING COLORS

A. UTSW Colors in mechanical and exposed spaces shall be as follows:

1. Colors shown are with Sherwin Williams paint and approved equivalent are allowed per Section 09 96 00 - High-Performance Coatings.

ITEM	COLOR	PAINT NUMBER
Structural Elements and Railing	Gray	Structural Gray SW 4031
Equipment Supports	Light Gray	Nickel SW 4030
Floor	Gray	Slate Gray SW 4026
Housekeeping Curbs (Face)	Yellow	Safety Yellow SW 4084
Equipment Curbs (Face)	Color to Match Equipment	Confirm with Utilities
Clearances and Safety Marking on Floors and Walls	Yellow	Safety Yellow SW 4084
Walls	White	Extra White LRV 86%
Gantry Crane	Yellow	Safety Yellow SW 4084
Fire Sprinkler / Fire Safety	Red	Safety Red SW 4081
Boiler (Existing)	Match Existing Equipment	Match Existing Color
Boiler (New)	Manufacturer Standard Colors	Confirm with Utilities
Steam	Aluminum Lagging	Aluminum
Condensate Return	Aluminum Lagging	Aluminum
Hot Water (Supply)	Dark Orange	International Orange SW 4082
Hot Water (Return)	Orange	Safety Orange SW 4083
Natural Gas	Yellow	Safety Yellow SW 4084
Natural Gas Vent	Yellow	Safety Yellow SW 4084
Fuel Oil	Yellow	Junction Yellow SW 4034
City Water	Light Blue	Polymer Blue SW 4055
Exterior Water	Aluminum Lagging	Aluminum Lagging with Heat Trace
Chiller (Supply)	Dark Blue	Safety Blue SW 4086
Chiller (Return)	Blue	Turbine Blue SW 4064
Chiller Refrigerant Vent	Aluminum Lagging	Aluminum
Condensing Water (Supply)	Dark Green	Safety Green SW 4085
Condensing Water (Return)	Light Green	Generator Green SW 4070
Condensing Water (Exterior)	Aluminum Lagging	Aluminum
Compressed Air	Green	Green Byte SW 4076
Refrigerant Recovery	Purple	Plumb SW 4080
Vents / Roof Vents	Gray	Galvino SW 4027
Hanger Rods	Same as Related Pipe	Confirm with Utilities
Storm Water	White	Ultra White LRV 88%
Atmospheric Relief Lines	Sames as Related Pipe	Confirm with Utilities
Ductwork, AHU, Fans, and Insulation	Aluminum Lagging	Aluminum

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

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

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

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

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

E. Identify pumps, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

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

END OF SECTION 22 05 53

SECTION 22 07 19

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 21 13 13 - Automatic Fire Sprinkler Systems for placement of hangers and hanger inserts.

B. Section 22 11 16 - Plumbing Piping for placement of hangers and hanger inserts.

1.4 RELATED REQUIREMENTS

A. Section 09 96 00 - High Performance Coatings for paint types for pipe painting.

B. Section 22 00 10 - Basic Plumbing Requirements.

C. Section 22 05 53 - Plumbing Identification for required colors and labeling on piping.

1.5 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

E. ASTM C335 - Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation.

F. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

G. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

H. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

I. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.

J. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.

K. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

L. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.

M. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.

N. ASTM C610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation.

O. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

P. ASTM D1056 - Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.

Q. ASTM D1667 - Standard Specification for Flexible Cellular Materials--Poly(Vinyl Chloride) Foam (Closed-Cell).

R. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.

S. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

T. ASTM E96/E96M - Standard Test Methods for Water Vapor.

U. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

V. UL 723 - Standard for Test for Surface Burning.

1.6 SUBMITTALS

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Product Data: Provide product description, list of materials and thickness for each service, and locations.
C. Samples: Submit two samples of any representative size illustrating each insulation type.
D. Indicate procedures, which ensure acceptable workmanship and installation standards will be achieved.
E. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.7 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with NFPA 255.

1.8 QUALIFICATIONS

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

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
C. Store insulation in original wrapping and protect from weather and construction traffic.
D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.
C. All insulation materials to be asbestos free.

PART 2 - PRODUCTS

2.1 HOT AND COLD DOMESTIC WATER (INCLUDING LABS)

A. Hot and cold water lines in buildings, including valves, strainers, unions, flanges, etc., except where specifically noted to the contrary, shall be insulated.
B. Cold water lines shall be insulated with 1/2 inch thick minimum 3 1/2 pound density preformed fiberglass insulation with a factory applied All Service Jacket, vapor sealing all joints, and factory performed fittings with vapor seal, or a flexible, 1/2 inch thick, "25 50" rated, closed cell elastomeric thermal insulation such as "Self Seal Armaflex 2000".
C. Elastomeric products shall be supplied in a pre-slit tubular form with a pressure sensitive adhesive system for closure and vapor sealing of the longitudinal joint.
    1. All elastomeric insulating products shall be guaranteed not to react with copper piping.
D. Valves shall be insulated with mitered pipe covering with voids filled with glass fiber blanket insulation.
E. Valves and fittings shall be vapor sealed with a water base asphaltic emulsion.
F. Fittings on concealed insulation shall be built up to the thickness of adjacent insulation with glass fiber fitting wrap and shall be finished with Glasfab tape embedded in vapor barrier emulsion.
G. Exposed fitting insulation shall be built up to same thickness as adjoining pipe insulation with one coat cement and after drying shall be finished with a white vapor seal and canvas jacket secured with "Arabol" adhesive and be suitable for painting.
H. Seams in jacket shall be placed in the least noticeable locations.
    1. Where seams, joint or fittings are rough they shall be covered with an application of insulating cement troweled on smoothly before the canvas is applied with Arabol adhesive.
    2. The canvas must be free of wrinkles and have a smooth, neat appearance.
I. All hot water piping systems shall be insulated as specified above for cold water, and the insulation thickness shall be 1 inch thick.
J. The only hot and cold water piping that will not require insulation are the exposed runouts under non-handicap plumbing fixtures. Where pipe chases are tight, adequate provision shall be made at the rough

in stage utilizing offset fittings or other means (except springing the pipe) to insure that insulation can be applied throughout the length of the pipe.

2.2 ROOF DRAIN PIPING

A. All roof drain piping and all horizontal runs in the building, and the bottom of all roof drains shall be insulated as specified for domestic cold water.

B. Vertical roof drain piping inside the building shall not be insulated.

2.3 FIRE PROTECTION PIPING

A. Fire protection piping, exposed or concealed, subject to freezing temperatures, shall be insulated with 7-1/2 lb. density fiberglass UL rated noncombustible pipe insulating system using sectional

1. pipe covering, jacketed with a factory applied vapor barrier laminate of aluminum foil and glass cloth. Exposed piping shall be sized for painting. Thickness shall be as follows:

Pipe Size (inches)	Insulation Thickness (inches)
2 and smaller	2
2-1/2 and larger	2-1/2

2.4 SANITARY DRAIN PIPING

A. All sanitary drain piping within 25 feet of a floor sink receiving cold condensate discharge and discharge and drain body shall be insulated as specified for domestic cold water.

2.5 INSULATION TYPES

A. Type A: Fiberglass

1. Manufacturers:
   a. Owens Corning Corporation.
   b. Substitutions: See Section 01 60 00 - Product Requirements.
2. Insulation:
   a. Glass fiber insulation piping insulation with a “K” factor of 0.23 BTU-In/Hr.-degree F at 75°F and 0.32 BTU-In/Hr.-degree F at 250°.
   b. Rated maximum service temperature of 850°F.
   c. Maximum density of 3.5-5.5 lbs/ft^3.
   d. Compressive strength of 28.5 psi minimum when tested in accordance with ASTM C165.
   e. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.
   f. Certified to meet the requirements of ASTM C795 for use over stainless steel.
   g. Rated as noncombustible when tested in accordance with ASTM E136.
   h. Insulation treated with water resistant resin on the surface and within each layer of the insulation.

B. Type B: Closed Cell Elastomeric

1. Manufacturers:
   a. Armacell.
   b. Substitutions: See Section 01 60 00 - Product Requirements.
2. Insulation:
   a. Closed cell elastomeric piping insulation with a “K” factor of 0.25 BTU-In/Hr.-degree F.
   b. Rated maximum service temperature of 220°F.
   c. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, CAN/ULC-S102-M88 or NFPA 255.
   d. Certified to meet the requirements of ASTM C795 for use over stainless steel.
   e. Rated as noncombustible when tested in accordance with ASTM E136.

2.6 PROTECTIVE JACKETING

A. General:

1. All jacketing shall be installed with the seam located along the bottom.
2. At valves and special fittings, provide removable jackets to nearest flange in both direction for maintenance and removal of fittings.

B. PVC Jacketing:

1. Manufacturers:
   a. Johns Manville Corporation; _____.

b. Substitutions: See Section 01 60 00 - Product Requirements.

2. PVC jacketing and fitting covers.
   a. Material shall have 25/50 rating and shall be limited to piping systems operating at 140 degrees or below.
   b. Thickness: 10 mil, 0.010 inch (0.25 mm).
3. PVC color jacketing is required on all piping and shall match color requirements in Section 22 05 53 - Plumbing Identification.

C. Canvas Jacket: UL listed 6 oz/sq yd (220 g/sq m) plain weave cotton fabric treated with dilute fire-retardant lagging adhesive.
1. Lagging Adhesive: Compatible with insulation.
   a. Manufacturers:
      1) Vimasco Corporation; ____.
      2) Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 INSTALLATION

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

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

C. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
1. Provide vapor barrier jackets, factory applied or field applied.
2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
3. Finish with glass cloth and vapor barrier adhesive.
4. PVC fitting covers shall not be used.
5. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
6. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

D. For insulated pipes conveying fluids above ambient temperature:
1. Provide specified jackets, with or without vapor barrier, factory applied or field applied.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
3. Finish with glass cloth and adhesive.
4. PVC fitting covers shall not be used.
5. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
6. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union.

E. Inserts and Shields:
1. Application: Piping 2 inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert Location: Between support shield and piping and under the finish jacket.
4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert Material: Heavy density insulating material suitable for the planned temperature range, and the weight of the pipe.

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

G. All piping and equipment shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

H. All insulation shall be applied by mechanics skilled in this particular work and regularly engaged in such occupation. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy work will not

be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

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

J. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least 3 inches. Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 22 00 10 - Basic Plumbing Requirements.

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

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

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

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

O. The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturers recommendations.

3.3 INSULATION “K” VALUE SCHEDULE

Service	Oper Temperature Degrees F	"K" Mean Temp Degrees F
Hot	105-140	.26 @ 100
Cold	40-55	.25 @ 75
(1) Fire line freeze protection (2) Domestic Cold Water; Storm		
Minimum "K" does not consider water vapor transmission and condensation. Additional insulation and/or vapor retarders may be required to limit water vapor transmission and condensation under extreme conditions.		
A minus 15 percent tolerance, on the insulation performance listed shall be permitted for manufacturers' standard insulation systems.		

END OF SECTION 22 07 19

SECTION 22 08 00

COMMISSIONING OF PLUMBING SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Commissioning process requirements for Plumbing systems, assemblies, controls, and equipment.

1. This project will have selected building systems commissioned. The equipment and systems to be commissioned are specified in Section 01 91 00 - General Commissioning Requirements.

1.3 RELATED REQUIREMENTS

A. Section 01 91 00 - General Commissioning Requirements.

B. Section 23 08 00 - Commissioning of HVAC Systems.

C. Section 26 08 00 - Commissioning of Electrical Systems.

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 DEFINITIONS

A. Refer to Section 01 91 00 - General Commissioning Requirements.

1.6 SUBMITTALS

A. Certificate of Readiness, signed by the Contractor, certifying that systems, assemblies, equipment, components, and associated controls are ready for testing.

B. Manufacturer’s completed start-up reports for equipment and systems.

1.7 CONTRACTOR'S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 - General Commissioning Requirements for details of Plumbing contractor’s responsibilities related to commissioning.

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

C. Attend commissioning meetings.

D. Provide information requested by the CxA for functional testing and for final commissioning documentation.

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

F. Functional testing of systems will be carried out solely by Plumbing contractor’s personnel, under the direction of CxA. Provide experienced personnel, familiar with the systems being installed under this project.

1.8 COMMISSIONING AGENT RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 - General Commissioning Requirements.

B. CxA will direct commissioning testing.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in Division 22 Sections. Provide submittals, test data, inspector record, and certification to the CxA.

B. Reference Project Specification Section 01 91 00 - General Commissioning Requirements for detailed requirements of commissioning of Plumbing systems.

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

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

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

3.2 SYSTEM START-UP

A. Contractor is solely responsible for system start-up. CxA may, at their discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies, and has so certified.

3.3 TESTING PREPARATION

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

B. Certify that testing, adjusting, and balancing procedures for Plumbing systems have been completed and submitted, discrepancies corrected, and corrective work approved.

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

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

E. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.

3.4 FUNCTIONAL TESTING / GENERAL

A. Reference Project Specification Section 01 91 00 - General Commissioning Requirements for detailed requirements of commissioning of Plumbing systems.

B. Provide measuring instruments to record test data as directed by the CxA.

3.5 PIPING SYSTEMS

A. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 22 piping Sections.

B. Plumbing Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan.

C. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA.

D. Include sequence of testing and testing procedures, description of equipment for flushing operations, drawings for each pipe sector, showing the physical location of each designated pipe test section, minimum flushing water velocity, and chemical treatment plan.

3.6 DEFERRED TESTING

A. Initial commissioning will be done to comply with 01 91 00 - General Commissioning Requirements.

B. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods. If testing cannot be carried out under these conditions to adequately verify system performance, testing will be deferred until such time as conditions are more satisfactory.

1. Contractor is to provide services of personnel and participate in deferred or seasonal testing process in the same manner as he would in non-seasonal testing.
2. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.7 RE-TESTING

A. Reference Project Specification Section 01 91 00 - General Commissioning Requirements for detailed requirements of re-testing of Plumbing systems.

3.8 SYSTEMS TO BE COMMISSIONED

A. Reference Project Specification Section 01 91 00 - General Commissioning Requirements for list of Plumbing systems to be commissioned.

END OF SECTION 22 08 00

SECTION 22 11 16

PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Wall, Floor, and Ceiling Plates.
B. Sleeves, Inserts, and Fastenings.
C. Valves.
D. Unions.
E. Flanges.
F. Sanitary Drainage System
G. Backflow Preventers
H. Interior Domestic Water Piping System.
I. Welded Piping
J. Natural Gas Distribution System.

1.3 RELATED REQUIREMENTS

A. Section 22 00 10 - Basic Plumbing Requirements.
B. Section 22 20 00 - Piping, Valves, and Fittings.

1.4 REFERENCE STANDARDS

A. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings.
B. ASME B31.1 - Power Piping.
C. ASME B31.3 - Process Piping.
D. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
E. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions.
F. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
G. AGA - American Gas Association.
H. ASME 31.1 - Power Piping.
I. ASME 31.2 - Fuel Gas Piping.
J. ASME 31.4 - Liquid Petroleum Transportation Piping Systems.
K. ASME B31.9 - Building Service Piping.
L. ASME BPVC - Boiler and Pressure Vessel Code.
M. ASME BPVC-IX - Welding and Brazing Qualifications.
N. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800.
O. ASME B16.3 - Malleable Iron Threaded Fittings.
P. ASME B16.4 - Cast Iron Threaded Fittings Class 125 and 250.
Q. ASME B16.18 - Cast Bronze Solder-Joint Pressure fittings.
R. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings
S. ASME B16.23 - Cast Copper Alloy Solder-Joint Drainage Fittings DWV.
T. ASME B16.26 - Cast Bronze Fittings for Flared Copper Tubes.
U. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings DWV.
V. ASTM A47/A47M - Ferritic Malleable Iron Castings.
W. ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
X. ASTM A74 - Cast Iron Soil Pipe and Fittings.

Y. ASTM A234/A234M - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
Z. ASTM B32 - Solder Metal.
AA. ASTM B42 - Seamless Copper Pipe.
BB. ASTM B43 - Seamless Red Brass Pipe.
CC. ASTM B75/B75M - Seamless Copper Tube.
DD. ASTM B88 - Seamless Copper Water Tube.
EE. ASTM B251/B251M - Wrought Seamless Copper and Copper-Alloy Tube.
FF. ASTM B302 - Threadless Copper Pipe (TP).
GG. ASTM B306 - Copper Drainage Tube (DWV).
HH. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
II. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
JJ. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
KK. ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
LL. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
MM. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
NN. ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
OO. ASTM D2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
PP. ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) Composite-Sewer Piping.
QQ. ASTM D2683 - Socket-Type Polyethylene Fillings for Outside Diameter-Controlled Polyethylene Pipe.
RR. ASTM D2729 - Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
SS. ASTM D2846/D2846M - Chlorinated Polyvinyl Chloride (CPVC) Pipe, Fittings, Solvent Cements and Adhesives for Potable Hot Water Systems.
TT. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
UU. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
VV. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
WW. ASTM F493 - Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
XX. AWS A5.8/A5.8M - Brazing Filler Metal. BA. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
YY. AWWA C110/A21.10 - Ductile - Iron and Gray - Iron Fittings 3 in. through 48 in., for Water and Other Liquids.
ZZ. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.
AAA. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
BBB. AWWA C651 - Disinfecting Water Mains.
CCC. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
DDD. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.
EEE. MSS SP-45 - Bypass and Drain Connections.
FFF. NCPWB (SPS) - Procedure Specifications for Pipe Welding.
GGG. NFPA 54 - National Fuel Gas Code.
HHH. NFPA 58 - Storage and Handling of Liquefied Petroleum Gases.
III. TDH - Texas Department of Health, Water System Regulations

1.5 SUBMITTALS

A. Submit under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.
B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
C. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.
B. Record actual locations of valves, etc.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.

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

1.8 QUALITY ASSURANCE

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

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

C. Welders Certification: In accordance with ASME BPVC-IX.

D. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

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

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

1.10 REGULATORY REQUIREMENTS

A. Perform Work in accordance with International Plumbing Code.

B. Conform to applicable code for installation of backflow prevention devices.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.

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

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

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

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

1.12 ENVIRONMENTAL REQUIREMENTS

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

1.13 ATTIC STOCK

A. Furnish under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.

B. Provide two repacking kits for each size valve.

PART 2 - PRODUCTS

2.1 WALL, FLOOR AND CEILING PLATES

A. Except as otherwise noted, provide C.P. (Chrome plated) brass floor and ceiling plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except underfloor and attic spaces.

1. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation.
2. Plates will not be required for piping where pipe sleeves extend 3/4 inch above finished floor.
3. Equipment rooms are classified as finished areas.
4. Round and rectangular ducts shall have closure plates (NOT chrome plated) made to fit accurately at all floor, wall and ceiling penetrations.

2.2 SLEEVES, INSERTS, AND FASTENINGS

A. General: Openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, ductwork, conduit, cable trays, etc., shall be sleeved.

1. Penetrations must pass through sleeves except soil pipe installed under concrete slabs on fill.
2. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer.
3. If a penetration is cored into an existing concrete, masonry or stone structure, then the installation of a sleeve will not be necessary.

B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4-inch, except that the minimum clearance shall accommodate a Thunderline Linkseal closure where piping exits the building, or penetrates a wall below ground level.
   1. Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe, duct, etc.
   2. Penetrations shall be of ample size to accommodate the pipe, duct, etc. plus any specified insulation.
   3. Sleeve materials shall be rigid metal of adequate strength.
   4. Void between sleeve and pipe shall be filled with Nelson Flameseal Firestop or approved equal caulk or putty.

C. Installation of sleeves in walls shall be the same as for floors.
   1. Refer to the details on the project drawings.
   2. Where the details differ from these specifications, the drawings take precedence.

D. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration.

E. Inserts:
   1. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction.
   2. Drilled anchors in concrete or masonry shall be submitted for the approval by the Owner.

F. Fasteners:
   1. Fastening of pipes, conduits, etc., in the building shall be as follows: To wood members by wood screws; to masonry by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry; to steel machine screws or welding (when specifically permitted or directed), or bolts, and to concrete by suitable inserts anchored to reinforcing steel, and poured in place unless other means are indicated on the plans. Power actuated fasteners (shooting) will not be acceptable under any circumstances. If it is necessary to install a method of fastening a hanger after the structure has been installed, then only clamps or drilled anchors shall be used.
   2. Note: Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.

G. Rat-proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be rat-proofed in a manner acceptable to the Architect/Engineer.

H. Weatherproofing:
   1. The annular space between a pipe and its sleeve in exterior walls or through floor to below grade shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound.
   2. Seal both surfaces of wall or floor.

I. Air Plenums: The space around piping, ductwork, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.

J. Fireproofing:
   1. Each mechanical and electrical contractor shall seal all cable trays, pipe, conduit, duct, etc., penetrations through roof, fire rated walls and floors with a foam or sealant as described below, that will form a watertight, vermin-tight barrier that is capable of containing smoke and fire up to 2000 degrees F for two hours.
   2. Sealing of cable trays, and conduits that extend through rated walls from ends of cable tray shall be done after conductors have been installed.
   3. Refer to Section 07 84 13 - Penetration Firestopping, Section 07 84 43 - Joint Firestopping, and Section 07 84 13 - Penetration Firestopping.

2.3 VALVES

A. Valves shall be located such that the removal of their bonnets is possible.

B. Flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position.

C. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position.

D. Valves must be true and straight at the time the system is tested and inspected for final acceptance.
E. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings.
    1. Any change in valve location must be so indicated on the Record Drawings.
F. Valves must be of threaded or flanged type.
G. No solder connected or grooved fitting valves shall be used on this project.
H. Bronze and iron body gate and globe valves shall be the product of one manufacture for each project.
    1. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.
I. Valves used in circulating systems, plumbing, and steam systems (low and medium pressure) shall be correlated to existing system requirements. Class 150 SWP.
    1. Class 200 valves shall be constructed of all ASTM B61 composition.
    2. All gate, globe and angle valves shall be union or screw-over-bonnet design.
    3. Metal used in the stems of all bronze gate, globe and angle valves shall conform to ASTM B371/B371M Alloy 694, ASTM B99 Alloy 651, or other corrosion resistant equivalents.
    4. Written approvals must be secured for the use of alternative materials.
J. Valves shall be re-packable, under pressure, with the valve in the full open position.
K. Packing for all valves shall be free of asbestos fibers and selected for the pressure-temperature service of the valve.
    1. It is incumbent upon the manufacturer to select the best quality, standard packing for the intended valve service. At the end of one year, period spot checks will be made, and should the packing show signs of hardening or causing stem corrosion then all valves supplied by the manufacturer shall be repacked by the Contractor, at no expense to the Owner, with a packing material selected by the Owner.
L. Valves located with stem in horizontal position shall be drilled and tapped in accordance with MSS SP-45 at Boss G to accommodate a drain valve.
M. Balancing and/or Shutoff Valves for Water Systems:
    1. Two inches and smaller, three-piece bronze body, bronze or stainless steel ball and stem, Teflon seats, packing and gasket, bronze gland follower, adjustable stuffing box, steel lever type handle, with plastic operating handle, quarter turn stops, and shall be Class 150.
    2. Manufacturer shall certify ball valves for use in throttling service.
    3. Stem extensions shall be furnished for use in insulated lines.
    4. Valves 2-1/2 inches and larger shall be tapped full lug butterfly valves with aluminum bronze discs of Alloy C955 and 316, 416, or 420 stainless steel shafts.
    5. Design must incorporate bushing between shafts and body of material suitable to provide a bearing surface to eliminate seizing or galling.
    6. Valve must be capable of providing a bubble tight seal at 200 psi for valves up to 12 inches (150 psi for larger valves) when used for end of line service without requiring the installation of a blind flange on the downstream side.
    7. Liners shall be resilient material suitable for 225°F temperature and bodies of ductile iron.
    8. Butterfly valves 8 inches and larger and butterfly valves used for balancing service, regardless of size, shall have heavy duty weather proof encased gear operators, with malleable iron handwheel.
    9. Valves 2-1/2 inches through 6 inches shall have lever handles which can be set in interim positions between full open and full closed.
    10. All butterfly valves shall be absolutely tight against a pressure differential of 150 psi.

2.4 UNIONS

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system.
    1. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items, machinery items and other special pieces of apparatus.
    2. Unions in 2 inches and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2-1/2 inches and larger shall be ground flange unions.
    3. Unions in copper lines shall be Class 125 ground joint brass unions or Class 150 brass flanges if required by the mating item of equipment.
    4. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items.

5. See particular Specifications for special fittings and pressure.

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

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

2.5 FLANGES

A. Slip on flanges shall not be used.

B. Bolts used shall be carbon steel or stainless steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions.

C. All thread rods will not be an acceptable for flange bolts.

D. Flat faced flanges shall be furnished where required to match flanges on pumps, check valves, strainers, etc.

E. All flanges shall be gasketed.

1. Place gasket between flanges of flanged joints.
2. Gaskets shall fit within the bolt circle on raised face flanges and shall be full face on flat face flanges.
3. Gaskets shall be cut from 1/16" thick, non metallic, non asbestos gasket material suitable for operating temperatures from 150°F to +750°F, Klingerseal C-4400, Manville Style 60 service sheet packing, or equal.

2.6 SANITARY DRAINAGE SYSTEM

A. Sanitary drainage system shall be installed as indicated on the Drawings complete with all fixtures, drains, traps and required connections.

B. Fixtures and drains shall be properly vented and trapped.

C. The Contractor shall complete the installation of the sanitary drainage system by making approved connections as indicated on the Drawings and shall be responsible for any and all connection charges.

D. Underground storm and sanitary waste piping, of all sizes, shall be cast iron hub and spigot type, with Tyseal (or approved equal) neoprene gaskets. Hubless piping systems shall not be used in a directly buried, underground application.

2.7 BACKFLOW PREVENTERS

A. A BFP shall be installed to isolate all non-potable water requirements from the building domestic water system. All BFP's shall be installed within the building.

2.8 INTERIOR DOMESTIC WATER PIPING SYSTEMS

A. ALL piping within confines of building walls shall be a part of the interior water piping system.

B. Interior Domestic Water Control Valves

1. Control valves shall be installed where indicated on Drawings and/or wherever necessary for controlling the several sections of the domestic water system.
2. Valves shall be provided on all inlet (and outlet where applicable) connections to all kinds of apparatuses, all risers, and all groups of fixtures.
    a. Groups of fixtures shall be arranged to have their group valves in one location.
    b. Access shall be provided to all concealed valves by means of an access door.
    c. Coordinate the location of valves with the architectural features of the building in order that the access doors will be located symmetrically with other features.
3. The hot and/or cold water supply lines to each and every fixture hereinafter specified shall be equipped with stop valves which shall be chromium plated where exposed chrome plated pipe is used.

C. Interior Domestic Water Headers

1. Provide headers as detailed on the drawings for cold water and hot water syste

D. Cross Connections

1. Care shall be exercised in fabricating plumbing lines to avoid all cross connections and to construct the piping systems in a manner which eliminates the possibility of water contamination.
2. The piping systems have been designed in every case to avoid the possibility of reverse flow or back siphoning. Care shall be exercised in constructing plumbing lines to make certain that not only the letter, but the spirit, of these safety precautions is carried out to the fullest possible extent.

E. Requirements of Interior Water Piping Systems

1. All piping shall have reducing fittings used for reducing or increasing where any change in the pipe sizes occurs. No bushing of any nature shall be allowed in piping.
2. All exposed chrome plated, polished or enameled connections from fixtures shall be put up with special care, showing no tool marks or threads at fittings, and supported by neat racks or hangers with round head screws of same material and finish.

2.9 WELDED PIPING

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

2.10 NATURAL GAS DISTRIBUTION SYSTEM

A. The gas distribution system shall be installed as indicated on the Drawings, complete with all valves, regulators, meters and other required items.

B. The Contractor shall make all arrangements and pay for all services and material which are required to have the gas company extend its gas main to the property line and to install the regulator and/or meter required for this project.
1. This Contractor shall, moreover, pay all fees and deposits which are required to have the meter "set" by the Gas Company.
a. This Contractor shall then extend the gas service into the buildings.
b. This Contractor shall make all arrangements and pay all fees which are required for odorizing the entire gas distribution system.
2. At every entrance of gas piping into a building, the piping shall first rise above grade on the building exterior to prevent upstream gas leaks from following the piping inside the building.
3. Provide wrench operated shutoff valve in the horizontal portion of this exterior piping at each location.

C. Verify and coordinate, with the actual various users on the site, all the times and timing involved with modification, additions to, or alterations thereof, of gas piping serving these users.

D. Natural Gas Valves
1. The gas regulator bypass globe valve shall be sized to pass only a slightly larger maximum flow rate than the gas regulator. It shall include provision for locking shut with a large padlock.

E. Natural Gas Cutoffs
1. On the inlet and discharge side of the meter and pressure regulators and at building entrance, install a wrench operated plug cock valve.
2. The flanges of this stop valve shall be dimensioned, drilled, faced and spot faced to conform to the Class 125 American Standard for Cast Iron Flanges ASME B16.1 .
3. Install zone valves on each floor accessible to occupants for shutting off areas of the building under emergency conditions.
4. Gas piping shall be welded up to these zone valves.

F. Natural Gas Piping
1. All gas piping within the building shall be installed exposed to view.
2. Gas piping systems installed underground shall utilize a factory applied protective coating system .
3. Under no circumstances shall any backfilling operations begin until these pipe protection operations have been completed.

G. Natural Gas Fittings
1. Unless otherwise specifically shown or called for, gas piping systems installed throughout the building shall be fabricated by a fusion welding process making use of welding fittings.
2. These fittings shall be fittings as specified in other sections.
3. In no case shall the wall thickness of a fitting incorporated in a gas piping system be less than that of the pipe to which it is jointed.
4. All screwed pattern fittings specifically called for shall be Class 150 malleable iron fittings of Crane Company or Walworth Company manufacture (300 lb. for unions).

H. Natural Gas Flanges:

1. In all instances in which flanges are required for the installation of flanged fittings for gas lines, the Contractor shall provide Crane or Walworth weld neck pattern, Class 150 forged steel flanges.
2. These flanges shall be dimensioned, faced grilled and spot faced to conform to the Class 150 ASME B16.9.
3. See piping section for additional requirements for flanges.

I. Natural Gas Headers

1. The gas distribution header installed by this Contractor in the building shall be fabricated of Schedule 40 steel pipe conforming in all details to Standard Specifications for WELDED AND SEAMLESS STEEL PIPE, ASTM A53/A53M Grade B, Type E or S, latest revision.
2. The header shall be dimensioned to conform to details shown on the Drawings. The pipe and welding materials for this header shall be carefully selected, and the welding operations shall be carefully supervised.
3. Welding nipples neatly aligned shall be provided for the outlets of the header. After the header has been completely fabricated, it shall be temporarily sealed and subjected to a pneumatic test pressure of 100 pounds per square inch.
    a. While the header is subjected to this pressure, all welded joints shall be given an application of soapy water for the purpose of detecting minute leaks which might not otherwise be observed.
        1) These leaks shall not be repaired by any peening operations.
        2) Such leaks shall be remedied by chipping and re-welding until the header is devoid of leaks at that pressure.
    b. The header shall then be subjected to a hydrostatic test pressure of 200 pounds per square inch.
        1) Under these circumstances, the test pressure of the water confined in the header shall not decrease in a four-hour period of observation.
        2) If leaks are encountered, they shall be eliminated in the manner prescribed by the Owner`s duly authorized representative.
4. The header shall be provided with a 1/2 inch drain connection "taken off" the bottom of the header and terminated in a suitable stop cock.
    a. This 1/2 inch drain connection shall have its origin in a 2 inches x 1/2 inch welding reducer having its 2 inch end so welded to the header as to completely drain that member. Each outgoing branch from the header shall be provided with a cock. The nature of the outgoing welding nipples shall be such that these cocks shall be lined up in a neat horizontal line.
    b. Each outgoing branch from the header shall be provided with a cock.
    c. The nature of the outgoing welding nipples shall be such that these cocks shall be lined up in a neat horizontal line.

J. Natural Gas Cocks

1. Near the point at which each outgoing line leaves the gas header, the Contractor shall install a stop valve or cock. These wrench operated valves shall each be provided with an appropriate wrench.
2. Cocks of the same type shall, moreover, be installed at each other point indicated on the Drawings.

K. Natural Gas Drip Pipes

1. Drip pipes shall be provided throughout the gas piping systems for the purpose of accumulating moisture and condensate.
2. They shall be sized no smaller than the gas piping to which they are connected in each instance.
3. These drip pipes shall be U-shaped providing an effective water seal of no less than 12 inches of water.
4. The extremity of each U-shaped drip pipe shall be threaded and capped with a suitably sized, screwed pattern, black, standard weight, malleable iron cap.
5. All drip pipes shall be located in an accessible position so that the condensate may either be pumped from the system or so that a water seal shall be provided in the event that the water forming the seal evaporates.

2.11 POLYPROPYLENE PIPE

A. Locations and use as approved in writing by UTSW FM.

B. Installation per manufacturer's instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt, on inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.
D. After completion, fill, clean, and treat systems. Refer to Section 22 00 10 - Basic Plumbing Requirements.

3.3 INSTALLATION

A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
B. Route piping in orderly manner and maintain gradient.
C. Install piping to conserve building space and not interfere with use of space.
D. Group piping whenever practical at common elevations.
E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16 - Piping Expansion Compensation.
F. Provide clearance for installation of insulation and access to valves and fittings.
G. Provide access where valves and fittings are not exposed. Coordinate access door location with architectural features.
H. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
I. Establish elevations of buried piping outside the building to ensure a minimum of cover.
J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
K. Provide support for utility meters in accordance with requirements of utility companies.
L. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 09 96 00 - High-Performance Coatings.
M. Excavate in accordance with Section 22 00 10 - Basic Plumbing Requirements for work of this Section.
N. Backfill in accordance with Section 22 00 10 - Basic Plumbing Requirements t for work of this Section.
O. Install bell and spigot pipe with bell end upstream.
P. Install valves with stems upright or horizontal, not inverted.
Q. Locate valves in readily accessible areas and where valve operation will not damage other components, materials, or devices.
R. Provide one plug valve wrench for every ten plug valves sized 2 inches and smaller, minimum of one. Provide each plug valve sized 2-1/2 inches and larger with a wrench with set screw.
S. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
T. Shock Arrestors:
    1. Install shock arrestors at each quick closing valve, solenoid type valve, and flush valve. Size shock arrestors in accordance with manufacturer's instructions.
    2. Install shock arrestors within five feet of valve, provide all access panel as required.
    3. Test and certify shock arrestors by Plumbing and Drainage Institute in accordance with ANSI/ASSE 1010.
U. Inline Automatic Flow Controllers:
    1. Install in accordance with manufacturer's instructions and in accordance with details on Drawings.
    2. Provide valves, strainers, and PT ports NSF approved for potable water systems.

3.4 FABRICATION OF PIPE

A. All the various piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material. Lines shall also be graded for proper drainage.
B. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the site.
C. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.

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

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

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

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

3.5 INSTALLATION OF SANITARY DRAINAGE PIPING:

A. Piping shall be run in the most direct manner. Horizontal pipes shall have a grade of 1/4 inch per foot, wherever possible, and not less in any case than 1/8 inch per foot, unless otherwise noted on Drawings.

B. Joints in hub and spigot cast iron pipe shall be made water and gas tight with Tyseal neoprene gaskets. Lead and Oakum may be used only under special conditions, with prior written permission from the Resident Construction Manager.

1. Joints in hubless cast iron soil pipe and fittings shall be made by the use of a neoprene sleeve and stainless steel shield made tight with a torque wrench and torqued to the manufacturer`s specifications.
2. Each clamp shall consist of a neoprene gasket with a stainless steel outer band which effectively captures the gasket material.
3. Each clamp shall bear the FM and UPC stamp, and shall be approved to Class I of Factory Mutual Standard #1680, and be a Heavy Duty No Hub Coupling, minimum 4 bands.
4. Materials used in the clamp shall be stainless steel.
5. Elbows and tees shall be braced against thrust loads which might result in joint separation due to dynamic forces caused by sudden, heavy rainfall conditions.
6. Where roof drains are 50 or more feet above the horizontal runout at grade level, the downspout piping system shall be constructed of Schedule 40 black steel pipe with weld fittings.

C. Provide cleanouts at the bottom of each downspout, at each change of direction and at intervals not exceeding 95 feet in horizontal runs.

1. Interior cleanouts shall be brass caulked into the lines, and where they occur in walls or floors of finished areas, shall be provided with nickel-bronze tops or access plates.
2. Interior cleanouts shall be of the same size at the pipe served up to 4 inches size and 4 inches for all larger lines.

D. Exterior cleanouts shall consist of a concrete encased wye in the line with sewer pipe extending upward therefrom and terminating in a concrete slab below grade.

1. A standard cast iron cleanout casting shall be set on this slab in such manner as to be flush with finished grade and to provide access through its cover to the cleanout.
2. A removable concrete stopper shall be set in the open top of the cleanout pipe.

E. Horizontal runs of storm drainage piping within the building, except in crawl space shall be insulated as specified.

F. Flashings:

1. Vent pipes passing through the roof shall be provided with lead roof flashings constructed of 2-1/2# sheet lead with bases extending no less than 10 inches on each side of the pipe.
2. The vertical portion of the flashing shall extend upward the entire length of the pipe and be turned inside the pipe at least 2 inches.
3. Lead flashings shall be fabricated and furnished by Mechanical Contractor and turned over to Roofing Contractor who will install them.

3.6 SANITARY DRAINAGE TESTING:

A. After the vertical lines of soil pipe, waste, and other parts of the sanitary system have been set from the basement to the top of the building, all outlets shall be temporarily "plugged up", except as are required for testing as described herein.

1. One floor level of the building shall be tested at a time.
2. Each floor shall be tested from a level below the structure of the floor, or the outlet of the building in the case of the lowest level, to a level of 12 inches above the floor immediately above the floor being tested, or the top of the highest vent in the case of the highest building level.
3. The pipes for the level being tested shall be filled with water to a verifiable and visible level as described above and be allowed to remain so for 24 hours.
4. If after 24 hours the level of the water has been lowered by leakage, the leaks must be found and stopped, and the water level shall again be raised to the level described, and the test repeated until, after a 24-hour retention period, there shall be no perceptible lowering of the water level in the system being tested.

B. A final test shall be conducted after all vertical and horizontal pipes and "rough-ins" have been complete but before the sewer connection is made.
1. The test procedure shall be identical with that described above except that the entire plumbing system, i.e., the vertical and horizontal pipe and "rough-in", shall be subjected to water under the head imposed by filling the system to the top of the building. After all testing operations have been completed, all waste lines shall be cleaned.

C. Should the completion of these tests leave any reasonable question of a doubt relative to the integrity of the installation, additional tests or measures shall be performed to demonstrate the reliability of these systems to the complete satisfaction of the Owner`s duly authorized representative. Such tests shall be conducted and completed before any joints in plumbing are concealed or made inaccessible.
1. Such tests shall be conducted and completed before any joints in plumbing are concealed or made inaccessible.

3.7 INTERIOR DOMESTIC WATER SYSTEM:

A. Interior Domestic Water Piping Fabrication
1. All piping shall have reducing fittings used for reducing or increasing where any change in the pipe sizes occurs. No bushing of any nature shall be allowed in piping.
2. All exposed chrome plated, polished or enameled connections from fixtures shall be put up with special care, showing no tool marks or threads at fittings, and supported by neat racks or hangers with round head screws of same material and finish.
3. Wade Shokstop, or approved equal, sealed air chambers shall be provided in all water branches to fixtures, sized in accordance with manufacturer`s recommendations, concealed, accessible, and located so as to protect each group of plumbing fixtures.
4. The fabrication of copper pipe and fittings shall in every detail conform to the recommendations and instructions of the fitting manufacturer. The tools used shall be the tools adapted to that specific purpose.
5. Refer to other parts of this Section for other information concerning installation of piping.

B. Interior Domestic Water Piping - Testing and Sterilization
1. All water piping systems shall be properly tested to assure their being absolutely tight. In the case of pipes which are to be insulated, these tests shall be completed and the piping system proven to be absolutely tight before any insulation is applied.
a. Wherever pipes are placed so that they will ultimately be concealed, these tests shall be conducted and the absolute tightness of each piping system shall be demonstrated before the system is concealed.
2. The procedure of these tests shall consist of subjecting a piping system to a hydrostatic pressure of 150 percent of the normal operating pressure or 125 psi, whichever is greater for a period of no less than twenty-four hours.
a. During this testing period, all pipe, fittings, and accessories in the particular piping system which is being tested shall be carefully inspected.
b. If leaks are detected, such leaks shall be stopped by means designated by the Owner's duly authorized representative and the hydrostatic test shall again be applied.
c. This procedure shall be repeated until, for an entire twenty-four hour period, no leaks can be found while the system being tested is subjected to the pressure mentioned above.
3. Wherever conditions permit, each piping system shall thereafter be subjected to its normal operating pressure and temperature for a period of no less than five (5) days.

a. During that period, it shall be kept under the most careful observation. The piping systems must demonstrate the propriety of their installation by remaining absolutely tight during this period.
b. Even though the completion of these tests is satisfactory, there is a continuing responsibility for the ultimate, proper, and satisfactory operation of such piping systems and their accessories.

4. After completion of the testing, the entire cold and hot water piping systems, with attached equipment, shall be thoroughly sterilized with a solution containing not less than 50 parts per million of available chlorine.
a. The chlorinating materials shall be either liquid chlorine conforming to U. S. Army Specification No. 4-1 or calcium hypochlorite or chlorinated lime conforming to the requirements of Federal Specification OC114.
b. The sterilizing solution shall be allowed to remain in the system for a period of eight (8) hours during which time all valves and faucets shall be opened and closed several times.
c. After sterilization, the solution shall be flushed from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million.

5. The sterilization process shall be conducted as required by the Health Department of the City in which the project is locate and the specifications above, and upon completion of the process, the Health Department shall test and certify the cleanliness of the water piping system.
6. The Mechanical Subcontractor shall pay all costs and charges incidental to this test and certification.

3.8 WELDED PIPING FABRICATION:

A. Piping and fittings shall be welded and fabricated in accordance with the latest editions of ASME B31.1 for all systems, and ASME B31.3 for Steam and Condensate systems, from the Code for Pressure Piping.
1. Machine beveling in shop is preferred.
2. Field beveling may be done by flame cutting to recognized standards.

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

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

D. Do not permit any weld to project within the pipe so as to restrict it.
1. 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.

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

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

G. In no cases shall Schedule 40 pipe be welded with less than three passes including one stringer/root, one filler and one lacer.

H. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two filler and one lacer. In all cases, however, the weld must be filled before the cap weld is added.

3.9 WELDED PIPING TESTING:

A. Welds are subject to inspection, visual and/or X-ray, for compliance with specifications.
1. Owner will, at the Owner's option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing.
a. Initial visual and X-ray inspections will be provided by the Owner.

2. Contractor shall be responsible for labor, material and travel expenses involved in the re-inspection and retesting of any welds found to be unacceptable. In addition, the contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME B31.1 B31.1 and ASME B31.3 due to the discovery of poor, unacceptable or rejected welds.

B. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the Code, current edition.

C. Weld fittings shall be USA factory made wrought carbon steel butt welding fittings conforming to ASTM A234/A234M and ASME B16.9 B16.9 as made by Grinnell, Tube Turn, Hackney, Taylor Forge, or Ladish Company.

1. Each fitting shall be stamped as specified by ASME B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties and chemical composition of the material.
2. Complete test reports may be required for any fittings selected at random.
3. Only one manufacturer of weld fittings will be approved for each project.
4. Fittings which have been machined, remarked, printed or otherwise produced domestically from imported forgings or materials will not be acceptable.
5. Each fitting shall have the manufacturer`s trademark permanently identified in accordance with MSS SP-25.
6. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process.
7. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these Specifications.

3.10 NATURAL GAS PIPING FABRICATION:

A. All interior gas piping shall, wherever possible, be installed so as to grade back toward the gas header in the basement.

1. In all cases where such grading is impracticable and it is necessary to grade the house piping away from the inlet, drip pipes of adequate capacity must be installed where traps are formed by such changes in grade.
2. Drip pipes shall terminate a screwed pattern, malleable iron black cap. No drip pipes shall be used as outlets for the attachment of any fixture or gas appliance.
3. Drip pipes must, moreover, be placed at the bottom of all vertical pipes which rise from and connect to the end of any horizontal pipe.

B. All house piping must be securely fastened in place in such a manner as to maintain its grading.

1. Under no circumstances shall extension bars be used for supporting gas piping.
2. Under no circumstances shall any gas piping be used to support any weight other than its own weight.

C. All branch outlet pipes shall be taken from the top or sides of running horizontal lines and not from the bottom.

1. No crosses shall be installed in any horizontal gas line.
2. No unions, gas cocks, or valves shall be used in any concealed location.
3. Every gas cock and valve shall be accessible for inspection and repair.

D. The general arrangement of all gas piping shall be such that the number of threaded joints involved is reduced to an absolute minimum.

1. If obstructions are encountered, pipe shall not be bent to circumvent such obstructions. Welding fittings shall be used for this purpose in the case of welded lines, and if threaded lines are involved, screwed fittings shall be used.
2. Wherever gas pipes run through outside brick, stone, or other walls, the opening around the pipe shall be securely and rigidly sealed.
3. Gas pipe sizes shall be at least one pipe size larger than the inlet of the gas appliance which they supply.
4. No bushings shall be used in conjunction with any gas piping.

3.11 NATURAL GAS PIPING TESTING

A. Gas piping systems shall be very carefully tested by the Contractor.
   1. These piping systems shall first be subjected to a pneumatic test pressure of 100 pounds per square inch.
   2. Hydro and pneumatic tests shall be dead weighted, recorded, and countersigned by the project inspector.
   3. While the systems are subjected to this air pressure, all welded joints shall have a soapy water solution applied for the purpose of detecting minute, as well as larger leaks, and shall be witnessed by Owner.
   4. A final test shall be performed after casework and lab hook up are completed at 15 psi for a minimum of 4 hours.
      a. If leaks are found, they shall be repaired by chipping and re-welding operations.
   5. Alternate testing and re-welding operations shall be repeated until gas piping systems are absolutely tight at the pneumatic test pressure indicated above.
      a. If leaks occur in the case of threaded joints, such leaks shall be eliminated by legitimate means, i.e., either by replacing leaking fittings or by tightening them properly.
      b. Leaking flanged joints shall have flange bolts appropriately tightened or have gaskets causing leaks replaced.

B. Entire gas piping systems shall be subjected to a pneumatic test pressure of 100 pounds per square inch. Such gas piping systems must be demonstrated to be absolutely tight when subjected to this pressure for a period of twenty-four hours.
   1. In all instances in which leaks are then found, they shall be eliminated in the manner designated by the Owner`s duly authorized representative.
   2. A 1/2 inch test connection and cap shall be provided in each branch of the gas piping system.

C. After all pneumatic testing of the entire gas piping system has been completed and all leaks have been repaired and at a time deemed suitable by the Owner`s duly authorized representative, the Contractor shall have the gas supply turned on and the gas odorant chemical added by a representative of the gas company.
   1. The Contractor shall then bleed gas from every riser and every runout until the odor is present in the proper quantity at every gas outlet.

3.12 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.
B. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.
C. Install ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
D. Install globe or plug valves for throttling, bypass, or manual flow control services.
E. Provide spring loaded check valves on discharge of water pumps.
F. Provide plug valves in Natural gas systems for shut-off service.
G. Provide flow controls in water recirculating systems where indicated.
H. Use grooved mechanical couplings and fasteners only in accessible locations or within riser shafts.
I. Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
J. Install ball valves for throttling, bypass, or manual flow control services.
K. Use plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.
L. Use butterfly valves interchangeably with gate and globe valves.
M. Use lug end butterfly valves to isolate equipment.
N. Provide 3/4 inch (20 mm) ball drain valves at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

3.13 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/8 inch per foot (one percent) minimum. Maintain gradients through each joint of pipe and throughout system.
B. Slope water piping and arrange to drain at low points.

3.14 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean.

B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651 .

3.15 EQUIPMENT CONNECTIONS

A. Under this Section, water lines shall be run to and connected to the pumps, quick fills, and other items of equipment as indicated.

B. Provide suitable shutoff valves, check valves, and, if required by the drawings, bypass valves at each and every such point of connection.

3.16 CONNECTIONS FOR GENERAL CONTRACTOR FURNISHED EQUIPMENT

A. Route lines as indicated on the Drawings to serve various items of equipment specified under General Specification.

1. Rough-in in accordance with detailed drawings furnished by the equipment supplier, and make final connections to the equipment when it is installed.
2. Rough-in shall terminate where noted on Drawings.
3. All pressure lines shall be provided with shutoff valves or cocks.
4. Drain lines shall be provided where required.
5. It shall be assumed that the equipment supplier will provide and install all valves and pipe specialties, etc., unless such items are specified herein or called for on the Drawings.

B. Laboratory and/or other special equipment and trim are specified in another section under which the equipment shall be furnished and installed.

1. Trim, sink strainers and tail pieces shall be furnished to Mechanical Contractor who shall receive, store and install them.
2. Mechanical Contractor shall furnish the sink P-traps and all materials and labor to rough-in and final connect as shown on the Drawings.

3.17 CONNECTIONS FOR OWNER FURNISHED EQUIPMENT

A. The Owner will be furnishing various pieces of equipment.

B. The Contractor shall provide the rough-in indicated on the Drawings.

C. Final connections are also included as part of this contract.

END OF SECTION 22 11 16

SECTION 22 11 19

PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Floor drains.
B. Cleanouts.
C. Strainers.
D. Backflow preventers.

1.3 RELATED REQUIREMENTS

A. Section 22 00 10 - Basic Plumbing Requirements
B. Section 22 11 16 - Plumbing Piping
C. Section 22 67 06 - Deionized Water System.

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ASSE 1001 - Hose Connection Vacuum Breakers.
C. ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent.
D. ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
E. ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti Backflow Types.
F. ASME A112.6.3 - Floor and Trench Drains.
G. ASTM C478 - Precast Reinforced Concrete Manhole Sections.
H. AWWA C510 - Double Check Valve Backflow Prevention Assembly.
I. AWWA C511 - Reduced-Pressure Principle Backflow Prevention Assembly
J. PDI-WH 201 - Water Hammer Arresters.

1.5 SUBMITTALS

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
C. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
D. Manufacturer`s Installation Instructions: Indicate assembly and support requirements.
E. Manufacturer`s Certificate: Certify that oil interceptors meet or exceed specified requirements.
F. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Record actual locations of equipment, cleanouts, backflow preventers, etc.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Operation Data: Indicate frequency of treatment required for interceptors.
C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Accept specialties on site in original factory packaging. Inspect for damage.

1.9 ATTIC STOCK

A. Furnish under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Provide two loose keys for each type of manhole cover and valve box.

PART 2 - PRODUCTS

2.1 FLOOR DRAINS

A. Floor drains (FD) shall be sized to conform to the information indicated on the Drawings or contained elsewhere in these Specifications. Extreme care shall be used to set the elevation of the drain to meet the low point elevation of the finished floor. Each floor drain shall be provided with a P-trap unless noted otherwise. Note that a deep seal type trap may be required under other Sections of these Specifications.
B. All floor drains will be furnished and installed with all accessories required for the particular construction in which they are to be mounted; and shall be as manufactured by Wade, Josam, Zurn, or approved equal.

2.2 CLEANOUTS

A. At each change in direction, at the end of each continuous waste line, at the foot of each riser in the building and at 50 foot intervals in long horizontal runs, of lines of 4 inch size and smaller, and not more than 95 foot intervals for larger lines, cleanouts shall be placed in soil and waste lines.
B. The size of the cleanouts shall be identical with the size of the soil or waste line in which they are placed for 4 inch and smaller lines.
C. The size of cleanouts in lines larger than 4 inches shall be 6 inches in all cases. All cleanouts shall be placed to be easily accessible for servicing.
D. Where they occur in pipe chases, they shall be placed above the floor in such a location so they will be easily accessible through access doors, or they shall be brought through the walls and be provided with covers.
E. All horizontal soil and waste lines shall have a cleanout placed in the end of the line by the use of a wye and a 1/8 bend, or by a combination tee wye and made easily accessible by extending the cleanout through the wall and be covered as described above.
F. Cleanouts shall be located at the end of all sanitary lines and above the flood level rim.
G. The screw plug of all cleanouts shall be of cast brass.
H. The bodies of floor cleanouts shall be tapped for iron pipe threads. The brass tap screws shall have flange caps with raised nuts.
I. Wherever such cleanouts occur in finished floor slabs or terminate in finished walls, they shall be provided with scoriated nickel bronze cleanout covers of such a size as to make the plugs over which they are installed readily accessible. These cleanouts shall be cast iron floor cleanout with cut off ferrule, tapered brass plug with 8 inch round screwed brass access cover with three eighths inches (3/8 inch) diameter Allen Head Screw.
J. Floor Cleanouts (All Areas): Wade W-8190 UT or Zurn ZN 1455 4-75-UT as described above.
K. Final mounting of cleanout or cover shall be set flush with the finished surface the device is mounted in.

2.3 STRAINERS

A. Strainers, 2 inch and smaller, bronze body, screwed ends, No. 10 mesh strainer, screwed cap with bronze blow-off valve (size to be determined by standard tap size in cap).
B. Cast iron body, 2 1/2 inches and larger, isolating type flanged ends where installed in copper lines, No. 7 perforated monel strainer, flanged cap with bronze ball blow-off valve (size of blow off valve shall be determined by standard tap size in cap).
C. Suction diffusers shall be Paco or approved equal, cast iron body and cover, steel diffuser, and stainless steel strainer, 125 pound ASA (flat face) flange for a working pressure of 175 psi and temperature of 300°F.

2.4 BACKFLOW PREVENTERS

A. Backflow preventers (BFP) shall be reduced pressure type, Febco 825, or approved equal. A BFP shall be installed to isolate all non-potable water requirements from the building domestic water system. (All BFP`s shall be installed within the building.)

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.2 INSTALLATION

A. Install in accordance with manufacturer`s instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of threaded sealant. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Pipe relief from back flow preventer to nearest drain.

E. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatories, sinks, and washing machine outlets.

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

END OF SECTION 22 11 19

SECTION 22 13 16

STORM AND SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Sanitary waste and vent piping.

B. Storm water piping.

1.3 RELATED REQUIREMENTS

A. Section 22 00 10 - Basic Plumbing Requirements.

B. Section 22 00 13 - UTSW Plumbing Design Requirements.

C. Section 22 05 29 - Hangers for Plumbing Piping.

D. Section 22 13 19 - Sanitary Waste Piping Specialties .

E. Section 23 21 13 - Hydronic Piping.

1.4 REFERENCE REQUIREMENTS

A. IPC International Plumbing Code - Current Version.

B. ASME B31.9 - Building Service Piping.

C. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.

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

E. ANSI A117.1 - Accessible and Usable Buildings and Facilities.

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

G. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 SUBMITTALS

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Submit product data for review on piping and fittings in accordance with the requirements of Division 01. Submittal data shall include:

1. Manufacturer of pipe.
2. Tests or listing by recognized testing laboratory that certifies material composition is in accordance with ANSI/ASTM requirements.
3. Product data for pipe and fittings to be used on each piping system.
4. Identification of where each pipe type will be used.

1.6 QUALITY ASSURANCE

A. Installation according to IPC requirements.

B. Identify pipe with marking including size, ASTM material classification and ASTM specification.

1.7 DELIVERY, STORAGE AND PROTECTION

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

PART 2 - PRODUCTS

2.1 CAST IRON PIPE AND FITTINGS

A. Conform to ASTM A-74, A-888, and CISPI 301-12.

B. Pipe and fittings shall be marked with the collective trademark of Cast Iron Soil Pipe Institute and be listed by NSF International.

C. Standard weight pipe with drainage fittings for:

1. Sanitary waste, vent, and drainage pipe 2 inch and larger above ground.
2. Building storm drains.

3. Rainwater conductors inside building.
4. Drain lines under buildings, and under exterior concrete or other paving. Extend cast iron piping at least 5 feet outside of building.

D. Joints in Cast Iron Pipe:
1. Below grade: Bell and spigot with neoprene compression gaskets
2. Above grade: No-Hub using stainless couplings, meeting CISPI 310-12. Provide 4-band, heavy duty couplings for piping 2 inch through 10 inch and 6-band heavy duty couplings for piping 12 inch and larger. Couplings shall comply with ASTM C 1540/ FM-1680 rated no hub bands for all cast iron piping material above slab on-grade.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation: For each installation, comply with requirements from 22 00 10 - Basic Plumbing Requirements.

B. Cast Iron Pipe Joints:
1. Install compression gaskets and No-Hub bands in accordance with CISPI installation methods and manufacturer's instructions.

C. Grading Pipes for Drainage:
1. Uniformly place storm drainage pipes and footing drain pipes at elevations and slopes indicated. If no elevations or slopes are indicated, slope pipes at not less than 1/8 inch per foot.
2. Uniformly place sanitary sewer pipes at elevations and slopes required by the local codes

D. Bracing Joints:
1. Provide braces and all-thread bridle rods as required to reinforce sanitary and storm piping joints at each change of direction within building and where otherwise not direct buried below ground.
2. If mechanical lock type couplings are used, then prepare pipe ends and make joints in accordance with pipe coupling manufacturer's printed instructions.
3. Where large pipes underground are subject to shock because of sudden changes in liquid flow rate, provide concrete "kicker" blocks at joints, fittings, and changes of pipe direction. Provide "kicker" blocks in accordance with applicable pipe industry trade or research organization recommendations.

E. Clean inside of pipe before installation. Keep installed piping clean, and protect ends from foreign matter by capping or plugging them.

F. Do not install piping above electrical equipment such as starters, variable frequency motor controllers, motor control center's, or disconnects. Maintain code required clearance above, below and to sides of electrical equipment.

G. Do not install piping above or passing through any IT rooms, IDF rooms, or service entrance rooms.

H. Run pipes in straight lines and square with building. Install risers plumb. Make offsets only where indicated and where necessary.

I. Piping passing through or under grade beams or through foundation walls shall be provided with a schedule 40 steel pipe sleeve two sizes greater than the piping passing through the sleeve.

J. Identify all storm, waste and vent piping in accordance with and as specified in Section 22 05 53.

3.2 INSPECTION AND TESTING

A. Inspection and Testing: For each installation, comply with requirements from 22 00 10 - Basic Plumbing Requirements.

3.3 CLOSEOUT ACTIVITIES

A. As part of project punch list requirements per Section 01 77 00 - Closeout Procedures and Submittals, include UTSW Utilities / Mechanical Shop, UTSW Controls / Utilities Operations, UTSW Plumbing Shop, UTSW Building Maintenance, UTSW PM, Commissioning Agent (if applicable), and other associated teams for mechanical focused review.

B. Provide revised Operations and Maintenance Data including final installed components, schedule, maintenance manuals, and warranty documentation to UTSW PM and to UTSW Building Maintenance.

END OF SECTION 22 13 16

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. This section includes requirements for:
   1. Cleanouts
   2. Trap primers

1.3 RELATED REQUIREMENTS

A. Section 22 00 10 - Basic Plumbing Requirements.
B. Section 22 00 13 - UTSW Plumbing Design Requirements.
C. Section 22 05 29 - Hangers for Plumbing Piping.
D. Section 22 05 53 - Plumbing Identification.
E. Section 22 11 16 - Plumbing Piping .
F. Section 22 11 19 - Plumbing Specialties.
G. Section 22 13 16 - Storm and Sanitary Waste and Vent Piping .
H. Section 22 20 00 - Piping, Valves, and Fittings.

1.4 REFERENCE REQUIREMENTS

A. IPC International Plumbing Code - Current Version.
B. ASME B31.9 - Building Service Piping.
C. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
D. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.
E. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
F. TDH - Texas Department of Health, Water System Regulations
G. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 SUBMITTALS

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Submit product data for review on piping and fittings in accordance with the requirements of Division 01. Submittal data shall include:
   1. Manufacturer of pipe.
   2. Tests or listing by recognized testing laboratory that certifies material composition is in accordance with ANSI/ASTM requirements.
   3. Product data for pipe and fittings to be used on each piping system.
   4. Identification of where each pipe type will be used.

1.6 QUALITY ASSURANCE

A. Installation according to IPC requirements.
B. Identify pipe with marking including size, ASTM material classification and ASTM specification.

1.7 DELIVERY, STORAGE AND PROTECTION

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

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers are indicated in subsequent paragraphs.

2.2 CLEANOUTS

A. Acceptable manufacturers:
   1. Zurn (Zurn model numbers are used below as Basis of Design).
   2. Josam.
   3. Wade.
   4. Jay R. Smith.
   5. Sioux Chief.
   6. Watts.
   7. Substitutions: See Section 01 60 00 - Product Requirements.
B. Exterior: Heavy duty cast iron cleanout housing with internal cleanout body and plug.
   1. Basis of Design: BaZ1400Z.
C. Finished concrete floor: Cast iron body with round adjustable polished nickel bronze top, ABS plug and carpet marker where required.
   1. Basis of Design: ZN1400.
D. Ceramic tile: Cast iron body, polished nickel bronze top, 1/2 inch terrazzo recess and closure plug.
   1. Basis of Design: ZN1400 Series.
E. Vinyl tile floor: Cast iron body, round nickel bronze top, 1/8 inch tile recess and closure plug.
   1. Basis of Design: ZN1400-X.
F. Carpet: Inside caulk round brass scoriated frame and cover and provide carpet marker.
   1. Basis of Design: ZN1400-CM.
G. Wall: Cast iron caulking ferrule with stainless round access cover and screws.
   1. Basis of Design: Z1441.
H. Access covers: Minimum size 12-inch x 12-inch located for access to valves, shock absorbers, trap primers, wall cleanouts, etc.
I. Furnish cleanouts occurring in waterproof floors with clamping devices.

2.3 TRAP PRIMERS

A. Acceptable manufacturers:
   1. Josam
   2. Zurn
   3. Wade
   4. Jay R. Smith
   5. Precision Plumbing Products
   6. Sioux Chief
   7. Substitutions: See Section 01 60 00 - Product Requirements.
B. Provide trap primer of brass construction, with removable operating parts, and integral vacuum breaker.
C. See Plumbing fixture section for specifications.

PART 3 - EXECUTION

3.1 INSTALLATION, INSPECTION, AND TESTING

A. Installation: For each installation, comply with requirements from 22 00 10 - Basic Plumbing Requirements.
B. Cleanouts
   1. Provide line size cleanouts up to 4 inch; 4-inch cleanout for lines larger than 4 inch.
   2. Locate cleanouts at all changes in direction greater than 45 degrees and in straight runs as shown 100 feet outside the building on drawing or spaced not greater than required by applicable Plumbing Code.
   3. Extend inaccessible cleanouts up through floor and/or wall to provide easy accessibility.
C. Trap Primers
   1. Install primers in accessible location or as shown on drawings.
   2. Trap primers shall be Plumbing and Drainage Institute approved.

3.2 CLOSEOUT ACTIVITIES

A. As part of project punch list requirements per Section 01 77 00 - Closeout Procedures and Submittals, include UTSW Utilities / Mechanical Shop, UTSW Controls / Utilities Operations, UTSW Plumbing Shop, UTSW Building Maintenance, UTSW PM, Commissioning Agent (if applicable), and other associated teams for mechanical focused review.

B. Provide revised Operations and Maintenance Data including final installed components, schedule, maintenance manuals, and warranty documentation to UTSW PM and to UTSW Building Maintenance.

END OF SECTION 22 13 19

SECTION 22 20 00

PIPING, VALVES, AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Piping.
B. Pipe fittings.
C. Valves.
D. Strainers.
E. Unions.
F. Flanges.
G. Backflow Preventers.

1.3 RELATED REQUIREMENTS

A. Section 09 96 00 - High-Performance Coatings.
B. Section 22 00 10 - Basic Plumbing Requirements.
C. Section 22 05 16 - Piping Expansion Compensation.
D. Section 22 05 29 - Supports and Anchors.
E. Section 22 05 48 - Vibration Isolation.
F. Section 22 05 53 - Plumbing Identification.
G. Section 22 07 19 - Plumbing Insulation.
H. Section 22 11 16 - Plumbing Piping for installation requirements.

1.4 REFERENCE STANDARDS

A. AGA - American Gas Association.
B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
D. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
E. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings.
F. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
G. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
H. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV.
I. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV.
J. ASME B16.34 - Valves — Flanged, Threaded, and Welding End.
K. ASME B31.1 - Power Piping.
L. ASME B31.9 - Building Services Piping.
M. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
N. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
O. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
P. ASTM A105/A105M - Standard Specification for Carbon Steel Forgings for Piping Applications.
Q. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
R. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
S. ASTM A182/A182M - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
T. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.

U. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
V. ASTM A536 - Standard Specification for Ductile Iron Castings.
W. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings.
X. ASTM B99 - Standard Specification for Copper-Silicon Alloy Wire for General Applications.
Y. ASTM B148 - Standard Specification for Aluminum-Bronze Sand Castings.
Z. ASTM B371/B371M - Standard Specification for Copper-Zinc-Silicon Alloy Rod.
AA. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
BB. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
CC. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
DD. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
EE. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
FF. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
GG. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
HH. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
II. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
JJ. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions.
KK. MSS SP-45 - Drain and Bypass Connections.
LL. Texas Government Code Chapter 2252.001-005 - Texas Government Code Chapter 2252.001-005.

1.5 SUBMITTALS

A. Submit product data under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Include data on pipe fittings, valves, and accessories.
C. Provide manufacturer’s catalog information. Indicate valve rating and data.
D. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.
B. Welding Certificates, Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.
    1. Welders Certification: In accordance with ASME BPVC-IX.
C. Maintain one copy of the above listed documents on site for inspection.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Store and protect products under provisions of Section 22 00 10 - Basic Plumbing Requirements.
C. Deliver and store valves in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 PIPING

A. Sanitary Drainage Pipe and Fittings:
    1. Pipe used for interior, above ground sewer and drainage purposes, unless specifically shown to the contrary, shall be service weight cast iron soil pipe conforming to ASTM A74 and CISPI 301 , hub and spigot for 10 inches and larger and hubless for 8 inches and smaller, each piece of pipe and each fitting shall have the manufacturer`s mark or name cast on it.
    2. Pipe and fittings from the sump pumps and sewage ejectors shall be Schedule 80 PVC with PVC bolted flange connections at pump discharge and at each valve. PVC piping shall be run from the pumps to the exterior piping connection point within 6 inches of 5 feet outside of the building.

3. Galvanized or black steel pipe shall not be used in any waste connection to a fixture or in any section of the soil or waste piping system. (Use ball valves in lieu of gate valves.)

B. Storm Water Pipe and Fittings:
   1. Piping:
      a. Storm Water piping shall be service weight cast iron soil pipe conforming to ASTM Specification A74 and CISPI 301, hub and spigot for pipe 10 inches and larger and hubless for 8 inches and smaller.
      b. Each piece of pipe and each fitting shall be coated at the factory with asphaltum or coal tar pitch and with the manufacturer`s mark or name cast on it.
      c. Copper piping shall be Type DWV copper pipe with wrought copper sweat joints where indicated on the Drawings.
      d. Where roof drains are 50 or more feet above the horizontal runout at grade level, the downspout piping system shall be constructed of Schedule 40 black steel pipe with weld fittings.
      e. Underground storm and sanitary waste piping, of all sizes, shall by cast iron hub and spigot type, with Tyseal (or approved equal) neoprene gaskets, coated at the factory with asphaltum or coal tar pitch, and with the manufacturer`s mark or name cast on it. Hubless piping systems shall not be used in a directly buried, underground application.
   2. Joints in hub and spigot cast iron pipe shall be made water and gas tight with Tyseal neoprene gaskets.
      a. Lead and Oakum may be used only under special conditions, with prior written permission from the Resident Construction Manager.
      b. Joints in hubless cast iron soil pipe and fittings shall be made by the use of a neoprene sleeve and 24 gage, Type 304 Stainless Steel shield made tight with a torque wrench and torqued to a minimum of 100 inch pounds.
      c. Each clamp shall consist of a neoprene gasket with a stainless steel outer band which effectively captures the gasket material.
      d. Each clamp shall bear the FM and UPC stamp, shall be approved to Class I of Factory Mutual Standard #1680, and shall be a Heavy Duty No Hub Coupling, minimum 4 bands.
   3. Cleanouts:
      a. Interior cleanouts shall be brass caulked into the lines, and where they occur in walls or floors of finished areas, shall be provided with nickel-bronze tops or access plates.
      b. Interior cleanouts shall be of the same size at the pipe served up to 4 inches size and four 4 inches for all larger lines.

C. Interior Domestic Water Piping and Fittings
   1. Interior domestic water piping larger than 6 inches shall be Schedule 40 galvanized steel pipe.
   2. This pipe shall conform in every detail to A.S.T.M. Standard Specifications for BLACK AND HOT-DIPPED ZINC-COATED GALVANIZED WELDED AND SEAMLESS STEEL PIPE ASTM A53/A53M latest revision, Type E or S.
   3. This threaded pipe shall be supplied with thread protectors on each end.
   4. All steel water pipe shall be hot-dipped galvanized pipe zinc coated both inside and outside.
   5. Materials within domestic water distribution systems that may come into contact with potable water delivered shall be UL classified in accordance with ANSI/NSF-61 for hot and cold potable water service and shall be certified to the low lead requirments of NSF-372.
      a. Manufacturer must provide written documentation of compliance.
   6. Unless otherwise shown on Drawings, all interior domestic water piping 4 inches and smaller shall be fabricated from Type L, hard drawn, copper pipe made of deoxidized copper (99.9 percent pure). No pipe smaller than 3/4 inch shall be used except at local connections or as detailed for laboratory areas.
   7. Interior domestic copper water pipe shall preferably be joined using non-lead-bearing solder, such as 95.5 silver or antimony solder (95 percent tin, and 5 percent silver or antimony).
   8. Domestic copper couplings may be press couplings and shall be connected similar to Fittings below.
   9. Interior Domestic Water Fittings
      a. All fittings for 6 inch and larger water lines shall be 125 lb., cast iron, flanged pattern fittings. These fittings shall be hot-dipped galvanized, after all machining operations have been completed. These fittings shall be of Crane Company, or approved equal, manufacture and

their flanges shall be dimensioned, faced drilled and spot faced to conform to the Class 150 American Standard for Steel Pipe Flanges and Flanged Fittings.

b. Copper fittings for 4 inches and smaller domestic copper water lines shall preferably be Streamline Solder Fittings manufactured by Streamline Pipe and Fittings Division, Mueller Brass Company, or approved equal.
   1) These wrought copper fittings shall be rigid and strong with openings machined to accurate capillary fit for the pipe.

c. Fittings for piping systems involving the use of domestic copper pipe shall preferably be fabricated with the use of Dunton`s 95-5 (95 percent tin and 5 percent antimony) solder manufactured by W. M. Dunton Company, or approved equal.
   1) Silver solder consisting of 95 percent tin and 5 percent silver is the only acceptable substitution.

d. Interior domestic copper water pipe ONLY may utilize copper press fittings when the following conditions are met:
   1) Written approval of the Owner`s Project Manager shall be obtained prior to bidding.
   2) Fittings shall be installed in portions of systems having an operating pressure that will not exceed 200 psig.
      (a) Fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22 .
      (b) Fittings shall comply with NSF 61 and NSF 372 utilizing EPDM, nontoxic, and synthetic rubber sealing elements.
      (c) Approved Manufacturers:
         (1) Viega.
         (2) Substitutions: Other products as approved by UTSW Facilities Management, complying with 01 60 00 - Product Requirements.
      (d) O-rings for domestic water copper press fittings shall be EPDM.
      (e) Copper press fittings shall be rated at 200 psi working pressure and 250 degree working temperature.
   3) Installation tools shall be as recommended by the fittings manufacturer.

10. Interior Domestic Water Headers
    a. Provide headers as indicated on Drawings for the distribution of the cold water and hot water systems.
       1) Galvanized headers shall be fabricated by a welding process by the use of extra strong black steel pipe and pipe supplies of the same character.
       2) Stainless headers may be welded or threaded.
       3) Copper headers may be braized or soldered.
       4) All flanges used in the case of such headers shall be dimensioned, faced, drilled and spot faced to conform to the Class 150 American Standard for Steel Pipe Flanges and Flanged Fittings (B16e).
       5) The header outlets shall be effected by welding to the header full length welding couplings of the proper size. These steel members shall be carefully "lined up".
    b. Upon completion, these headers shall be subjected to a hydrostatic test of 300 pounds per square inch gauge. All defects noted upon inspecting the headers thus tested shall be repaired by chipping, machining and burning out defects, and re-welding. After repairs have been made, the headers shall be retested as described above.
    c. After the galvanized headers have been tested and found to be tight, they shall be galvanized by a "double-dip" process.
       1) The manufacturer shall be required to provide certificates assuring the fact that the headers were so "double-dipped".
       2) Both exterior and interior surfaces shall receive a heavy zinc coating by a hot dipping process.
       3) Galvanized steel nipples shall be used to extend the various header outlets to the gate valves placed in each outgoing water line near the header.
       4) These nipples shall be of such a length that the gate valves in the outgoing water lines are neatly lined up in a horizontal plane.

5) At a point just beyond these gate valves, a 3/4 inch valved drain line shall be installed in the case of each outgoing branch leaving the header.
6) The purpose of such valve branches shall be to drain the system into which the flow of water is controlled by the gate valves previously mentioned.
7) These 3/4 inch drain line valves from the various branches leaving the headers shall be likewise lined up in a straight horizontal line.
8) These 3/4 inch drain lines shall terminate in a common "drain line".
9) That 1 inch drain line shall be the header drain line.
10)

d. Shock Arrestors
1) Acceptable manufacturers:
(a) Josam.
(b) Wade.
(c) Jay R. Smith.
(d) Precision Products.
(e) Zurn.
(f) Sioux Chief.
2) Arrestor shall be piston type, polycarbonate with two EPDM O-rings, lubricated with FDA-approved Dow Corning 111 silicone compound in Type K or L copper body, suitable for 200 psig minimum pressure at 200 degrees F.
3) Arrestor shall be ANSI/ASSE 1010 certified and must be accessible.

e. Inline Automatic Flow Controller
1) Provide automatic flow controllers at recirculating branches and at recirculating pump as scheduled and detailed on Drawings.
2) Acceptable Manufacturers: FDI, Inc. Model ICCS
3) Body: Series 300 Stainless Steel.
4) Union Nut: Nickel plated brass.
5) Flow Cartridge: Series 300 Stainless Steel wear surfaces.
(a) Accuracy: Flow rate plus or minus5 Percent over 95 Percent of the control range.
(b) Certification: NSF/ANSI 61-G certified by NSF for potable water applications.
6) Temperature rating: 180 degree F. Tested and approved for commercial hot water applications.
7) Pressure Rating: 400 PSI static pressure.
8) Provide portable meter kit including the following accessories:
(a) Hoses, fittings, and adapters as required for connection to pressure/temperature ports.
(b) 6-inch diameter face, 270 degree arc, beryllium diaphragm gauge.
(c) Provide with carrying case, calibration instructions, and capacity curves.

D. Welded Piping
1. Weld fittings shall be USA factory made wrought carbon steel butt-welding fittings conforming to ASTM A234/A234M and ASME B16.9 latest edition, as made by Weld Bend, Tube Turn, Hackney, or Ladish Company.
2. Each fitting shall be stamped as specified by ASME B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fittings selected at random.
3. Only one manufacturer of weld fittings will be approved for the project.
4. Fittings that have been machined, remarked, printed or otherwise produced domestically from non-domestic forgings or materials will not be acceptable.
5. Provide each in accordance with MSS SP-25.
6. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process.
7. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these specifications.

E. Natural Gas Piping

1. All pipe used for the fabrication of gas piping systems shall be Schedule 40 black steel pipe that conforms in every detail to Standard Specifications for WELDED AND SEAMLESS STEEL PIPE, ASTM A53/A53M , Type E or S.
2. Unless otherwise specifically required, all steel pipe provided for gas piping systems shall be provided with plain ends and assembled with weld fittings on all pipe 1-1/4 inch and larger of 3/4 inch and larger if before the emergency shut off valve.
3. No pipe smaller than 3/4 inch, or as detailed for laboratory furniture, shall be used. From the emergency shutoff valve to the outlets the pipe shall be assembled with threaded fittings provided all joints are exposed or within the confines of the laboratory furniture.
4. From the emergency shutoff valve to the outlets the pipe shall be assembled with threaded fittings provided all joints are exposed or within the confines of the laboratory furniture.
5. All gas piping within the building shall be installed exposed to view.

2.2 VALVES

A. Refer to Section 22 11 16 - Plumbing Piping for installation and examination.

B. Any alternate valves or materials shall be approved in writing by UTSW FM.

C. All bronze and iron body gate and globe valves shall be the product of one manufacture for each project.
1. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacturer, all ball valves shall be of the same manufacturer, etc.

D. Valves used in circulating systems, plumbing, and steam systems (low and medium pressure) shall be correlated to existing system requirements. Class 150 SWP.
1. Class 300 valves shall be constructed of all ASTM B61 composition.
2. All gate, globe and angle valves shall be union or screw over bonnet design.
3. Metal used in the stems of all bronze gate, globe and angle valves shall conform to ASTM B371/B371M Alloy 694, ASTM B99 Alloy 651, or other corrosion resistant equivalents.
4. Written approvals must be secured for the use of alternative materials by UTSW Facilities Management.

E. All iron body valves shall have the pressure containing parts constructed of ASTM designated of 126 class B iron.
1. Stem material shall meet ASME B16.1 Alloy 360 or ASTM B371/B371M Alloy 876 silicon bronze or its equivalent.

F. Gates and globes shall be bolted bonnet with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting is preferred on yoke cap for maintenance lubrication of the yoke bushing.

G. All cast steel body valves shall have the pressure containing parts constructed of ASTM A216/A216M - GR-WCB carbon steel.
1. Gate and globe valves shall be bolted bonnet outside and screw and yoke design with pressure temperature rating conforming to ASME B16.34. vs ASME B16.34
2. Stems shall meet ASTM designation A-186-F6 chromium stainless steel.
3. Wedge (gate valves) may be solid or flexible type and shall meet ASTM A182/A182M -F6 chromium stainless steel on valves from 2 inches to 6 inches. Sizes 8 inches and larger may be A-216-WCB with forged rings or overlay equal to 182-F6.
4. Seat ring shall be hard faced carbon steel or 13 percent chromium ASTM A182/A182M-F6 stainless.
5. Handwheels shall be A47 Grade 35018 malleable iron or Ductile Iron ASTM A536.

H. All forged steel body valves shall have the pressure containing parts constructed of ASTM A105/A105M, Grade 2 forged carbon steel.
1. Seat and wedges shall meet ASTM A182/A182M -F6 chromium stainless steel.
2. Seat rings shall be hard faced.
3. Valves shall conform to ASME B16.34 pressure-temperature rating.

I. All valves shall be repackable, under pressure, with the valve in the full open position.

J. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron hand wheels, except iron body valves 2-1/2 inches and larger which may have either malleable iron or ASTM A126 Class B, gray iron hand wheels.

K. Packing for all valves shall be free of asbestos fibers and selected for the pressure temperature service of the valve.
1. It is incumbent upon the manufacturer to select the best quality, standard packing for the intended valve service.

2. At the end of one year, period spot checks will be made, and should the packing show signs of hardening or causing stem corrosion then all valves supplied by the manufacturer shall be repacked by the Contractor, at no expense to the Owner, with a packing material selected by the Owner.

L. Valves located with stem in horizontal position shall be drilled and tapped in accordance with MSS SP-45 at Boss G to accommodate a drain valve.

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

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

O. Standards of Quality for Valves: Standard of Quality for Valves: (Compare Charts between Sections)

			Milwaukee	Nibco	Stockham or as Noted
2" and smaller	Ball Valve for shut off	Domestic Hot & Cold Water Plumbing Systems Recirculating	BA100A	T-585-70	Appollo 77-100, Kitz #68
2-1/2" & larger	Gate Valve	Plumbing	F-2885-M	F-617-0	G-623, Kitz #72
2-1/2" & larger	Globe, Angle & Balancing Valve	Plumbing	F-2981-M	F-718-B	G-514-T Kitz #76
2-1/2" & larger	Butterfly Valve for shutoff	Domestic Hot & Cold Water Plbg Systems; Heating Water	ML-123B 642BG	LD2000	**DeZurik 632,L,D,Rs66,6 Demco
2" and smaller	Check Valve	All Water Systems	510	T-433	B-345
2-1/2" & larger	Check Valve	All Water Systems	1400 Series	W-920-W	Stockham "Duo-Check"
2" & smaller	Globe Valve	Primary Hot Water	--	276AP	Kitz #175
2-1/2" & larger	Globe Valve	Primary Hot Water	F-2983-M	F-768-B	Kitz #7122E
2" to 12"	Hub End	(AWWA)	--	--	Mueller 2380-5
1-1/2" & smaller	Lubricated Gas Cock	Lab Gases	BB2-100	1795 with Wrench	Rockwell 142 & 1797 (with wrench)

2" and larger	Lubricated Gas Cock	Lab Gases		179F with Wrench	Rockwell 143
2" & smaller	Isolation Ball Valve	Lab Gases	--	--	Spirax Sarco Model 60

* Requires extended stem in insulated lines.
** Valves 8 inches and larger, and valves used for balancing service regardless of size, shall have heavy-duty weatherproof encased gear operators.
*** Requires ball drip assembly.
Contractor may submit request for equivalent valve. Must show torque ratings for substitute and equivalence to base spec.
Valve operators shall be rated for 2.5x the torque for full shutoff.

2.3 STRAINERS

A. Strainers,
   1. 2 inches and smaller, bronze body, screwed ends, No. 10 mesh strainer, screwed cap with bronze blow-off valve (size to be determined by standard tap size in cap). Cast iron body,
   2. 2-1/2 inches and larger, isolating type flanged ends where installed in copper lines, No. 7 perforated monel strainer, flanged cap with bronze ball blow-off valve (size of blow-off valve shall be determined by standard tap size in cap).
   3. Special Note: All strainers 6 inches and larger shall have studs mounted in the body flange in lieu of bolts for removal of cap. Baskets for strainers 6 inches and larger shall have stainless steel reinforcing bands at ends to prevent collapsing.

B. Suction diffusers shall be Paco or approved equal, cast iron body and cover, steel diffuser, and stainless steel strainer, 125 pound ASA (flat face) flange for a working pressure of 175 psi and temperature of 300°F.

2.4 UNIONS

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system.

B. No unions will be required in lines assembled with solder joint fittings except at equipment items, machinery items and other special pieces of apparatus.

C. Unions in 2 inches and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2-1/2 inches and larger shall be ground flange unions.

D. Unions in copper lines shall be Class 125 ground joint brass unions or Class 150 brass flanges if required by the mating item of equipment.

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

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

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

2.5 FLANGES

A. All 150 lb. and 300 lb. ASME/ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ASME B16.5 and ASTM A181/A181M Grade I or II or A-105-71 as made by Tube Turn, Hackney or Ladish Company.

B. Only one manufacturer of weld flanges will be approved for each project.

C. Each fitting shall be stamped as specified by ASME B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material.

D. Complete test reports may be required for any fitting selected at random.

E. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable.

F. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25.

G. Bolts used shall be carbon steel or stainless steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions.

H. All-thread rods will not be an acceptable for flange bolts.

I. Bolts shall have a tensile strength of 60,000 psi and an elastic limit of 30,000 psi.

J. Flat faced flanges shall be furnished where required to match flanges on pumps, check valves, strainers, etc.

K. All flanges shall be gasketed.

1. Contractor shall place gasket between flanges of flanged joints.
2. Gaskets shall fit within the bolt circle on raised face flanges and shall be full face on flat face flanges.
3. Gaskets shall be cut from 1/16 inch thick, non metallic, non asbestos gasket material suitable for operating temperatures from -150°F to +750°F, Klingerseal C-4400, Manville Style 60 service sheet packing, or equal.

2.6 BACKFLOW PREVENTERS

A. Backflow preventers (BFP) types:

1. Reduced pressure type, Basis of Design Febco 825 or approved equal by UTSW FM.
2. Spill-Proof Vacuum Breaker, Basis of Design by Watts.
3. Regular Vacuum Breaker, Basis of Design by Watts.
4. Double Check, Basis of Design by Watts.

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. Refer to Section 22 00 10 - Basic Plumbing Requirements.

3.2 INSTALLATION

A. Refer to Section 22 11 16 - Plumbing Piping for installation requirements.

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

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

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16 - Piping Expansion Compensation.

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

G. Provide access where valves and fittings are not exposed.

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

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

J. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Section 09 96 00 - High-Performance Coatings.

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

L. Locate valves in readily accessible areas and where valve operation will not damage other components, materials, or devices.

3.3 FABRICATION OF PIPE

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

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

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

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

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

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

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

3.4 APPLICATION

A. Use grooved mechanical couplings and fasteners only in accessible locations or within riser shafts.

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

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

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

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

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

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

H. Use butterfly valves interchangeably with gate and globe valves.

I. Use lug end butterfly valves to isolate equipment.

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

END OF SECTION 22 20 00

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Emergency Fixtures.
B. Vacuum Breakers.
C. Trap Primers.

1.3 RELATED SECTIONS

A. Section 01 25 00 - Substitution Procedures
B. Section 07 92 00 - Joint Sealants
C. Section 22 00 10 - Basic Plumbing Requirements
D. Section 22 11 16 - Plumbing Piping
E. Section 22 11 19 - Plumbing Specialties
F. Section 22 33 50 - Domestic Water Heaters
G. Section 23 05 29 - Supports and Anchors

1.4 ALLOWANCES

A. Cash Allowance: Include under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Allowance includes purchase and delivery of owner selected fixtures. Installation is included in this section and is part of the Contract Sum/Price.

1.5 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
C. ANSI Z358.1-2014 - American National Standard for Emergency Eyewash and Shower Equipment.
D. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
E. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
F. ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures.
G. ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.
H. ASME A112.19.2 - Vitreous China Plumbing Fixtures.
I. ASME A112.19.3 - Stainless Steel Plumbing Fixtures.
J. ASME A112.19.4M - Porcelain Enameled Formed Steel Plumbing Fixtures.
K. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals (Dimensional Standards).
L. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices.
M. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
N. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
O. ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping.
P. ASTM D570 - Standard Test Method for Water Absorption of Plastics.
Q. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
R. ASTM D696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30C and 30C with a Vitreous Silica Dilatometer.
S. ASTM D785 - Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.
T. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

U. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
V. ASHRAE Std 18 - Method of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration.
W. ADA Standards - 2010 ADA Standards for Accessible Design.
X. Texas Accessibility Standards (TAS).

1.6 SUBMITTALS

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Product Data: Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
C. Manufacturer`s Installation Instructions.
D. Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
E. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Accept fixtures on site in factory packaging. Inspect for damage.
C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.9 FIELD MEASUREMENTS

A. Verify that field measurements are either as indicated on shop drawings or as instructed by the manufacturer, and designate in the submittal that it has been verified, and which measurements are the basis for construction.
B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories and sinks.

1.10 WARRANTY

A. Provide five year warranty under provisions of Section 22 00 10 - Basic Plumbing Requirements.

1.11 ATTIC STOCK

A. Furnish under provisions of Section 22 00 10 - Basic Plumbing Requirements.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Regulatory Requirements:
1. Comply with applicable codes for installation of plumbing systems.
2. Perform all work and provide products in compliance with requirements of ADA Standards, ANSI A117.1, and the Texas Accessibility Standards (TAS).
B. Provide plumbing fixtures where indicated on the Drawings.
1. These plumbing fixtures shall be standard products as manufactured by the following. Any substitution requests must be submitted according to the requirements of Section 01 25 00 - Substitution Procedures.
a. American Standard.
b. Kohler.
c. Crane.
d. Halsey-Taylor.
e. Eljer.
f. Sloan.

2. Plumbing accessories shall be standard products as manufactured by the following. Any substitution requests must be submitted according to the requirements of Section 01 25 00 - Substitution Procedures.
    a. Bemis Manufacturing Co.
    b. Brass Craft.
    c. Chicago Faucets.
    d. Fiat Products.
    e. Halsey Taylor.
    f. Jay R. Smith Mfg. Co.
    g. McGuire Manufacturing Co. Inc.
    h. Plumberex Specialty Products, Inc.
    i. T&S Brass.
    j. Watts.
3. Emergency Fixtures shall be standard products as manufactured by the following. Any substitution requests must be submitted according to the requirements of Section 01 25 00 - Substitution Procedures.
    a. Bradley.
    b. Guardian
    c. Encon.
    d. Haws.
    e. Acorn.

C. Product Requirements:
1. Fixtures shall be free from mars or chips and shall be new, first quality and shall be furnished with sufficient supports in order to adequately hang each and every unit.
2. Space between fixtures and masonry walls shall be grouted with white silicon grout, Basis of Design: General Electric.
3. Space between fixtures and sheetrock or wood panel walls shall not be grouted but the fixture shall fit flat against the wall surface with no more than 1/16 inch gap.
4. Faucets, fittings, supply stops, and similar devices shall be of one manufacturer unless otherwise specified.
    a. Water faucets and valve bodies shall be cast brass with a minimum copper content of 85%.
    b. All shall have standardized interchangeable operating units constructed of a removable and replaceable unit containing all parts subject to wear.
    c. Water faucets shall contain an adjustable internal volume control unit.
    d. Exposed parts shall be chromium plated.
5. (At Cup Sinks Only) Polypropylene Fixtures:
    a. Base:
        1) Orion Fittings.
    b. Optional:
        1) Enfield Industrial.
        2) Town & Country Plastics.
6.

2.2 FITTINGS AND PIPES

A. Fittings and piping shall be brass and, wherever exposed, shall be polished chrome plated. Provide tight fitting wall or floor escutcheons of chrome-plated brass wherever pipes pass through floors, walls or ceilings.

B. Furnish and install all required water, waste, soil and vent connections to all plumbing fixtures, together with all fittings, supports, fastening devices, cocks, valves, traps, etc., leaving all in complete working order.

C. Supplies for all lavatories and drinking fountains shall be loose key angle stops with 1/2 inch I.P.S. female inlets and shall include wall flanges, and 1/2 inch O.D. flexible risers with bull nose or flared end outlets.
1. Components to be chrome plated.
2. In all cases, all piping, tubing, fittings, and faucets shall be installed using a mechanical non-slip connection, such as bull nose, flared, flanged, ferrule, or threaded fittings.
3. Fittings requiring a friction fit using slip-on or gasketed connections are not acceptable.

2.3 EMERGENCY FIXTURES

A. All emergency fixtures must meet the requirements outlined in ANSI Z358.1-2014 and other applicable safety codes per project.

B. Deck Mounted Eyewash / Drench Hose with Backflow Preventer

1. Basis of Design: Guardian G5022 or equivalent product by acceptable manufacturer.
2. Components: Deck mounted hand-held eye wash / drench hose, without bowl. Provide 2 polypropylene spray heads with integral flip-up dust covers, filters, mounted on chrome plated brass assembly, and flag style handle. Includes 1/2 inch stay open chrome-plated brass squeeze valve with replaceable stainless steel seat and locking clip, stainless steel squeeze handle with plastic cover, nylon handle, nylon deck flange with locator guide, and 8 foot PVC hose.
3. Mounting: Right hand. Include hardware to secure to countertop.
4. Thermostatic Mixing Valve: Mixing valve precisely blends hot and cold water to deliver tepid water to eyewash.
5. Sign: Provide ANSI-compliant identification sign.
6. Isolation Ball Valve - WOG rated valve, pressure rating to match floor requirements. Install in-line, readily accessible, and as close as possible prior to the unit installation. For above ceiling installation, indicate valve location with ceiling tack or additional signage.
7. Visual or audible accessories (ex. Strobes or audible alarms) when a unit is activated shall not be installed, unless approved in writing by OSBC Chemical / Biological Safety team.

2.4 VACUUM BREAKERS

A. All outlets with hose threads shall be provided with vacuum breakers.

B. Where vacuum breakers have not been specified with fixture trim and on all hose faucets not associated with plumbing fixtures both inside and outside of buildings, contractor shall furnish and install 3/4 inch hose thread vacuum breakers attached to the hose outlet threads with tamper proof set screw.

C. Vacuum breaker shall be as manufactured by Chicago Faucet or by Watts.

2.5 TRAP PRIMER

A. Pressure principal activated, Multi-fixture device.

B. Precision Plumbing Products or approved equal.

C. Provide trap primers for all floor and hub drains in mechanical rooms even if not shown on Drawings.

2.6 SINKS - CUP

A. Fixture:

1. 6 inches diameter x 4 inches deep, Countertop mounted, polypropylene, single-bowl, 1-1/2 inches outlet, without faucet ledge, with stopper.
2. Orion CS3.

B. Faucet:

1. Single-hole Countertop mounted, single-handle, single-temperature, 4-arm color-coded handle, 6 inches diameter fixed gooseneck, integral vacuum breaker, serrated hose nozzle.
   a. Chicago Faucet 928.

C. Trim:

1. 1-1/2 inches tailpiece and P-trap of specified material for acid waste piping (see Section 22 11 16).

2.7

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Furnish and install all labor, materials, equipment, tools and services and perform all operations required in connection with or properly incidental to the installation of complete plumbing fixtures, as indicated on the Drawings, reasonably implied therefrom, or as specified herein, unless specifically excluded.

B. Plumbing fixtures shall be supplied, set and connected as listed herein and as shown on the Drawings. Fixtures shall be protected from damage during construction, and shall be thoroughly cleaned of all tape and adhesives prior to final acceptance.

C. Coordinate special mounting heights of plumbing fixtures with architectural details of each toilet area.

D. Install in accordance with manufacturer`s instructions.

E. Install each fixture with trap, easily removable for servicing and cleaning.

F. Install components level and plumb.

G. Install and secure all fixtures in place with specified wall carriers and bolts.

H. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.5 ADJUSTING

A. Adjust work under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

A. Clean work under provisions of 22 00 10 - Basic Plumbing Requirements.

B. At completion clean plumbing fixtures and equipment.

3.7 PROTECTION OF FINISHED WORK

A. Protect finished Work under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Do not permit use of fixtures during construction, until after Substantial Completion has been announced by Owner.

3.8 FIXTURE HEIGHTS

A. Fixture size, design and mounting height shall meet the requirements of ADA Standards, ANSI A117.1, and the Texas Accessibility Standards (TAS).

3.9 FIXTURE ROUGH-IN SCHEDULE

	Hot Water	Cold Water	Waste	Vent
Lavatory	1/2 inch	1/2 inch	2 inch	1-1/2 inch
Water Closet		1 inch	4 inch	2 inch
Urinal		3/4 inch	2 inch	1-1/2 inch
Shower (where applicable)	1/2 inch	1/2 inch	2 inch	2 inch

END OF SECTION 22 40 00

SECTION 22 61 10

LABORATORY COMPRESSED AIR SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Laboratory fittings.
B. Piping.
C. Valves.

1.3 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete
B. Section 22 00 10 - Basic Plumbing Requirements
C. Section 22 11 16 - Plumbing Piping
D. Section 23 05 29 - Supports and Anchors
E. Section 23 05 53 - Mechanical Identification
F. Section 26 05 19 - Building Wire Cable and Connectors (600V and Below)
G. Section 26 27 26 - Wiring Devices and Floor Boxes

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ASME - Boiler and Pressure Vessel Code.
C. ASME B16.3 - Malleable Iron Threaded Fittings.
D. ASME B16.18 - Cast Bronze Solder-Joint Pressure Fittings.
E. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
F. ASME B16.26 - Cast Bronze Fittings for Flared Copper Tubes.
G. ASME B31.1 - Power Piping.
H. ASME B31.9 - Building Services Piping.
I. ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
J. ASTM A234/A234M - 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.
M. ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
N. ASTM D2683 - Socket-Type Polyethylene Fillings for Outside Diameter-Controlled Polyethylene Pipe.
O. NFPA 70 - National Electrical Code.
P. NFPA 99 - Health care Facilities Code.

1.5 SUBMITTALS

A. Submit under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.
B. Shop Drawings: Indicate piping system schematic with electrical characteristics and connection requirements.
C. Product Data: Provide manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.
D. Test Reports: Submit inspector`s certificate for air receiver for inclusion in Operating and Maintenance Manuals.
E. Manufacturer`s Installation Instructions: Indicate hoisting and setting requirements, starting procedures.
F. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.

B. Record actual locations of equipment and components. Modify shop drawings to indicate final locations.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.

B. Operation Data: Submit for air compressor, air receiver and accessories, after cooler, refrigerated air dryer, and pressure reducing station.

C. Maintenance Data: Submit for air compressor, air receiver and accessories, after cooler, air dryer, and pressure reducing station.

1.8 REGULATORY REQUIREMENTS

A. Conform to ASME codes for installation of pressure vessels.

B. Provide certificate of compliance from Factory Mutual indicating approval of air receiver.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters` Laboratories, In, as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of 22 00 10 - Basic Plumbing Requirements.

B. Accept air compressors, refrigerated air dryer on site in factory fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.

C. Protect piping and equipment from weather and construction traffic.

1.10 WARRANTY

A. Provide five year warranty under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.

B. Warranty: Include coverage for reciprocating air compressors, motors, receivers, and controls.

1.11 ATTIC STOCK

A. Provide maintenance materials under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.

B. Provide 4 quart containers of compressor oil.

PART 2 - PRODUCTS

2.1 LABORATORY FITTINGS

A. Laboratory fittings will be furnished to the job site by the Laboratory Equipment Supplier, with necessary holes cut in the laboratory equipment. The Contractor shall receive, store, and install the fittings and make all necessary connections thereto.

2.2 PIPING

A. Compressed air piping shall be ASTM B88, Type K, hard drawn, seamless copper tubing with wrought copper solder fittings. No ferrous piping will be permitted in the system. Where threaded nipples are required these shall be I.P.S. brass.

B. All piping shall be pitched back so as to drain to the point shown on the Drawings. All branch air take-offs shall be made from the top of the mains.

C. Piping shall be cleaned in accordance with CGA recommendations for piping for Oxygen Service.

2.3 VALVES

A. Compressed air and laboratory or medical gas valves shall be Spirax Sarco Model 60, stainless steel ball valves, with screwed joint and Teflon seats.

2.4 TESTS

A. Test air lines at 150 pounds per square inch and proved tight at this pressure. All tests shall be observed by a representative of the Architect before the tests are removed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer`s instructions.

B. Install valved drip connections at low points of piping system.

C. Install take offs to outlets from top of main, with shut off valve after take off. Slope take off piping to outlets.

D. Install compressed air couplings, female quick connectors, and pressure gages where outlets are indicated.

E. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.

F. Identify and label piping system and components. Refer to Section 23 05 53 - Mechanical Identification.

G. Start-up assistance and in-service training to be provided by factory authorized personnel.

3.2 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 22 00 10 - Basic Plumbing Requirements and Section 22 11 16 - Plumbing Piping.

B. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.1 .

C. Repair or replace compressed air piping as required to eliminate leaks, and retest to demonstrate compliance.

D. Cap (seal) ends of piping when not connected to mechanical equipment.

END OF SECTION 22 61 10

SECTION 22 62 19

MEDICAL GAS AND VACUUM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Medical gas systems.

1.3 RELATED REQUIREMENTS

A. Section 01 79 00 - Demonstration and Training
B. Section 01 91 00 - General Commissioning Requirements
C. Section 09 96 00 - High-Performance Coatings

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ASME B16.18 - Cast Copper Alloy Solder-Joint Pressure Fittings.
C. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
D. ASME B40.100 - Pressure Gauges and Gauge Attachments.
E. ASME - Boiler and Pressure Vessel Code.
F. ASTM A269/A269M - Stainless and Welded Austentic Stainless Steel Tubing for General Service.
G. ASTM A403/A403M - Wrought Austentic Stainless Steel Piping Fittings.
H. ASTM B32 - Solder Metal
I. ASTM B88 - Seamless Copper Water Tube.
J. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration field Service.
K. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
L. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
M. ASTM D2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
N. AWS A5.8/A5.8M - Brazing Filler Metal.
O. CGA G-7 - Compressed Air for Human Respiration.
P. CGA V-5 - Diameter Index Safety System Non-Interchangeable Low Pressure Connections for Medical Gas Applications.
Q. FM (AG) - Factory Mutual System - Approval Guide.
R. FS TT-P-645 - Primer, Paint, Zinc Chromate, Alkyd Type.
S. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet.
T. FS WW-V-35C - Valve Ball.
U. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
V. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
W. NFPA 55 - Compressed Gases and Cryogenic Fluids Code.
X. NFPA 99 - Standard for Health Care Facilities.

1.5 SUBMITTALS

A. Shop Drawings: Indicate general assembly of components, mounting and installation details, and general layout of control and alarm panels. Submit detailed medical wall assembly drawings.
B. Product Data: Provide manufacturers literature and illustrations for all components indicating size, dimensions and configuration.
C. Independent Testing Agency Reports: Indicate systems are complete, zone valves installed, alarm systems functional, and pressure and cross connections tests performed. Document tests.
D. Manufacturer`s Installation Instruction: Indicate requirements for equipment and systems.

E. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Submit 3 copies of as-built drawings, and provide electronic file in AutoCAD format.

B. Record actual locations of piping, valving, and outlets.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit digital copiy of operation and maintenance manuals complying with Section 01 77 00 - Closeout Procedures and Submittals.

B. Operation Data: Include installation instructions, assembly views, lubrication instructions, and assembly views.

C. Maintenance Data: Include maintenance and inspection data, replacement part numbers and availability, and service depot location and telephone.

1.8 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 99 .

B. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

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

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

C. Testing Laboratory: Company specializing in performing the testing of this Section with minimum three years documented experience.

1.10 REGULATORY REQUIREMENTS

A. Conform with applicable codes for medical gas systems.

B. Provide certificate of compliance indicating approval of systems.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Accept material on site in factory containers and packing. Inspect for damage.

B. Protect from damage and contamination by maintaining factory packaging and caps in place until installation.

1.12 SCHEDULING

A. Schedule Work to ensure equipment is installed and systems tested and certified prior to substantial completion.

1.13 SCOPE

A. Provide all labor, materials, equipment, tools and services and perform all operations required in connection with or properly incidental to the installation and testing of oxygen, nitrogen, nitrous oxide, compressed air and vacuum piping systems including fittings, valves, medical gas outlets, air compressors, nitrogen and nitrous oxide manifolds, vacuum pumps, alarms, etc. for complete operable systems.

B. The stock and model numbers of equipment listed hereinafter identify equipment manufactured by NCG Division of Chemetron Corp., Chicago, Ill. Equal equipment by approved manufacturers will be acceptable.

PART 2 - PRODUCTS

2.1 PIPING

A. Piping for vacuum and gases of every character shall be ASTM B88 Type L, hard drawn, seamless copper tubing with wrought copper solder fittings. No ferrous piping will be permitted in the system. Where threaded nipples are required, these shall be I.P.S. brass. All vacuum piping shall be purged with dry nitrogen while being soldered.

B. Piping shall be pitched back so as to drain to the point shown on the Drawings. All branch takeoffs shall be made from the top of the mains.

C. Fittings for copper tube shall be wrought copper fittings and attached with silver solder alloy containing not less than 50 percent silver. All soldering shall be done with dry nitrogen flowing through the pipe to prevent oxidation and scale information.

D. Before erection, all pipe, tubing, valves, and fittings (except those supplied expressly cleaned for oxygen, nitrogen, nitrous oxide, air-and-vacuum service by manufacturer) shall be thoroughly cleansed of all grease, oil and other combustible materials by washing in a hot solution of sodium carbonate or trisodium phosphate mixed in equal proportions of one pound to three gallons of water.
   1. Scrubbing and continuous agitation of the parts shall be employed where necessary to remove all deposits and to ensure complete cleansing.
   2. After washing, all materials shall be rinsed thoroughly in clean, hot water.
   3. After rinsing, great care must be exercised in the storage and handling of all materials and in the condition of tools used in cutting and reaming to prevent oil or grease being introduced into the tubing.
   4. Where such contamination is known to have occurred, the materials affected must be rewashed and then rinsed.

E. Where screwed connections are required at equipment, suitable adapters shall be provided with threaded connections. A thin paste of litharge and glycerin shall be applied to the external threads only.

F. After erection of pipe and tubing, but prior to installation of the service outlet valves, each system shall be blown clear of moisture and foreign matter by means of dry nitrogen or oil free air.

G. After installing service outlet valves, each system shall be subjected to a test pressure of 150 psig by means of water-pumped (oil free) nitrogen or air. This test pressure shall be maintained until each joint has been thoroughly examined for leaks by means of soapy water. A soap solution mixed in the following proportions should be used: one ounce of castile or palm oil soap, eight ounces of water, and four ounces of glycerine. Dissolve the soap in the water, add the glycerin and mix thoroughly. Wipe joints clean after test. All leaks shall be properly repaired and the system retested.

H. A final test shall be 24 hours standing pressure test with water pumped (oil free) air or dry nitrogen at 150 psig to check the completeness of prior joint pressure tests. If water pumped nitrogen is used, particular care must be exercised to assure that it is all flushed out with oxygen before placing the system in service.

2.2 SERVICE OUTLETS

A. Wall type service outlets shall be installed where indicated on Drawings approximately 50 inches above finished floor unless otherwise directed.

B. Outlets shall be modified NCG 378 D.I.S.S. series, quick release type as listed by Underwriter`s Laboratories, designed for recessed piping.

C. Each service shall be housed in a special designed back box, assembled complete with special stainless-steel cover plate, plaster flanges and tubing guards ready for rough wall mounting, and with an 8 inch of 1/4 inch nominal I.D. Type "K" copper tubing for completing the connection to the service line.

D. Check Units shall be safety keyed to prevent interchangeability of services.
   1. They shall have a self sealing dust plug and a primary and secondary check, both of which shall seal simultaneously when equipment is not attached.
   2. The Check Units for each service shall be pressure tested at the factory and furnished completely assembled except for the stainless steel cover plates.
   3. A color-coded nameplate identifying the gas service shall be affixed to each Check Unit to minimize the possibility of interchanging gas services during installation.
   4. Check Units shall be furnished with a protective cover imprinted with installation instructions and covering the inlet to prevent plaster dust or other foreign matter from contaminating the internal parts of the unit during installation.
   5. Check Units shall be designed so as to be completely serviceable from the front including removal of the secondary check and the filter screen without the use of special tools.
   6. Check Units shall be so designed that attachment or removal of equipment is a one hand operation and release mechanism shall be such that inadvertent pushing or bumping of the attached equipment will not tend to release it.
   7. The outlet, when installed, shall have no projections beyond the finishing cover plate.
   8. Where more than one service is indicated at a single location, they shall be combined into a multiple unit under a single cover plate.

E. See Drawings for details of special cover plates and for special service panels which combine gas service outlets and electrical items.

F. Ceiling type recessed service outlets shall be installed where indicated on Drawings.

1. Outlets shall be modified NCG 376 D.I.S.S. series and shall meet the requirement for wall type service outlets specified hereinbefore, including special cover plates, back boxes, pin indexing between fascia and matching, keyed slot in channel slot box saddle.
2. Coupler for attachment of hose and adaptor connecting thereto, shall be threaded type meeting Compressed Gas Association (CGA) D.I.S.S. specifications.
3. Hose shall be of plastic, conductive type, color coded for identity of service and terminating at a point 7 feet above finished floor, in quick release, color coded female couplers, safety keyed for gas service supplied. (Note: Ceilings in new addition at 10 foot, ceilings in remodel building at 9 foot.)
4. Outlet back boxes shall be supported from overhead structure utilizing anti-sway bars as required to prevent movement of the outlets.
5. Connect all ceiling outlets to an established common ground.

G. High pressure ceiling or wall type recessed nitrogen outlets shall be installed where indicated on Drawings. Outlets shall be modified NCG 239590-64 and shall meet requirements for ceiling type recessed service outlets hereinbefore specified, including special cover plates, back boxes, etc. Outlet stations are to incorporate a quick disconnect valve mechanism functioning as follows:

1. Service attachment without opening pressure.
2. Pressure actuation in a succeeding mechanical function.
3. Pressure shutoff and bleed of entrapped pressure while holding hose secure.
4. Release of adapter and hose, a succeeding mechanical function, without high pressure entrapment. Provide a NCG No. 000606-63 nitrogen hose assembly with DynaCon male and female adapters. Length as required for termination at a point 7 feet above finished floor.

2.3 MEDICAL GAS VALVES

A. Valves not in boxes shall be NCG bronze bodied, double seal, full flow ball type, with Teflon seat seals and 0-ring packing designed for working pressures up to 300 psi with a chrome plated brass ball which seals in both directions.

1. The valves shall be so designed that only a quarter turn of the lever type handle is necessary between the open and closed positions.
2. Valves shall be supplied and properly washed for oxygen service.
3. Gas service labels shall be provided for each service as required.

B. Shutoff valves in recessed boxes shall be installed in boxes with back box constructed of 18-gauge Paintlok steel with a gray baked on semigloss finish and with plaster flanges on all four sides for securing to wall.

1. The valves shall be bronze bodied, double seal, full flow ball type with Teflon seat seals, 0-ring packing designed for working pressures up to 300 psi, chrome plated bronze balls which seal in both directions, and adjustable Teflon stem seals and bearings, self compensating to guard against leakage due to wear.
2. Tubing extensions shall be factory soldered to the valve flanges for connection to piping outside the box.
3. Valves and tubing extensions shall be chrome plated, preassembled, pressure tested and rigidly mounted to the box for ease of installation.
4. The valves shall require only a quarter turn of the handle to completely open or close.
5. A color-coded gas label shall be supplied with each valve, which can be marked to indicate the area controlled.
6. The cover shall be of 18-gauge stainless-steel with No. 4 brushed finish, and shall incorporate an internal service identification cover and shield, providing shutoff directions.
7. The combination internal and external fascia shall attach to the box assembly without the use of screws, and shall compensate for variations in plastic thickness.
8. Mounted in the finishing frame shall be a clear, rigid, vinyl window for easy access to the valve.
    a. Window shall contain a caution label reading: "CAUTION, CLOSE ONLY IN EMERGENCY" and "PULL RING TO BREAK WINDOW".

2.4 AIR AND VACUUM VALVES

A. Stop valves at compressors, tanks, vacuum pumps, and in vacuum piping shall be Jenkins 32A bronze ball valves with screwed connections and Teflon seats.

2.5 FINAL CHECKING AND OPERATING INSTRUCTIONS

A. A representative of the equipment manufacturer shall periodically check with the Contractor during initial installation of the pipeline systems equipment.

B. Represtantive shall assist the Contractor in final check to make certain that all systems are in perfect operating condition.

C. The equipment manufacturer`s representative shall provide 8 hours of instruction to the hospital personnel in the use of the piping systems and the related equipment which is operated from those systems.

2.6 LABORATORY FITTINGS

A. Laboratory fittings will be furnished to the job site by the laboratory equipment supplier, with necessary holes cut in the laboratory equipment.

B. The Mechanical Contractor shall receive, store and install the fittings and make all necessary connections thereto.

2.7 STANDARDS AND CODES

A. The recommendations of the National Fire Protection Association (NFPA) as set forth in Pamphlet No. 56, 565 and 566, and the "Standard for Medical/Surgical Vacuum Systems in Hospitals" as set forth in Compressed Gas Association (CGA) Pamphlet No. P-2.1, Second Edition 1967, shall apply to this installation and shall be adhered to in all respects.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in complete compliance with governing Codes and manufacturers instructions.

B. Except for piping and pipe fittings, all components shall be supplied by a single manufacturer and shall be fully compatible with Owner`s existing system and service devices.

3.2 TESTING

A. Test in accordance with NFPA 99, Sections 4-3 through 4-10. Provide to Owner a notarized letter of certification from equipment manufacturer certifying the following:

1. No cross connections exist.
2. Alarm system is adjusted and performing to manufacturer`s design.
3. All components have been installed, adjusted and are functioning in accordance with manufacturer`s recommendations.

3.3 COMPATIBILITY

A. Verify compatibility of all new components with existing system and services.

END OF SECTION 22 62 19

SECTION 22 64 00

MEDICAL GASES STARTUP AND CERTIFICATION PROCEDURE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. The following requirements:
   1. Test, certify and startup the medical gas equipment and pipeline systems.
   2. The Certification of the medical gas pipeline system must be performed by a certifier technically competent and experienced in the field of medical gas pipeline testing. Certifiers shall be licensed to ASSE (American Society of Sanitary Engineering) Series #6030 (N.I.T.C. Level M-4 or equivalent). Testing shall be preformed by a party other than the installing contractor.

B. The air compressor and vacuum pump supplier shall be present at site for system startup to verify equipment is installed and operating properly as required by NFPA 99.

1.3 RELATED REQUIREMENTS

A. Section 01 79 00 - Demonstration and Training
B. Section 01 91 00 - General Commissioning Requirements
C. Section 22 08 00 - Commissioning of Plumbing Systems.
D. Section 22 61 10 - Laboratory Compressed Air System.
E. Section 22 62 19 - Medical Gas and Vacuum Systems.
F. Division 26: Electrical
   1. Under Division 26, provide wiring for vacuum pumps and air compressors
   2. Under Division 22, provide local and remote wiring to alarm panels in accordance with NFPA 99 . Provide conductors and raceways as specified in Division 26.

1.4 REFERENCE STANDARDS

A. NFPA 99 - Health Care Facilities Code.
B. Texas Government Code Chapter 2252.001-005 - Texas Government Code Chapter 2252.001-005.

1.5 SUBMITTALS

A. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CERTIFICATION PROCEDURE

A. Perform mechanical check of all medical gas outlets prior to the certification inspection. Any necessary repairs or rework shall be done prior to system certification inspection. Check to include:
   1. Outlets properly supported.
   2. Installation complete.
   3. Appropriate adapters fit and securely lock in place.

B. The Owner is responsible for ensuring that bulk tank and/or cylinder supplies are installed, connected, and filled (or partially filled) prior to system certification inspection.

C. Medical gas system suppliers and/or Certification Company and Plumbing Contractor sign Medical Gas Pipeline Inspection Agreement describing service to be performed by the medical gas system supplier, services not performed by the medical gas system supplier, price quotation, and exceptions affecting quoted price.

D. The Contractor shall provide a qualified certifier to perform pipeline certification inspection and to provide report and certification in accordance with previously signed agreement.

1. Any discrepancies discovered during the inspection shall be noted, corrected, and any and all portions of the system affected by corrective action shall be retested and findings recorded after retest.

E. Provide representative who shall serve as customer contact person and who shall witness the certification inspection and certify that all outlets have been checked and are in accordance with inspection procedure and findings as witnessed.

F. Hospital Maintenance Department to provide representative who shall witness the certification and certify that all spaces and the outlets have been checked in accordance with inspection procedure.

G. All air, oxygen, nitrous oxide and carbon dioxide outlets shall be tested to deliver 3.5 SCFM at 50 psi with a maximum pressure drop of 5 psi. All instrument air outlets shall be tested to deliver 5 SCFM at 160 psi with a maximum pressure drop of 5 psi. Medical surgical vacuum inlets shall draw 3.0 SCFM without reducing the vacuum pressure below 12" gauge HV at any adjacent station inlet. These tests shall be performed with oil-free, dry nitrogen.

H. Each medical gas outlet shall be purge tested to verify that a minimum of 35 cubic feet of oil free dry nitrogen shall be filtered through a clean white 0.45 micron filter at a minimum flow of 3.5 SCFM. Filter shall not accrue more than 0.1 mg of matter. This test shall be performed at twenty- five percent of the zones for each gas type. Samples taken within each zone shall be taken at the outlet farthest from the zone valve.

I. For clinical air, oxygen, instrument air, nitrous oxide and carbon dioxide systems measure and record the dewpoint, total hydrocarbons, and halogenated hydrocarbons. The maximum allowable variation for each parameter shall be:
   1. Dewpoint: .5 degrees C @ 50 PSI
   2. Total hydrocarbons: 1.0 PPM
   3. Halogenated hydrocarbons: 2.0 PPM
   4. Tests shall be performed on the outlet most remote from the source and compared with source gas tests. The two tests shall not exceed the measurements outlined above. These tests shall be performed with oil-free dry nitrogen.

J. The valves shall be tested to verify proper operation and rooms or areas of control. Each valve shall be labeled for the rooms or area they control. Verify room names with owner's representative, prior to labeling valves.

K. The alarm panels wiring shall be tested to ensure that all components are functioning properly. The alarm panels shall be tested per NFPA 99.

L. The certifier shall furnish copies of Medical Gas Pipeline Inspection Report and Medical Gas Pipeline Certification. Transmit a copy of the report and certification to each of the following parties:
   1. Contractor.
   2. Owner's Construction Manager.
   3. Architect.
   4. Consulting Engineer.
   5. Hospital.
   6. UTSW Facilities Management.

M. The following procedure should be followed in addition to the above on extensions to existing systems:
   1. Architect shall, with adequate advance notice, request that certifier or inspection team is on-site when old piping is cut-in for installation of new lines.
   2. Architect or Contractor shall arrange to have certifier or inspection team on-site when the existing piping is cut into for installation of new lines.
   3. Main line shut-off valves shall be installed in new piping as close as possible to point to cut-in to previously installed piping.
   4. After verification of proper labeling, pressure and proper gas distribution of previously installed piping and after cut-in procedure, the aforementioned valves shall be considered the service valve of supply for the new piping.
   5. Before connection to the existing system and before system is put into service, the system shall be pressure tested, purged, outlet flow, tested, and gases analyzed per NFPA 99.
   6. After re-establishing pressure in each previously installed supply line after "cut-in", the previously installed outlets immediately upstream for each gas and for each cut-in point shall be opened to

ensure that the proper gas is being delivered. Gas should be bled to atmosphere prior to analyzation to ensure purging from point of cut-in to test point.

N. The presence of the desired gas shall be confirmed with the combined use of an analyzer designed to measure the specific gas dispensed, and a pressure gauge attached to an appropriate adaptor with results tabulated below:
   1. Oxygen: 99-100 percent Oxygen, Pressure: 50 psi, plus or minus 5 psi
   2. Nitrous Oxide: 99-100 percent Nitrous Oxide, Pressure: 50 psi plus or minus 5 psi
   3. Vacuum: Pressure-Negative
   4. Carbon Dioxide: plus or minus 1 percent Oxygen; Temporarily reduce pressure at source to 30 psi. Outlet pressure shall be 30 psi, plus or minus 5 psi
   5. Medical Air: 19.5-23.5 percent oxygen, Pressure: 50 psi, plus or minus 5 psi

O. After a new medical air compressor is installed, tests shall be performed at the sample port and results shall not exceed the following parameters:
   1. Dewpoint: 39 deg. F @ 50 psi
   2. Carbon monoxide: 10 PPM
   3. Carbon dioxide - Air: 500 PPM
   4. Gaseous hydrocarbons - Air: 25 PPM (as Methane)
   5. Halogenated hydrocarbons-Air: 2 PPM

3.2 CROSS CONNECTION TESTING AND CERTIFICATION

A. Cross connection testing and certification of the medical gas system must be performed by party technically competent and experienced in the field of medical gas pipeline testing.

B. Medical gas system shall be tested in accordance with NFPA 99 and Section 22 62 19 - Medical Gas and Vacuum Systems.

C. In addition to cross connection testing, this specification shall require the technical certifier to test each individual pipeline systems component for performance to design specifications and make any necessary adjustments to ensure a complete and working system.

D. The system shall be tested for cross connection in one of the following methods:
   1. Test one pipeline system at a time at 50 psi while the others are at atmospheric pressure including the vacuum system.
   2. Reduce the pressure in all medical gas systems to atmospheric pressure. Increase the test pressure to the piping to the following pressures:
      a. Gas Mixtures: 20 psi
      b. Nitrous Oxide: 40 psi
      c. Oxygen: 50 psi
      d. Compressed Air: 60
      e. Any medical-surgical vacuum system shall be in operation at same time that medical gases are tested.

E. Obtain and present to the Owner a complete bond report of pipeline certification from the equipment manufacturer. This letter of certification shall indicate:
   1. That the system is free of crossed connections.

END OF SECTION 22 64 00

SECTION 22 66 00

LAB WASTE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Acid waste piping system (non Glass).

1.3 RELATED REQUIREMENTS

A. Section 22 00 10 - Basic Plumbing Requirements

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

C. ASTM D1599 - Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings.

D. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.

E. ASTM D3311 - Standard Specification for Drain, Waste, and Vent (DWV).

F. ASTM D4101 - Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials.

G. ASTM F1290 - Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings.

H. ASTM F1412 - Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems.

I. IAPMO (UPC) - Uniform Plumbing Code

1.5 SUBMITTALS

A. Submit under provisions 22 00 10 - Basic Plumbing Requirements.

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

C. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Record actual locations of drain piping.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.

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

1.8 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

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

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

1.10 REGULATORY REQUIREMENTS

A. Perform Work in accordance with Uniform Plumbing Code IAPMO (UPC)

B. Conform to applicable code for installation of piping.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Accept materials on site in shipping containers with labeling in place. Inspect for damage.
C. Provide temporary protection for all materials from the elements and corrosive nature of the environment.
D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.12 ENVIRONMENTAL REQUIREMENTS

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

1.13 ATTIC STOCK

A. Furnish under provisions of Section 22 00 10 - Basic Plumbing Requirements.

PART 2 -PRODUCTS

2.1 WALL, FLOOR AND CEILING PLATES:

A. Except as otherwise noted, provide C.P. (Chrome plated) brass floor and ceiling plates around all pipes, conduits, etc., passing exposed through walls, floors, or ceilings, in any spaces except underfloor and attic spaces.
B. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation.
C. Plates will not be required for piping where pipe sleeves extend 3/4 inch above finished floor.
D. All equipment rooms are classified as finished areas. Round and rectangular ducts shall have closure plates (NOT chrome plated) made to fit accurately at all floor, wall and ceiling penetrations.

2.2 SLEEVES, INSERTS, AND FASTENINGS:

A. General:
   1. All openings through all floors, walls, and roofs, etc., regardless of material for the passage of piping, ductwork, conduit, cable trays, etc., shall be sleeved.
   2. All penetrations must pass through sleeves except soil pipe installed under concrete slabs on fill.
   3. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer.
   4. If a penetration is cored into an existing concrete, masonry or stone structure, then the installation of a sleeve will not be necessary.
B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4 inch, except that the minimum clearance shall accommodate a Linkseal closure, by Garlock, An Enpro Company, where piping exits the building, or penetrates a wall below ground level.
   1. Contractor shall be responsible for the accurate location of penetrations in the slab for his pipe, duct, etc.
   2. All penetrations shall be of ample size to accommodate the pipe, duct, etc. plus any specified insulation.
   3. Sleeve materials shall be rigid metal of adequate strength. Void between sleeve and pipe shall be filled with Nelson Flameseal Firestop or approved equal caulk or putty.
C. Installation of sleeves in walls shall be the same as for floors.
   1. Refer to the details on the project drawings.
   2. Where the details differ from these specifications, the drawings take precedence.
D. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.
E. Inserts:
   1. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction.
   2. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed.

3. Drilled anchors in concrete or masonry shall be submitted for the approval by the Owner.

F. Fasteners: Fastening of pipes, conduits, etc., in the building shall be as follows:
   1. Wood members by wood screws.
   2. Masonry by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry.
   3. Steel machine screws or welding (when specifically permitted or directed), or bolts.
   4. Concrete by suitable inserts anchored to reinforcing steel, and poured in place unless other means are indicated on the plans. Power-actuated fasteners (shooting) will not be acceptable under any circumstances.
   5. If it is necessary to install a method of fastening a hanger after the structure has been installed, then only clamps or drilled anchors shall be used.
   6. Note: Under no circumstances will the use of plastic anchors or plastic expansion shields be permitted for any purpose whatsoever.

G. Rat-proofing: The open space around all ductwork, piping, etc., passing through the ground floor and/or exterior walls shall be rat-proofed in a manner acceptable to the Architect/Engineer.

H. Weatherproofing: The annular space between a pipe and its sleeve in exterior walls or through floor to below grade shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound. Seal both surfaces of wall or floor.

I. Air Plenums: The space around piping, ductwork, etc., passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.

J. Fireproofing:
   1. Each mechanical and electrical contractor shall seal all cable trays, pipe, conduit, duct, etc., penetrations through roof, fire rated walls and floors with a foam or sealant as described below, that will form a watertight, vermin-tight barrier that is capable of containing smoke and fire up to 2000 degrees F for two hours.
   2. Sealing of cable trays, and conduits that extend through rated walls from ends of cable tray shall be done after conductors have been installed.
   3. Refer to fireproofing and firestopping specifications in Division 07 for product requirements.

2.3 HANGERS

A. Entire system shall be installed free of stress.

B. Horizontal lines shall allow for lateral movement of pipe and shall be supported by a padded hanger every 4 to 6 feet.

C. Vertical lines shall be supported by a padded riser clamp under bottom most coupling in the stack. This riser clamp shall restrict sideward as well as downward movement.

D. Three-inch and larger diameter stacks shall be supported at each floor by a riser clamp on the pipe O.D., smaller diameter stacks shall be supported at every other floor. All riser clamps shall be padded with 1/4 inch thick solid neoprene or buna N rubber.

2.4 LAB WASTE AND VENT PIPE AND FITTINGS (ABOVE SLAB ONLY, INCLUDING CRAWL SPACES)

A. Polypropylene Pipe Schedule 40 joined by the coil electrofusion method. Pipe shall be manufactured of flame retardant homopolymer polypropylene. Flammability requirements are based on ASTM D635 “Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self Supporting Plastics in a Horizontal Position”

B. Flame Retardant Polypropylene fittings shall be manufactured to Schedule 40 wall thickness dimensions.

C. Fittings shall be joined to the polypropylene pipe by means of coil fusion method. Fittings shall meet the same flammability requirements as described for pipe above. Fittings to be same manufacturer as pipe. Fittings joined by mechanical means are not allowed.

D. All components of the system shall conform to the following applicable ASTM Standards, ASTM D4101, ASTM D3311, ASTM D1599, ASTM D2122, ASTM F1290 and ASTM F1412. All pipe shall be marked with manufacturers name, pipe size, schedule, type, quality control mark and ASTM information. All fittings shall be legibly marked showing manufacturer trademark, fitting size, manufacturer part number, and symbol indicating the material.

E. Shall be Fuseal pipe and fittings as manufactured by GF Piping Systems LLC (Little Rock, Arkansas), or approved equal by the Owner or A-E.

2.5 LAB WASTE AND VENT PIPE AND FITTINGS ABOVE GRADE (RETURN AIR PLENUMS)

A. Polypropylene Pipe Schedule 40 joined by the coil electrofusion method. Pipe shall be manufactured of flame retardant homopolymer polypropylene. Flammability requirements are based on ASTM D635 "Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self Supporting Plastics in a Horizontal Position"

B. Flame Retardant Polypropylene fittings shall be manufactured to Schedule 40 wall thickness dimensions.

C. Fittings shall be joined to the polypropylene pipe by means of coil fusion method. Fittings shall meet the same flammability requirements as described for pipe above. Fittings to be same manufacturer as pipe. Fittings joined by mechanical means are not allowed.

D. All components of the system shall conform to the following applicable ASTM Standards, ASTM D4101 , ASTM D3311, ASTM D1599, ASTM D2122, ASTM F1290 and ASTM F1412. All pipe shall be marked with manufacturers name, pipe size, schedule, type, quality control mark and ASTM information. All fittings shall be legibly marked showing manufacturer trademark, fitting size, manufacturer part number, and symbol indicating the material.

E. Pipe shall be covered and wrapped with 3M Fire Barrier Plenum Wrap 5A. Install according to the manufacturer's specifications.

F. Shall be Fuseal pipe and fittings as manufactured by GF Piping Systems LLC Little Rock, Arkansas), or approved equal by the Owner or A-E.

2.6 LAB WASTE PIPE AND VENT PIPE AND FITTINGS ABOVE SLAB (UNDER BENCH)

A. Polypropylene Pipe Schedule 40 joined by the coil electrofusion method. Pipe shall be manufactured of flame retardant homopolymer polypropylene. Flammability requirements are based on ASTM D635 "Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self Supporting Plastics in a Horizontal Position"

B. Flame Retardant Polypropylene fittings shall be manufactured to Schedule 40 dimensions.

C. Fittings shall be joined to the polypropylene pipe by means of coil fusion method. Fittings shall meet the same flammability requirements as described for pipe above. Fittings to be same manufacturer as pipe. Fittings joined by mechanical means are not allowed.

D. All components of the system shall conform to the following applicable ASTM Standards, ASTM D4101, ASTM D3311, ASTM D1599, ASTM D2122, ASTM F1290 and ASTM F1412 . All pipe shall be marked with manufacturers name, pipe size, schedule, type, quality control mark and ASTM information. All fittings shall be legibly marked showing manufacturer trademark, fitting size, manufacturer part number, and symbol indicating the material.

E. Laboratory sink and cup sink tailpieces and p-traps shall be flame retardant polypropylene with heat fused socket joints and DWV pattern fittings. Mechanical connections at laboratory sink are not allowed.

F. Any laboratory sink fused p-trap will have tap at bottom for cleanout.

G. Shall be Fuseal pipe and fittings as manufactured by GF Piping Systems LLC, or approved equal by the Owner or A-E.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify excavations under provisions of Section 22 00 10 - Basic Plumbing Requirements.

3.2 INSTALLATION

A. Pipe and fittings shall be installed according to current installation instructions as delivered or documented on-line by the manufacturer.

1. On-site installation seminar shall be conducted by the manufacturer, by manufacturer's personnel who are certified to conduit said seminar.
2. Seminar topics shall include all aspects of product installation (storage, set-up, support spacing, fusion process, testing procedures, etc).
3. At the conclusion of the installation seminar, all installers will be given a certification test and, upon successful completion of said test, will be issued a certification card verifying they have met the requirements of the manufacturer with regards to knowledge of proper product installation and testing methods.

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

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

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

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

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

G. Pipes passing through walls and floors shall be fitted with pipe sleeves a minimum of 2" greater diameter than the pipe. Caulk the annular space between the pipe and the sleeve. Piping shall be protected against weld splatter.

H. Installer shall then waterproof floor penetrations with Metallic Oxide grout.

3.3 TESTS

A. The system shall be tested in accordance with all local Plumbing Codes and tested as specified for sanitary waste system, except as follows:

B. Test sections of the piping system with a maximum of 30-foot head of water (approx. 15 PSI).

C. Under no circumstances should the system be tested with air or any other gas.

D. Joints may be leak tested 10 minutes after the fusion cycle is completed.

END OF SECTION 22 66 00

SECTION 22 67 06

DEIONIZED WATER SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Labor, materials, equipment, tools and services to perform all operations required in connection with or properly incidental to the construction of a deionized water distribution system as shown on the drawings, reasonably implied therefrom, or as specified herein unless specifically excluded.

B. Includes systems for production and distribution of Reverse Osmosis Water (RO) and Deionized Water (DI).

C. Work consists of a distribution system as shown on the Drawings.

1. Work shall include testing, disinfection, adjusting and balancing the flow and pressures for the entire system.

1.3 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete.

B. Section 22 00 10 - Basic Plumbing Requirements.

C. Section 22 05 29 - Hangers for Plumbing Piping

D. Section 22 05 53 - Plumbing Identification.

E. Section 22 11 16 - Plumbing Piping.

F. Section 22 11 19 - Plumbing Specialties.

G. Section 26 05 19 - Building Wire Cable and Connectors (600V and Below).

H. Section 26 27 26 - Wiring Devices and Floor Boxes.

1.4 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.

B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

D. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.

E. ASME B31.9 - Building Services Piping.

F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

H. ASTM B32 - Standard Specification for Solder Metal.

I. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

J. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

K. ASTM D3222 - Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.

L. AWWA B604 - Granular Activated Carbon.

M. NEMA 12 - Enclosures.

N. NFPA 70 - National Electrical Code.

O. Texas Government Code Chapter 2252.001-005 - Texas Government Code Chapter 2252.001-005.

1.5 SUBMITTALS

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Shop Drawings: Indicate piping system schematic with electrical characteristics and connection requirements.

C. Product Data: Provide manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.

D. Test Reports: Submit inspector's certificate for air receiver for inclusion in Operating and Maintenance Manuals.

E. Certification: Provide Water Quality Association Certification and TNRCC Level III Certification as a Water Specialist for supervising agent.

F. Manufacturer's Installation Instructions: Indicate hoisting and setting requirements, starting procedures.

G. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Record actual locations of equipment and components. Modify shop drawings to indicate final locations.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Operation Data: Submit for back washable carbon filters, particulate prefilters, twin water softening system, UV sterilizers, RO unit, pumps, DI Mixed beds, and all instruments and controls.

C. Maintenance Data: Submit for back washable carbon filters, particulate prefilters, twin water softening system, UV sterilizers, RO unit, pumps, DI Mixed beds, and all instruments and controls.

1.8 REGULATORY REQUIREMENTS

A. Conform with applicable ASME codes for installation of pressure vessels.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Accept delivery of packaged deionized water equipment, storage vessel, etc., on site in factory fabricated containers with shipping skids and pipe end protectors in place. Inspect for damage.

C. Protect piping and equipment from dirt and debris, weather, and construction traffic.

1.10 WARRANTY

A. Provide five year warranty under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Warranty: Include coverage for deionized water system, storage tank, controls.

C. System supplier shall guarantee that under actual operating conditions the effluent from the system shall meet the purity parameters as given on the drawings for a minimum of one year.

D. Manufacturer shall guarantee defective workmanship and materials of mechanical equipment for one (1) year from date without charge to the Owner or Contractor.

1.11 ATTIC STOCK

A. Provide maintenance materials under provisions of Section 22 00 10 - Basic Plumbing Requirements.

PART 2 - PRODUCTS

2.1 SEDIMENT PREFILTERS

A. Cartridge filter in polypropylene housing.

B. Provide FDA approved materials.

2.2 ACTIVATED CARBON FILTERS

A. Activated Carbon Automatic Backwash Water Filter. Tank of fiberglass wrapped one piece thermoplastic inner liner, NSF and UL listed. Fully automatic backwash with top mounted control valve and electro-mechanical controller. Activated Carbon media to meet FDA Codex and AWWA B604 standards, NSF certified.

2.3 WATER SOFTENING SYSTEM:

A. Refer to project drawings for system design requirements. Existing system shall be tested to meet the requirements of new equipment being installed. Non-compliance shall be reported to EOR and water quality provider.

B. For the conventional system, the regeneration sequence shall be in this order: Backwash, brine, slow rinse, fast down flow flush, and return to service.

C. Piping: Provide CPVC schedule 80 piping within softener system.

D. Tank:

1. Softener tank shall be a FRP one-piece seamless molded vessel, 150-psi working pressure and 120 degrees F design.
    a. Tank shall be FRP with cover and plastic overflow adapter.
    b. Both the Water Quality Association and NSF shall list the tanks or materials used in their construction.
    c. Tanks shall be warranted for 5 years from the date of substantial completion.
2. Lower distribution system shall consist of a full flow non-clogging CPVC Schedule 80 slotted distributor tube.
    a. Brining system shall be wet salt storage type, adjustable between minimum and maximum salting levels without removing the brine valve.
    b. Shall be suitable for storage of sufficient salt for at least six (6) regenerations at maximum brining.
    c. Provide with heavy duty brine well to house the heavy duty, fully repairable, plastic brine valve that includes diaphragm type air shut off system.

E. Main operating valve on each softener shall be 5-cycle, automatic hydraulically balanced piston, seal and spacer type to independently pilot service flow and regeneration.

1. Valve body shall be of solid lead-free brass.
2. Maximum hydrostatic pressure: 300 PSIG
3. Working pressure: 125 PSIG at a temperature range of 34-110 degrees F.
4. System shall have soft water and inlet water pressure gauges and sample cocks.

F. The water softening control shall be programmable to operate in conjunction with a flow-sensing device located in the outlet piping of each tank in the system provide for demand regeneration.

1. Enclosure shall be NEMA 3R equivalent, water resistant, rain tight, corrosion resistant and UV stable.

G. Provide flow meter packages.

1. These are used as input devices for the water treatment equipment controller for the measurement of treated water flow. Flow data is used to repeatedly measure and deliver a specified volume of treated water at a minimum accuracy range of +/- 5 percent.
2. Meter shall be made of lead-free brass or Noryl and shall register even during power outages.

H. Flow controls for backwash, brine, slow rinse, and flush shall be fully automatic, requiring no field adjustment.

I. Water testing set shall be furnished for each system, shall be ASTM test type complete with container and instructions.

2.4 UV STERILIZERS

A. Ultraviolet Sterilizer: Stainless steel with fused quartz sleeves for lamp installation. Shortwave, low pressure mercury vapor discharge tubes, with Monitor, elapsed time indicator, sight port plug.

B. Ultraviolet Lights:

1. In-line Ultraviolet Lights.
2. Acceptable Manufacturers:
    a. Neotech.
    b. Substitutions: See Section 01 60 00 - Product Requirements.
3. Materials:
    a. Wetted Surfaces: 316L stainless steel electropolished to a surface finish of 15 RA and passivated.
4. Connections: Provide flanged.
5. Accessories:
    a. "S" Pattern light traps - Located on inlet and outlet.
6. Instrumentation:
    a. Temperature sensor with shut down interlock, local alarm, dry contacts.
    b. UT intensity meter with local alarm and dry contacts.
    c. LED operating indicators for each UV lamp.

d. Elapsed running time meter.
e. Remote start/stop capability.

7. Electrical: 120 VAC, single phase, 60 HZ.

2.5 REVERSE OSMOSIS SYSTEM

A. Refer to project drawings for system design requirements. Existing system shall be tested to meet the requirements of new equipment being installed. Non-compliance shall be reported to EOR and water quality provider.

B. Reverse Osmosis system, Single pass, complete skid-mounted package with prefilter, pump, pressure vessel, thin film composite membranes, piping, wiring, and controls. Suitable for continuous operation in semi-conditioned space. System shall have the following components:

1. Thin Film Composite Membranes.
2. Stainless Steel multi-stage pump.
3. PLC Controls.
4. Heavy duty FRP vessels.
5. Painted Steel Frame.
6. 5 micron prefilter with polypropylene housing.
7. Product TDS monitor.
8. Permeate/Concentrate Flowmeters.
9. High and Low pressure protection.
10. Pre and Post flush Operations.
11. Panel mounted instruments and indicator lamps.
12. NEMA 12 4X Control Panel.
13. Pump discharge and Reject Throttle valves.
14. 316 Stainless Steel High Pressure plumbing piping.
15. TDS Rejection monitor.
16. Reject recirculation loop with flow meter.

2.6 STORAGE TANK

A. Polyethylene, dome top, bottom cone, with stand.

B. Provide level sensor for high level alarm, low level alert, and low level alarms.

2.7 DI WATER PUMPS

A. Vertical, multi-stage, centrifugal pumps.

B. Material: 316L Stainless Steel wetted parts.

C. Mechanical shaft seal.

D. Provide taps for gauges.

E. High efficiency, continuous service, inverter duty ODP motor.

2.8 DI MIXED BEDS

A. Fiberglass vessels, virgin mixed bed exchange resins.

2.9 FINAL FILTERS

A. Multistack cartridge filters with housing. Housing all wetted parts 316L Electropolished stainless steel.

2.10 INSTRUMENTATION MANIFOLD

A. The instrumentation manifold shall have as a minimum the following instruments:

1. PH and conductivity.
2. TOC/Resistivity.
3. Particulates.
4. Flow Rate, GPM.
5. Temperature.
6. Pressure.
7. Sampling Valves.

B. The following alerts and alarms must be transmitted to CDAS:

1. Tank High Level Alarm.
2. Tank Low Level Alert.
3. Tank Low Level Alarm.
4. Low Supply Pressure.

2.11 PIPING, VALVES AND FITTINGS (PVDF - POLYVINYLIDENE FLUORIDE)

A. Pipe valves and fittings for purified water service shall be:
   1.
   2. Type: Schedule 80, virgin, polyvinylidene fluoride per ASTM D3222 Type 1, Grade 2.
   3. All pipe, fittings, and valves shall be tested and approved for potable water by National Sanitation Foundation (NSF).
      a. Provide hallmarks for compliance on each component.
   4. All system piping components shall be the products of one manufacturer.

B. Manufacturers:
   1. Asahi.
   2. Georg Fischer.
   3. Sani-Tecch
   4. Simtech.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

C. Installation practices shall comply with manufacturer's instructions, including support spacing and joint fusion including infared butt fusion by a trained and certified technician.

D. Sleeves: Provide sleeves in return air plenums.
   1. Provide a sleeved system through the installation of grooved Schedule 10 galvanized piping and couplings.
   2. Provide sleeve piping no less than 2 inches greater diameter than the polyvinylidene fluoride piping contained within it.
   3. Provide only rolled groove piping.
      a. The Victaulic "Fit" fittings and piping system, or any similar set screw type fitting system is specifically prohibited. Vic-Let and Vic-O-Well or similar type fittings are **specifically prohibited** for use on this project.
   4. Where a reduced tee fitting is required, then a reducing tee or regular tee with bell reducer shall be used.
   5. **If any of the above described prohibited materials or installation methods are used, then the material or installation method shall be corrected at the contractor's expense.**

E. Valves shall be ball valve type and shall be manufactured of the same virgin, unpigmented molding compound as the fittings to assure compatibility.

F. All ball valves shall have Viton seals, and PTFE seats.
   1. Pressure rating: 150 psi at a minimum of 68F.
   2. Basis of Design: PVDF Manufactured by: GF Piping Systems.

G. The Contractor shall supply a fusion welding machine to the owner prior to completion of the project.
   1. Furnish training for a minimum of two of the Owner's personnel on the operation of the fusion machine, installation of the piping and fittings, and the maintenance required for the machine and piping systems.
      a. Minimum of 4 hours at Owner's premises at the Physical Plant of the institution where this project is constructed.
      b. The training shall instruct maintenance and installation personnel, including hands-on training to ensure proper use of equipment to follow manufacturer requirements.

2.12 PIPING, VALVES AND FITTINGS (CPVC SCHEDULE 80) (DI RETURN ONLY)

A. Pipe and Fitting Type: Schedule 80, virgin, CPVC per ASTM D2846/D2846M Type 1, Grade 2.
   1. Design Stress: 1,360 psi at 73 degrees, maximum service temperature 280 degrees F.

B. All pipe, fittings, and valves shall be tested and approved for potable water by National Sanitation Foundation (NSF).
   1. Provide hallmarks for compliance on each component.

C. All system piping components shall be the products of one manufacturer.

D. Pipe Manufacturers:
   1. Basis of Design: GF Piping Systems.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

E. Fitting Manufacturers:
   1. Basis of Design: GF Piping Systems.

2. Substitutions: See Section 01 60 00 - Product Requirements.

F. Manual Valves: Stainless steel ball type with Teflon seats, packing and gasket,
   1. Manufacturers:
      a. Basis of Design: GF Piping Systems.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

G. Solenoid Valves:Designed for pure water service.
   1. Material: Body is stainless steel with ethylene propylene elastomers.
   2. Manufacturers:
      a. Basis of Design: GF Piping Systems.
      b. Substitutions: See Section 01 60 00 - Product Requirements.

H. Installation practices, including support spacing and joint threading, shall be in compliance with manufacturer's printed recommendations.
   1. Socket weld joints are preferred over threaded joints.

I. all system piping components shall be the products of one manufacturer.

J. Sleeves: Provide sleeves in return air plenums.
   1. Provide a sleeved system through the installation of grooved Schedule 10 galvanized piping and couplings.
   2. Provide sleeve piping no less than 2 inches greater diameter than the polyvinylidene fluoride piping contained within it.
   3. Provide only rolled groove piping.
      a. The Victaulic "Fit" fittings and piping system, or any similar set screw type fitting system is specifically prohibited. Vic-Let and Vic-O-Well or similar type fittings are **specifically prohibited** for use on this project.
      b. Where a reduced tee fitting is required, then a reducing tee or regular tee with bell reducer shall be used.
      c. **If any of the above described prohibited materials or installation methods are used, then the material or installation method shall be corrected at the contractor's expense.**

2.13 FLOW CONTROL VALVES

A. The Mechanical Contractor shall furnish and install a 3/8-inch PVC flow control valve in each and every deionized water fixture return tap that limits the flow to 1/2 GPM. The Contractor shall supply and install a 2 GPM a natural polypropylene flow control valve in each deionized water connection to washers.

B. Flow control valves shall maintain a constant flow regardless of inlet pressure changes between 15 and 100 psig. No metal shall be in contact with the liquid.

C. PVDF:
   1. Diaphragm Valves.
      a. Basis of Design: GF Piping Systems.
      b. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Ball Valves:
      a. Basis of Design: GF Piping Systems.
      b. Substitutions: See Section 01 60 00 - Product Requirements.
   3. Sampling Valves:
      a. Basis of Design: GF Piping Systems.
      b. Substitutions: See Section 01 60 00 - Product Requirements.
   4. Check Valves:
      a. Basis of Design: GF Piping Systems.
      b. Substitutions: See Section 01 60 00 - Product Requirements.
   5. Self-Contained Pressure Regulating Valves:
      a. Basis of Design: GF Piping Systems.
      b. Substitutions: See Section 01 60 00 - Product Requirements.

D. Actuators:
   1. Basis of Design: GF Piping Systems.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

E. Flow Control Valves:,
   1. Basis of Design: GF Piping Systems.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

2.14 PRESSURE REGULATING VALVES

A. Contractor shall supply and install, where shown on the drawings, socket fusion natural, virgin, unpigmented polypropylene pressure regulating valves.

B. Valves shall accurately reduce and regulate steady or varying inlet pressures and maintain a constant predetermined outlet pressure.

C. Pressure regulating valves shall be Series "PR", as manufactured by Plastomatic Valves, Inc., or approved equal.

2.15 PRESSURE GAGES

A. Pressure Gages shall be 2-1/2-inch diameter, dual calibrated for 0 to 100 psi and SI units, having 316 stainless steel bourdon tube. The gauges supplied and/or installed for the service specified shall be manufactured by Ashcroft, Fig. No. 1079-S or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. PVDF Joint Fabrication:

1. Install and perform joining in accordance with manufacturer's instructions and recommended procedures.
    a. Fabricate in clean area with ventilation from areas with grinding or welding.
    b. Clean components thoroughly and in compliance with manufacturer's instructions.
    c. Jointing shall be made with equipment as indicated by manufacturer.
    d. Label joints and record operating conditions.
    e. Scratched pipe must be replaced.
    f. Provide joints as indicated on drawings and where to connect with accessories and equipment. Install according to manufacturer's instructions.
        1) Provide ANSI flanged joints for connecting to equipment at locations where other types have not been indicated.
        2) Threaded joints are not acceptable.

B. Configuration:

1. Support all piping according to manufacturer's recommendations including at pump discharge locations.
2. Provide continuous support for horizontal runs.
3. Locate valves to ensure complete drainage per manufacturer's recommendations.
4. System shall include low point drains and high point vents as indicated on drawings and as noted in submittal reviews by Architect.
5. Ensure pipe is protected from contact with rough or sharp items, to prevent damage.
6. Locate check valves and orifice plates in vertical sections. Provide eccentric valves or plates for horizontal installation with correct orientation.
7. Install piping without spring or force and ensure equipment connections are without stress.
8. Minimize all dead legs. Distance from sealing point on branch to inside of main line wall to be less than four branch line diameters.
9. Ensure installation accommodates thermal expansion of system with both piping and supports.
10. Install all in-line items to ensure access for maintenance, calibration, replacement of components, and sampling.
11. Orient all gauges to the main pathway of the space.

C. Equipment:

1. Install equipment on concrete housekeeping pad. Refer to Section 22 00 10 - Basic Plumbing Requirements.
2. Install line size isolation and check valves on circulation pump discharge.
3. Install valved bypass around purification equipment.
4. Install manual air vent valves at all high points of piping system, including piping direction changes from horizontal to vertical drops (ells only).
5. Install take offs to outlets with shut off valve after take off. Slope take off piping to outlets.

D. Identify piping system and components. Refer to Section 23 05 53 - Mechanical Identification.

3.2 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 22 00 10 - Basic Plumbing Requirements.

B. Repair or replace piping as required to eliminate leaks, and retest to demonstrate compliance.

C. Cap (seal) ends of piping when not connected to mechanical equipment.

3.3 INSTRUCTIONS AND START-UP – DI SYSTEM

A. At the time of delivery of equipment to the job site, the DI Water system shall be supplied with six complete sets of bound instructions covering installation, operating and maintenance.

B. Contractor shall provide for the service of a competent supervising agent from the DI system manufacturer/supplier to inspect the completed installation, start the system into operation, and acquaint the operators with the proper operation and maintenance of the equipment. As proof of competency, the supervising agent shall carry both Water Quality Association Certification and TNRCC Level III Certification as a Water Specialist.

C. At the time of start-up of equipment, the supplier of equipment shall provide all media fill including activated carbon, an initial brine maker full of 99 percent pure pellet salt for each softener system, and mixed bed ion exchange media.

3.4 INSTRUCTIONS AND START-UP – DI PIPING SYSTEM

A. Entire piping system shall be cleaned, pressure tested, and sanitized. Submit cleaning, testing, and sanitization procedures for approval.

B. Recommended Cleaning Procedures:

1. Preliminary flush with potable water.
2. Provide temporary bypass of DI equipment to create. Fill loop with solution of DI water and Alconox at 25 grams per gallon or equivalent solution. Circulate solution for minimum 60 minutes. Bleed minimum 1/2 gallon from each end connection valve during process.
3. Flush system with DI water, minimum 5 line volumes.
4. Refill with DI Water and Hydrogen peroxide to a 3 percent hydrogen peroxide solution. Let stand 1 hour. Recirculate minimum 1 hour, bleed minimum 1/2 gallon from each end connection during process.
5. Flush system with DI water until potassium permanganate test indicates negative for H2O2. Check resistivity and continue flush with DI water until resistivity reaches point equal to DI water source.

3.5 TESTING

A. Inspection:

1. Visually inspect all joints and verify that they comply with manufacturer’s criteria for a properly formed joint.
2. For joints fused by machines that generate labels, verify that each joint has label.
3. Check diaphragm valve bonnet bolts for correct torque.

B. Hydrotest:

1. Execute all pressure testing safely.
   a. Do not pressurize plastic piping with gas.
   b. Isolate equipment or instrumentation that cannot to be exposed to test pressure.
   c. Notify personnel with access to system that testing is to take place. Tag each use point to indicate that valve is not to be used.
   d. Ensure that air is completely vented from system to avoid a hazardous condition.
   e. Pressurize system gradually.
   f. Provide controls to prevent pressure from exceeding specified test pressure.
2. Ensure that cleanliness of system is not compromised.
   a. Provide water for testing and flushing that has quality equal to or better then service water.
   b. When performing preliminary testing of sections of system, after test is complete flush all water out of system and ensure that it drains completely. Close all openings in system after draining.
3. Execute final acceptance test on completed piping system.
   a. Do not insulate or conceal piping until testing is complete.
   b. Test system in sections or as a whole, but all joints need to be covered in test.
   c. Ensure that air is completely vented from system.
   d. Pressurize gradually and hold system at 100 psig for 4 hours. An initial pressure decrease will occur due to pipe elongation after pressurization. After 4 hours, pressure loss will stabilize, and

pressure must then hold at test pressure without a loss of 1% over period of one hour to pass test.

e. Monitor pressure with gauge located near bottom of system that is readable to at least plus or minus 1 psi.

f. Note if pressure drops more than 1% over test period and determine source of leakage.

1) Cut out and reinstall defective joints.

2) Hand tighten wing nuts on sanitary clamps if required. If leakage continues, install new gasket. Do not tighten using tools.

3) Retest.

4. Provide written certification that includes identification of portion of system tested, date, time, test criteria, test medium and pressure, duration, and name and title of person responsible for test.

3.6 CLOSEOUT ACTIVITIES

A. As part of project punch list requirements per Section 01 77 00 - Closeout Procedures and Submittals, include UTSW Utilities, UTSW Plumbing Shop, UTSW Building Maintenance, UTSW PM, and other associated teams for plumbing focused review.

B. Provide revised Operation and Maintenance Data including final installed components schedule, maintenance manuals, and warranty documentation to UTSW PM and to UTSW Building Maintenance.

END OF SECTION 22 67 06

DIVISION 23

HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 00 00

UTSW MECHANICAL DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

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

B. This document address design criterion not specifically covered by the Mechanical Code (UMC), American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) or set requirements that may exceed the minimum requirements of both.

1.3 APPLICABILITY

A. This Specification applies to all HVAC projects designed and constructed by facilities management personnel, outside Architect/Engineering (A/E) firms, and all construction contractors.

B. No deviations to the standard are acceptable without the written authorization of the Owner or Owner's Representative.

C. UNIFORM GENERAL CONDITIONS, SUPPLEMENTARY GENERAL CONDITIONS, and DIVISION 1 of the Specifications apply to the work specified in this Section.

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

1.4 GENERAL

A. The Contractor shall execute all work hereinafter specified or indicated on accompanying Drawings .

B. Contractor shall provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the Drawings.

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

D. The mechanical, electrical, and plumbing Drawings are necessarily diagrammatic by their nature, and are not intended to show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of standards referenced elsewhere in these specifications, and structural and architectural conditions

E. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work

1. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc , in finished portions of the building, unless specifically noted otherwise.
2. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.

F. When the mechanical, electrical, and plumbing Drawings do not give exact details as to the elevation of pipe, conduit and ducts, the Contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved.

G. Piping, exposed conduit and the duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat manner.

1. The drawings do not show all required offsets, control lines, pilot lines and other location details.
2. Work shall be concealed in all finished areas.

1.5 TERMS AND DEFINITIONS

A. General Requirements: The provisions of requirements of other Division 01 Sections apply to entire work of Contract and, where so indicated, to other elements that are included in Project. Basis Contract definitions are included in the General Conditions.

B. Indicated: The term "indicated" is a cross reference to graphic representations, notes or schedules on drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements on contract documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used in lieu of "indicated," it is for the purpose of helping reader locate the cross reference, and no limitation of location is intended except as specifically noted.

C. Directed, requested, etc.: Where not otherwise explained, terms such as "directed," "requested," "authorized," "selected," "approved," "required," "accepted," and "permitted" mean "directed by Architect/Engineer," "requested by Architect/Engineer" and similar phrases. However, no such implied meaning will be interpreted to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

D. Approve: Where used in conjunction with Architect's/Engineer's response to submittals, requests, applications, inquiries, reports and claims by Contractor, the meaning of term "approved" will be held to limitations to Architect's/Engineer's responsibilities and duties as specified in General and Supplementary Conditions. In no case will "approval" by Architect/Engineer be interpreted as a release of Contractor from responsibilities to fulfill requirements of contract documents or to extend Architect's/Engineer's responsibility into Contractor's area of construction supervision and job safety.

E. As required: Where "as required" is used in these specifications or on the drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the contractor certain complications in performing the work described or indicated. These complications entail the normal coordination activities expected of the Contractor where multiple trades are involved and new or existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to achieve the end result."

F. Furnish: The term "furnish" is used to mean "supply and deliver to project site, ready for unloading, unpacking, assemble, installation, and similar operations. Where "furnish" applies to work for which the installation is not otherwise specified, "furnish" in such case shall mean "furnish and install."

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.

I. CDAS – Central Data Acquisition System (CDAS) is the campus-wide central monitoring station, which is located in the Facilities Management Office (P Building).

J. Dry Lab – Laboratories, which are not equipped with multiple utilities, but require a greater degree of electrical power and HVAC than an office area.

K. Engineer – UTSW Engineer, Owner, or Owner's designated representative.

L. Gas Cylinder Room – Any room that contains carbon dioxide, nitrogen, or argon cylinders in excess of 50 Lbs capacity.

M. Wet Lab – Any laboratory equipped with sinks, fume hoods, biological safety cabinets, or other equipment, which requires multiple utilities (such as gas, air or vacuum), and a greater degree of HVAC than a dry lab.

N. Concealed: Areas which cannot be seen by the building occupants.

O. Exposed: Areas which are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms.

1.6 RELATED REQUIREMENTS

A. Section 01 77 00 - Closeout Procedures and Submittals.

B. Section 01 79 00 - Demonstration and Training.

C. Section 01 91 00 - General Commissioning Requirements.

D. Section 09 96 00 - High-Performance Coatings.

E. Section 23 00 00 - UTSW Mechanical Design Requirements.

F. Section 23 05 53 - Mechanical Identification.

G. Section 23 08 00 - Commissioning of HVAC Systems.

1.7 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS

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

B. Fees and Costs:

1. If, during the course of the construction, a need arises to buy utilities, the Contractor shall pay all fees attendant thereto.
2. If City or privately owned utility piping or electrical cable needs to be extended, relocated, or terminated, the Contractor will pay all permits and construction/inspection fees associated with that particular work.

C. All work performed on this project is under the authority of the State of Texas, therefore no local construction fees or construction permits will be required except as may be required for new service taps, or new or modified connections to City controlled services.

1. If inspections by City personnel are specifically required by this document, then the Contractor is responsible for any fees or permits in connection to those requirements.

D. Compliance:

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

1.8 CONTRACT DOCUMENTS

A. All dimensional information related to new structures shall be taken from the appropriate Drawings.

1. All dimensional information related to existing facilities shall be taken from actual measurements made by the Contractor on the site.

B. The interrelation of the Specifications, the Drawings, and the schedules are as follows:

1. The Specifications determine the nature and setting of the several materials.
2. The Drawings establish the quantities, dimensions, and details.
3. The schedules give the performance characteristics.
4. If the Contractor requires additional clarification, the request shall follow the contractually prescribed information flow requirements.

C. Should the Drawings or Specifications conflict within themselves or with each other, the better quality, or greater size or quantity of work or materials shall be performed or furnished except where directed otherwise in writing by the design professional.

1.9 OWNER FURNISHED PRODUCTS

A. Products furnished to the site and paid for by Owner will be indicated as a Cash Allowance. Refer to Division 01 of the Construction Documents for information and requirements.

1.10 FUTURE WORK

A. Future work will be noted on the Drawings.

1.11 ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner`s option.

1. Accepted Alternates will be identified in Owner Contractor Agreement.

B. Coordinate related work and modify surrounding work as required.

C. Schedule of Alternates: See "Special Conditions" and Bid Form.

D. Any Alternate Proposals are summarized in Division 01 of the Specifications.

E. The Contractor is directed to refer to all Sections of the Specifications and Drawings for this project to determine the exact extent and scope of the various Alternate Proposals as each pertains to the work of all trades.

1.12 SUBMITTALS

A. Refer to Division 01, UGC, and supplemental UGC's for specification requirements pertaining to timeliness of submission and review, quantity, and format.

B. Each specification section describes the content of the submittals and any submittals which must be approved prior to submission of others.

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

D. Submit shop drawings for OSBC review and approval where any equipment or components must coordinate with life safety elements.

1. Submit shop drawings showing locations of smoke detectors installed in line with humidifiers to be approved by OSBC.

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

F. Submit Fabrication Drawings when:

1. Equipment proposed varies in physical size and arrangement from that indicated on the Drawings, thus causing rearrangement of equipment space.
2. Where tight spaces require extreme coordination between ductwork, piping, conduit, and other equipment.
3. Where called for elsewhere in these Specifications.
4. Where specifically requested by the Architect/Engineer.

G. Fabrication Drawings shall be made at no additional charge to the Owner or the Architect/Engineer.

1. All required Fabrication Drawings, except as noted otherwise, shall be prepared at a scale of not less than 1/4 inch = 1 foot.
2. Fabrication Drawings for ductwork, air handling units, and sections in Mechanical Rooms shall be drawn at a minimum scale of 3/8 inch = 1 foot.
3. Submit Fabrication Drawing to the Architect/Engineer and UTSW Facilities Management for review in the quantity and format as specified in Division 1. The Architect/Engineer and UTSW will review the fabrication drawings and return with comments.

H. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.13 SUBSTITUTION OF MATERIALS AND EQUIPMENT

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

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

C. General:

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

D. It is not the intent of the Drawings and/or Specifications to limit products to any particular manufacturer or to discriminate against an "APPROVED EQUAL" product as produced by another manufacturer.

1. Some proprietary products are mentioned to set a definite standard for acceptance and to serve as a reference in comparison with other products.
2. When a manufacturer`s name appears in these Specifications, it is not to be construed that the manufacturer is unconditionally acceptable as a provider of equipment for this project.
3. The successful manufacturer or supplier shall meet all of the provisions of the appropriate specification(s).

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

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

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

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

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

I. Certification: The Contractor shall carefully examine all data forwarded for approval and shall sign a certificate to the effect that the data has been carefully checked, found to be correct with respect to dimensions and available space, that the equipment complies with all requirements of the Specifications. and that the product is suitable for its intended use on this project.

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

K. Materials and Equipment Lists:
1. Provide digital copies of the list of materials and equipment, the name of manufacturer, trade name, type, and catalog number shall be submitted to the Architect/Engineer in quantity and format as described in Division 01.
2. The lists shall be accompanied by digital sets of pictorial and descriptive data derived from the manufacturers` catalogs, sales literature, or incorporated in the Shop Drawings.
3. Should a substitution be accepted, and should the substitute material prove defective, or otherwise unsatisfactory for the service intended within the guarantee period, this material or equipment shall be replaced with the material or equipment specified at no additional cost to the Owner.

1.14 MATERIALS AND WORKMANSHIP

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

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

1.15 FLAME SPREAD PROPERTIES OF MATERIALS

A. Materials and adhesives incorporated in this project shall conform to NFPA .

B. The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, etc , specified for each system, and shall not exceed a smoke developed rating of 50.

1.16 REGULATORY REQUIREMENTS

A. The "Authority Having Jurisdiction" for Fire and Life Safety related compliance in accordance with the rules and regulations promulgated by the Texas State Fire Marshal as an Agency of the State of Texas is UT Southwestern Medical Center Office of Safety and Business Continuity.

B. Plan reviews, installations, inspections, and approvals shall be done as a function of the Fire and Occupational Safety program under the direction of the Director of Fire and Occupational Safety (University Fire Marshal).

C. It is required that the installation shall meet the minimum standards prescribed in the latest editions of the following listed codes and standards identified in Section 01 41 00 - Regulatory Requirements and listed in other Specification sections. Additional requirements include but not limited to:

1. All referenced codes and standards shall be those current at the date of issue of the design documents.
2. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
3. National Fire Protection Association Standards (NFPA): Currently accepted edition.
4. ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
5. ASHRAE Std 62.1 Ventilation and Acceptable Indoor Air Quality.
6. American Gas Association Publications (AGA): Directory of Approved Gas Appliances and Tested Accessories.
7. American Society of Mechanical Engineers (ASME): Boiler and Pressure Vessel Codes.
8. Air Conditioning and Refrigeration Institute Standards (ARI): All standards related to refrigeration and air conditioning equipment and piping furnished under these Specifications.
9. Sheet Metal and Air Conditioning Contractors National Association, Inc (SMACNA): All current editions of applicable manuals and standards (See Sections 23 31 00 - Ductwork and 23 33 00 - Ductwork Accessories).
10. Air Moving and Conditioning Association (AMCA): All current editions of applicable manuals and standards.
11. American Society of Testing Materials (ASTM): All current editions of applicable manuals and standards.
12. American Water Works Association (AWWA): All current editions of applicable manuals and standards.
13. National Electrical Manufacturers` Association (NEMA): All current editions of applicable manuals and standards.
14. International Codes, current edition or as listed elsewhere in the contract.
15. Texas Occupational Safety Act: All applicable safety standards.
16. Occupational Safety and Health Act (OSHA).
17. TAS, ADA, and ANSI Standards: All work shall be in accord with all regulations and requirements of the Standards and Specifications for Handicapped and Disabled for the Construction of Public Buildings and Facilities in the State of Texas Usable by Physically Handicapped and Disabled persons, ANSI Standards, and the requirements of the American Disabilities Act.
18. All materials and workmanship shall comply with all applicable state and national codes, Specifications, and industry standards
    a. In all cases where Underwriters` Laboratories, Inc has established standards for a particular type material, such material shall comply with these standards
    b. Evidence of compliance shall be the UL "label" or "listing" under Reexamination Service.
19. The Contract Documents are intended to comply with the aforementioned rules and regulations; however, some discrepancies may occur.

a. Where such discrepancies occur, the Contractor shall immediately notify the Architect/Engineer in writing of said discrepancies and apply for an interpretation.
b. Should the discovery and notification occur after the execution of a contract, any additional work required for compliance with said regulations shall be paid for as covered by Division 1 of these Contract Documents, providing no work of fabrication of materials has been accomplished in a manner of noncompliance.
c. Should the Contractor fabricate and/or install materials and/or workmanship in such a manner that does not comply with the applicable codes, rules and regulations, the Contractor who performed such work shall bear all costs arising in correcting these deficiencies to comply with said rules and regulations.

1.17 COMMISSIONING

A. Comply with project requirements for commissioning. Refer to Section 01 91 00 - General Commissioning Requirements and associated sections.

1.18 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

A. Storage at Site: The Contractor shall not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, water, weather, humidity, dust damage, and vandalism.
B. Capacities shall be not less than those indicated but shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.
C. Conformance with Agency Requirements:
1. Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters` Laboratories, Inc , or constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, the Contractor shall submit proof that the items furnished under this Section of the Specifications conform to such requirements.
a. The label of the Underwriters Laboratories, Inc , applied to the item will be acceptable as sufficient evidence that the items conform to such requirements.
b. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.
D. Nameplates:
1. Refer to Section 23 05 53 - Mechanical Identification for requirements.
2. Each major component of equipment shall have the manufacturer`s name, address, and catalog number on a plate securely attached to the item of equipment. Attachment shall be appropriate to the type of surface to ensure longevity of attachment.
3. All data on nameplates shall be legible at the time of Final Inspection.
E. Prevention of Rust:
1. Standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.
2. The treatment shall withstand 200 hours in salt spray fog test, in accordance with Method 6061 of Federal Standard No 141.
3. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creep beyond 1/8 inch on either side of the scratch mark.
4. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item.
5. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.
F. Protection from Moving Parts:
1. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts shall be fully enclosed or properly guarded for personnel protection.
2. Guards shall be compliant with OSHA requirements.
G. Verification of Dimensions:
1. The Contractor shall be responsible for the coordination and proper relation of the work to the building structure and to the work of all trades.

2. The Contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work.
3. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.

1.19 WALL, FLOOR AND CEILING PLATES

A. Except as otherwise noted, provide C P (Chrome plated) brass floor and ceiling plates around all pipes, ducts, conduits, etc , passing exposed through walls, floors, or ceilings, in any finished spaces except underfloor and attic spaces.
1. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secured to such pipe or insulation.
2. Plates will not be required for piping where pipe sleeves extend 3/4 inch above finished floor.
3. All equipment rooms are classified as finished areas.
4. Round and rectangular ducts shall have closure plates (NOT chrome plated) made to fit accurately at all floor, wall and ceiling penetrations.

1.20 SLEEVES, INSERTS, AND FASTENINGS

A. General:
1. All openings through all floors, walls, and roofs, etc , regardless of material for the passage of piping, ductwork, conduit, cable trays, etc , shall be sleeved.
2. All penetrations must pass through sleeves except soil pipe installed under concrete slabs on fill.
3. Sleeves shall be set in new construction before concrete is poured, as cutting holes through any part of the concrete will not be permitted unless acceptable to the Architect/Engineer in writing.
a. If a penetration is cored into an existing solid concrete or stone structure, then the installation of a sleeve will not be necessary.
4. Sleeves set in floors shall extend 4-inches above finished floor elevation and be sealed water tight to the floor.

B. The minimum clearance between horizontal penetrations including insulation where applicable, and sleeve shall be 1/4 inch, except that the minimum clearance shall accommodate a Link-seal by Garlock, an Enpro Company, or approved equal product, closure where piping exits the building, or penetrates a wall below ground level.

C. Contractor shall be responsible for the accurate location of penetrations in the slab for pipe, duct, etc.
1. All penetrations shall be of ample size to accommodate the pipe, duct, etc plus any specified insulation.
2. Sleeve materials shall be rigid metal of adequate strength.
3. Void between sleeve and pipe shall be filled with Nelson Flameseal Firestop or approved equal caulk or putty.

D. Sleeves:
1. Installation of sleeves in walls shall be the same as for floors.
2. Refer to the details on the project drawings.
a. Where the details differ from these specifications, the drawings take precedence.
3. Sleeves for penetrations passing through walls or floors on or below grade shall be removed, if practical, and after the pipes have been installed, the void space around the pipe shall be caulked with a suitable material to effect a waterproof penetration.
a. Note that the practicality of the removal of the sleeve shall be the decision of the Construction Inspector. The decision of the Inspector shall be final.

E. Inserts:
1. Where the construction schedule allows, suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction.
2. If the inserts are later found not to be in the proper location for the placement of hangers or if the construction schedule does not allow inserts to be installed, then drilled anchors shall be installed.
3. Drilled anchors in concrete or masonry shall be submitted for approval.

F. Fasteners:
1. Fastening of pipes, conduits, etc , in the building shall be as follows:
a. To wood members - by wood screws.

b. To masonry - by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry.
c. To steel - machine screws or welding (when specifically permitted or directed), or bolts.
d. To concrete by suitable inserts anchored to reinforcing steel, and poured in place unless other means are indicated on the plans.
e. Power-actuated fasteners (shooting) will not be acceptable under any circumstances.
f. If it is necessary to install a method of fastening a hanger after the structure has been installed, then only clamps or drilled anchors with torque nuts and washes shall be used.

2. Note: The use of plastic anchors or plastic expansion shields is prohibited.

G. Rat proofing: The open space around all ductwork, piping, etc , passing through the ground floor and/or exterior walls shall be rat proofed in a manner acceptable to the Architect/Engineer.

H. Weatherproofing: The annular space between a pipe and its sleeve in exterior walls or through floor to below grade shall be filled with polyurethane foam rods 50 percent greater in diameter than the space as backing and fill material and made watertight with a permanent elastic polysulfide compound.

1. Seal both surfaces of wall or floor.

I. Air Plenums: The space around piping, ductwork, etc , passing through air plenums shall be made airtight in a manner acceptable to the Architect/Engineer.

J. Fireproofing:

1. Each contractor shall seal duct, etc , penetrations through roof, fire rated walls, and floors with a foam or sealant as described below or in Division 7 that will form a watertight, vermin tight barrier that is capable of containing smoke and fire up to 2,000 degrees F for two hours.
2. Refer to fireproofing and firestopping specifications in Division 07 for product requirements.

1.21 PROJECT/SITE CONDITIONS

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

B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections.

C. Obtain permission of Architect/Engineer in writing before proceeding.

D. In some cases the existing system(s) will be expanded or replaced.

1. Contractor shall thoroughly familiarize themselves with the existing system(s) and bring to the attention of the Architect/Engineer any situations, which deviate from those, indicated in the Contract Documents.

1.22 MANUFACTURER`S RECOMMENDATIONS

A. The manufacturer`s published directions shall be followed in the delivery, storage, protection, installation, piping, and wiring of all equipment and material.

1. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflict between the requirements of the Contract Documents and the manufacturers` directions.
2. The Contractor shall obtain the Architect/Engineer`s instructions before proceeding with the work.
3. Should the Contractor perform any such work that does not comply with the manufacturers` directions or such instructions from the Architect/Engineer, the Contractor shall bear all costs arising in connection with the deficiencies.

1.23 SPACE AND EQUIPMENT ARRANGEMENT

A. The size of mechanical and electrical equipment indicated on the Drawings is based on the dimensions of a particular manufacturer.

1. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment proposed will fit in the space.
2. Fabrication Drawings shall be prepared for approval when required by the Architect/Engineer or Owner to indicate a suitable arrangement.

B. All equipment shall be installed in a manner to permit access to all surfaces.

1. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.

C. All equipment intended for floor mounting shall be installed on housekeeping pads or grouted bases that elevate the base away from damage.

1. Housekeeping pads to be sealed to match floor waterproofing system.
2. Housekeeping pad edges to be painted Safety Yellow.

3. Once equipment is set in place, seal around base perimeter per requirements of Section 07 92 00 - Joint Sealants.

1.24 LARGE APPARATUS

A. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed.

B. Following placement in the space, such apparatus shall be thoroughly and completely protected from damage as hereinafter specified.

1.25 PROTECTION

A. The Contractor shall at all times take such precautions as may be necessary to properly protect all materials and equipment from damage from the time of delivery until the completion of the work.
   1. This shall include the erection of all required temporary shelters and supports to adequately protect any items stored in the open on the site from the weather, the ground and surrounding work; the cribbing of any items above the floor of the construction; and the covering of items in the incomplete building with tarpaulins or other protective covering; the installation of electric heaters in electrical switchgear and similar equipment to prevent moisture damage.
   2. Failure on the part of the Contractor to comply with the above will be sufficient cause for the rejection of the items in question.

B. Take particular care not to damage the building structure in performing work.
   1. All finished floors, step treads, and finished surfaces shall be covered to prevent any damage by workmen or their tools and equipment during the construction of the building.

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

D. Storage of all equipment shall be per manufacturer's recommendations.

E. All pumps, fans and motors shall be rotated by hand when received and when stored to maintain bearing lubrication.

1.26 COOPERATION BETWEEN TRADES AND WITH OTHER CONTRACTORS

A. Each trade, subcontractor, and/or Contractor must work in harmony with the various other trades, subcontractors and/or Contractors on the job as may be required to facilitate the progress to the best advantage of the job as a whole.

B. Each trade, subcontractor, and/or Contractor must pursue its work promptly and carefully so as not to delay the general progress of the job.

C. This Contractor shall work in harmony with Contractors working under other contracts on the premises.

1.27 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

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

B. The Electrical Trades shall provide all interconnecting wiring for the installation of all power.

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

D. The Mechanical Trades shall provide complete wiring diagrams indicating power wiring and interlock wiring.
   1. Diagrams shall be submitted for review within 30) days after the submittals for equipment have been reviewed.
   2. Diagrams shall be based on accepted equipment and shall be complete full phase and interlock control Drawings, not a series of manufacturer`s individual diagrams.
   3. After these diagrams have been reviewed, copies shall be transmitted to the Electrical Trades by the Contractor.
   4. See Section 23 09 00 - Instrumentation and Control for HVAC for additional clarification.

1.28 SUPERVISION

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

B. It shall be the responsibility of each superintendent to study all Drawings and familiarize themselves with the work to be done by other trades.

C. Coordinate with other trades and, before material is fabricated or installed, superintendent shall ensure that the work will not cause an interference with another trade.

D. Where interferences are encountered, they shall be resolved at the job site by the superintendents involved.

E. Where interferences cannot be resolved without major changes to the design, the matter shall be referred to the A/E for ruling.

1.29 SITE OBSERVATION

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

1.30 PRECEDENCE OF MATERIALS

A. The specifications determine the nature and setting of materials and equipment.

B. The drawings establish quantities, dimensions, and details.

C. The installation precedence of materials shall generally be as follows:

1. Note that if interference is encountered, this shall guide the contractor in the determination of which trade shall be given the "Right-of-Way" This does not require elements with a lower preference to be relocated if such relocation is required to resolve interference or to provide better access.
    a. Building lines.
    b. Structural Members.
    c. Soil and Drain Piping.
    d. Vent Piping.
    e. Supply, Return, and Outside Air Ductwork.
    f. Exhaust Ductwork.
    g. HVAC Water and Steam Piping.
    h. Condensate Piping.
    i. Fire Protection Piping.
    j. Natural Gas Piping.
    k. Domestic Water (Cold and Hot).
    l. Refrigerant Piping.
    m. Electrical Conduit.

1.31 RECORDS FOR OWNER

A. Records shall comply with Section 01 77 00 - Closeout Procedures and Submittals and requirements described herein.

B. The Contractor shall maintain a set of prints in the Field Office for the sole purpose of recording "installed" conditions.

1. Daily note all changes made in these Drawings in connection with the final installation including exact dimensioned locations of all new underground utilities, services and systems and all uncovered existing active and inactive piping outside the building.

C. At Contract completion, the Contractor shall provide a set of reproducible drawings and set of specifications electronic format (PDF).

1. The contractor shall transfer the information from the prints maintained as described above, and turn over this neatly marked set of reproducible Drawings and specifications representing the "as installed" work to the Architect/Engineers for verification and subsequent transmittal to the Owner.
2. The Contractor shall refer to Division 01 of these Specifications, and to the Uniform General Conditions, for additional information.
3. These Drawings and Specifications shall include as a minimum:
    a. Addendum written drawing changes.
    b. Addendum supplementary drawings.

c. Accurate, dimensioned locations of all underground utilities, services and systems.
d. Identification of equipment work shown on Alternates as to whether alternates were accepted and work actually installed.
e. Change Order written drawing changes.

D. "As installed" PDF's shall bear a stamp or hand lettered title block generally located in lower right hand corner of Drawing entitled "AS INSTALLED DRAWING" with Company name of the installing trade Subcontractor and with a place for the date and the name of the responsible company representative.

E. In addition to the above, the Contractor shall accumulate, during the progress of the job, the following data in electronic format (PDF) and turn over to the Architect/Engineer for review, and subsequent delivery to the Owner:
1. All warranties and guarantees and manufacturers` directions on equipment and material covered by the Contract.
2. Operating instructions and preventative maintenance procedures for heating and cooling and other mechanical and electrical systems.
3. Valve tag charts and diagrams specified herein.
4. Approved wiring diagrams and control diagrams representing "as installed" conditions.
5. Copies of approved Shop Drawings.
6. Any and all other data and/or drawings required as submittals during construction.
7. Repair parts list of all major items and equipment including name, address and telephone number of local supplier or agent.

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

G. Refer to additional requirements in the commissioning section of Division 01.

1.32 ATTIC STOCK

A. Provide one set of filters and two sets of belts at conclusion of the project to the Owner for attic stock.

1.33 WARRANTY

A. Refer to Division 01 and to individual specification sections for warranty requirements Unless otherwise specified, a 5-year parts and labor warranty shall be provided on all systems and equipment.

PART 2 – PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be acceptable to the authority having jurisdiction as suitable for the use intended.

B. Furnish products listed and classified by Underwriter's Laboratory, Inc as suitable for purpose specified and shown.

C. Unless otherwise specified materials shall be new and free from any defects.

2.2 ACCESS DOORS

A. General: This Contractor shall provide wall, floor, or ceiling access doors for unrestricted access to all concealed items of mechanical, plumbing, or electrical equipment or devices including items requiring general maintenance or access.

B. Utilize Section 08 31 13 - Access Doors and Frames for products and requirements.

C. Access doors shall be a minimum of 24 x 24 inches in size unless approved by UTSW FM in writing. Location shall provide appropriate access.

PART 3 – EXECUTION

3.1 EXISTING FACILITIES

A. The Contractor shall be responsible for loss or damage to the existing facilities caused by them and their workers, and shall be responsible for repairing or replacing such loss or damage.
1. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in service maintenance of all plumbing, heating, air conditioning, electrical, and ventilating services for the new and existing facilities.
2. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.

C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall same upon completion of work in the areas affected.

D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed, all Contractors shall remove and reinstall in locations approved by the Architect/Engineer all devices required for the operation of the various systems installed in the existing construction.

1. This includes but is not limited to temperature controls system devices, electrical switches, relays, fixtures, piping, conduit, etc.

E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner.

1. Comply with notification requirements per Section 01 10 00 - Summary.
2. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner.
3. All costs of outages, including overtime charges, shall be included in the contract amount.

3.2 DEMOLITION AND RELOCATION

A. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the drawings or required by the installation of new facilities.

1. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage.
2. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination or otherwise disposed of as directed by the Owner.
3. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition.
4. The Contractor may, at their discretion, and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.

B. All items that are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated.

1. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order.
2. All relocations shall be performed by workers skilled in the work and in accordance with standard practice of the trades involved.

C. When items scheduled for relocation and/or reuse are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal.

1. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.

D. Service lines and wiring to items to be removed, salvaged, or relocated shall be removed to points indicated on the drawings, specified, or acceptable to the Owner.

1. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain.
2. Such services shall be sealed, capped, or otherwise tied off or disconnected in a safe manner acceptable to the Owner.
3. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas.
4. Services to existing areas or facilities that must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.

3.3 INSTALLATION METHODS

A. Where to Conceal: All pipes, conduits, etc , shall be concealed in pipe chases, walls, furred spaces, or above the ceilings of the building unless otherwise indicated.

B. Where to Expose:

1. In mechanical rooms, janitor`s closets tight against pan soffits in exposed "Tee" structures, or storage spaces, but only where necessary, piping may be run exposed.
2. All exposed piping shall be run in the most aesthetic, inconspicuous manner, and parallel or perpendicular to the building lines.

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

D. Maintaining Clearance:
1. Where limited space is available above the ceilings below concrete beams or other deep projections, pipe and conduit shall be sleeved through the projection where it crosses, rather than hung below them in a manner to provide maximum above-floor clearance.
2. Sleeves shall be as herein specified.
3. Piping, ductwork and other installed materials shall be located so as to not obstruct maintenance clearance for mechanical components such as controls, filters and the like.
4. Piping shall not create trip-hazards through floor-mounting but be routed in a manner overhead or below the floor.

E. Piping:
1. Piping shall be identified with both color and labels as indicated in Section 23 05 53 - Mechanical Identification.
2. All pipe, conduits, etc , shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing.
3. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch.
4. Piping, ducts and conduits run in furred ceilings, etc., shall be similarly installed, except as otherwise shown All pipe openings shall be kept closed until the systems are closed with final connections.
5. All piping not directly buried in the ground shall be considered as "interior piping."
6. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, the Contractor shall notify the construction inspector so that arrangement can be made for an inspection of the above ceiling area about to be "sealed" off.
    a. The Contractor shall give as much advance notice as possible but no less than 10 working days.
7. All above ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view.
    a. All mechanical work at and above the ceiling, including items supported by the ceiling grid, such as air inlets or outlets, shall be complete and installed in accordance with contract requirements, including power to fans and other powered items.
    b. Adequate lighting shall be provided to permit thorough inspection of all above-ceiling items.
    c. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling, Facilities Management, Architect/Engineer, and the Resident Construction Manager`s Construction Inspector Areas to be included and time of inspection shall be coordinated with the Construction Inspector.
    d. The purpose of this inspection is to verify the completeness and quality of the installation of the air conditioning systems, the electrical systems, the plumbing systems, and any other special above ceiling systems such as pneumatic tube, vacuum systems, fire sprinkler piping and cable tray systems.
    e. The ceiling supports (tee bar or metal framing) shall be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.
    f. No ceiling materials may be installed until the resulting deficiency list from this inspection is worked off and the Construction Inspector has given approval.
8. Proper accessibility to equipment may be required to be demonstrated by the commissioning agent or inspector.

3.4 CONNECTIONS FOR OTHERS

A. The Contractor shall rough in for and make all gas, water, steam, sewer, etc. connections to all fixtures, equipment, machinery, etc., provided by others in accordance with detailed roughing-in Drawings

provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.

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

C. Shutoff Valves: In each service line connected to an item of equipment or piece of machinery, provide a shutoff valve.

D. Traps: On each drain not provided with a trap, provide a suitable trap.

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

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

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

3.5 CUTTING AND PATCHING

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

B. Methods of cutting:

1. 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.
2. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer Openings in precast concrete slabs for pipes, conduits, outlet boxes, etc., shall be core drilled to exact size.

C. Restoration: All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.

D. Masonry:

1. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry.
2. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation.
3. 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.

E. Plaster:

1. All mechanical work in areas containing plaster shall be completed prior to the application of the finish plaster coat.
2. Cutting of finish plaster coat will not be permitted.

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

1. Rebar placement shall be determined prior to floor coring operations.
2. Any rebar, which has been cut, shall be submitted in writing to the Architect/Engineer for evaluation.

3.6 ROOF PENETRATIONS AND FLASHING

A. Pipe, conduit and duct sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided and installed by a qualified contractor for all roof penetrations.

B. This shall be the responsibility of the General Contractor.

3.7 OPERATION PRIOR TO COMPLETION

A. When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, they may do so, providing they properly supervises the operation, and has the Construction Inspector`s written permission to do so.

B. The warranty period shall not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.

C. Regardless of whether or not the equipment has or has not been operated, the Contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the Owner.

1. The date of acceptance and performance certification will be the same date.

D. Air handling equipment shall only be operational with all specified filter media in place and additional filter media in place to prevent dust from entering the return and exhaust air systems.

E. Additional requirements for operation of equipment prior to completion found in the commissioning sections of Division 1 and Division 23 shall be followed.

3.8 CLEANING AND PAINTING

A. All equipment, piping, conduit, ductwork, grilles, insulation, etc , furnished and installed in the tunnel and mechanical rooms under Division 23 of these Specifications and as hereinafter specified shall be cleaned, prepared, and painted according to the following specification. Color of finish painting in Mechanical Rooms shall be painted in accordance with Color Schedule for machinery spaces using Sherwin Williams paint numbers, or approved equivalent.
   1. In the event of a conflict between the specifications referenced, the provisions of this specification shall prevail only for Divisions 22, 23 and 26 work.
   2. UTSW Approved paint colors: Refer to Section 23 05 53 - Mechanical Identification.
   3. Paint Specification: Refer to Section 09 96 00 - High-Performance Coatings.
   4. Natural gas piping shall be painted in its entirety.

B. All equipment furnished by the mechanical and electrical subcontractors shall be delivered to the job with a suitable factory protective finish and shall be painted, after installation, with the color hereinafter specified.

C. The following materials shall not be painted:
   1. Materials: copper, galvanized metal, stainless steel, fiberglass, PVC, and PVDF.
   2. Aluminum jacketing on insulation.
   3. Nameplates on equipment shall be protected during painting to prevent damage.

D. Before painting, materials and equipment surfaces shall be thoroughly cleaned of cement, plaster, and other foreign materials, and all oil and grease spots shall be removed.
   1. Such surfaces shall be carefully wiped and all cracks and corners scraped out.
   2. Exposed metal work shall be carefully brushed down with the steel brushes to remove rust and other spots and left smooth and clean.

E. For painting purposes, the equipment and piping inside of built-up air handling units shall be painted the same as if they were within the walls of a Mechanical Room.

F. Scope of painting for Division 23 work in areas other than those defined as "exposed" is as follows:
   1. Underfloor spaces:
      a. All uncovered steel pipe, supports, exposed pipe and hanger rod threads, and hangers shall be cleaned and painted with two coats of black asphaltic emulsion.
      b. Galvanized steel and copper lines shall not be painted.
   2. Concealed spaces:
      a. All canvas finishes shall be painted with one sizing coat if not already sized, containing mildew resistant additive and adhesive prior to any other specified finish paint.
   3. If insulated, the piping shall be primed, only, prior to insulation, and the insulation jacketing shall be painted as specified for piping The requirements of this paragraph are "primary" and have priority over any conflicting specification or instruction, should a conflict in the Construction Documents exist.

G. In addition to painting in mechanical rooms, materials, piping, ductwork, conduit, gear, supports, foundations, equipment, and appurtenances installed by the mechanical and electrical subcontractors in exposed areas shall be finish painted with two coats enamel paint of color selected by the Architect/Engineer, refer to Section 09 96 00 - High-Performance Coatings.

H. Additional areas to be defined as "exposed" for purposes of painting, are defined on the Drawings.

I. The surfaces to be finish painted shall first be prepared as follows:
   1. On canvas finishes pretreated as specified above.
   2. Insulated surfaces having vapor barrier jacket exposed to view shall first be painted with one (l) coat of sealer.
   3. Galvanized and black steel surfaces shall first be painted with one (1) coat of P&L galvanized metal primer. Primer may be eliminated on concealed fire and gas piping.
   4. Aluminum surfaces shall first be painted with one (1) coat of P&L zinc chromate primer.
   5. Cast iron pipe shall first be primed with a "non bleed" primer.

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

J. All ferrous metal surfaces without a protective finish and not galvanized in exposed and concealed areas including chases, under floor, and above ceilings shall be painted with 2 coats of P&L zinc chromate primer as the construction progresses to protect against deterioration.

3.9 CHECKING AND TESTING MATERIALS AND/OR EQUIPMENT

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

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

C. Refer to the commissioning sections of Division 1 and Division 23 for additional start-up, testing, and acceptance requirements.

3.10 TESTS

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

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

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

D. Maintain Log of Tests as hereinafter specified.

E. See Specifications for additional tests and requirements.

F. All testing reports shall be submitted to UTSW Facilities Management for review and approval.

3.11 LOG OF TESTS

A. All tests shall have pertinent data logged by the Contractor at the time of testing.
   1. Data shall include date, time, personnel, description, and extent of system tested, test conditions, test results, specified results, and other pertinent data.
   2. Data shall be delivered to the Architect/Engineer and UTSW Facilities Management as specified under "Requirements for Final Acceptance" in Section 01 77 00 - Closeout Procedures and Submittals.
   3. All Test Log entries shall be legibly signed by the Project Contractor or the authorized job superintendent.

3.12 COOPERATION AND CLEANUP

A. It shall be the responsibility of each trade to cooperate fully with the other trades on the job to help keep the job site in a clean and safe condition At the end of each day`s work, each trade shall properly store all tools, equipment and materials, and shall clean all debris from the job.

B. Upon the completion of the job, each trade shall immediately remove all tools, equipment, any surplus materials, and all debris caused by that portion of the work.

3.13 CLOSEOUT ACTIVITIES

A. As part of project punch list requirements per Section 01 77 00 - Closeout Procedures and Submittals, include UTSW Utilities / Mechanical Shop, UTSW Controls / Utilities Operations, UTSW Electrical Shop, UTSW Building Maintenance, UTSW PM, Commissioning Agent (if applicable), and other associated teams for mechanical focused review.

B. Provide revised Operation and Maintenance Data including final installed components schedule, maintenance manuals, and warranty documentation to UTSW PM and to UTSW Building Maintenance.

3.14 TRAINING

A. Refer to Section 01 79 00 - Demonstration and Training as well as individual technical Sections for specific training requirements.

B. Where training is called for in other sections provide a minimum of 8 hours on site training for Owner's representatives.

C. Training shall be presented by a qualified instructor with training experience and technical knowledge of the product.

D. Submit a training agenda, proposed date, and instructor qualifications to the Owner for approval.

END OF SECTION 23 00 00

SECTION 23 05 13

MOTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. High-efficiency TEFC, horizontal and vertical, single-speed, squirrel cage polyphase induction motors, up to and including 500 hp, in NEMA frame sizes 143T and larger for severe duty applications (commonly referred to as severe duty motors).

1.3 RELATED REQUIREMENTS

A. Section 01 79 00 - Demonstration and Training.

B. Section 23 00 00 - UTSW Mechanical Design Requirements.

C. Section 23 82 19 - Fan Coil Units.

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.

C. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings.

D. IEEE 112 - IEEE Test Procedure for Polyphase Induction Motors and Generators.

E. NEMA MG 1 - Motors and Generators.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 SUBMITTALS

A. Submit product data under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.

C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

D. Submit manufacturer`s installation instructions under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

E. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for intended use, and their accessories, with minimum five years documented product development, testing, and manufacturing experience.

B. Comply with NFPA 70.

C. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of high efficiency motors.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.8 REQUIREMENTS

A. IEEE Standard for Petroleum and Chemical Industry Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors up to and Including 500 HP.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Store and protect products under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.10 WARRANTY

A. Provide five-year manufacturer`s warranty under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Warranty: Provide five year manufacturer warranty for motors larger than 1 horsepower.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Toshiba.

B. Baldor Electric Company/ABB Group.

C. US Motors.

D. General Electric.

2.2 GENERAL CONSTRUCTION REQUIREMENTS

A. Electrical Service: Refer to Drawing Schedules for required electrical characteristics.

B. Motors: Design for continuous operation in 40 degrees C environment, a service factor of 1 15

C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer`s name and model number, Service Factor, Power Factor, efficiency.

D. Electrical Connection: Conduit connection boxes, threaded for conduit For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

E. In addition, all motors shall be provided with adequately sized electrical connection box with threaded hub for attachment of flexible conduit, unless bus duct connection is indicated.

F. Where motors are connected to driven equipment by the use of a V-belt drive, they shall be furnished with adjustable rails.

G. Single phase motors, in general, shall be less than 3/4 horsepower and shall be 120 or 208 volt, 60-hertz motors.

1. These motors shall have built-in thermal overload protection with automatic reset, and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

H. Efficiency: NEMA Premium.

2.3 STARTING EQUIPMENT

A. Each motor shall be provided with proper starting equipment.

1. The trade furnishing the motor, unless hereinafter specified or scheduled to the contrary, shall provide this equipment.
2. All motor starting equipment provided by any one trade shall be of the same manufacture unless such starting equipment is an integral part of the equipment on which the motor is mounted.
3. The Mechanical Subcontractor shall furnish all starters for Division 23 work, except those starters scheduled to be provided in Section 26 24 19 - Motor Control Centers.

B. Motor starters shall conform to NEMA Standards for Industrial Control, #IC-1, latest issue, and shall be housed in NEMA Standard enclosures.

C. Control voltage in each starter shall be either 24V or 120 volts to ground (as required), with an individual control transformer provided in each starter as required.

D. Manual starters for fractional horsepower single phase motors shall be on-off or snap switch type combined with thermal overload device.

E. The switch shall be so constructed so that it cannot be held closed under a sustained motor overload.

F. Magnetic starters shall have thermal overload protection in each of the ungrounded legs and shall be solenoid operated.

G. Provide the correct size heater element to protect the motor and allow it to operate based on motor nameplate amperes and ambient temperatures anticipated for each individual motor.

H. Each starter shall be provided with a control power transformer or 120v control power circuit.

I. Pushbuttons with or without pilot lights, hand-off-automatic switches and other scheduled apparatus shall be standard duty type mounted in NEMA enclosures or in cover of starter as specified or scheduled, and shall be furnished by the trade furnishing the starter except as specifically indicated elsewhere.

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

K. Motor bearings shall meet requirements for bearings in applicable equipment sections.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION 23 05 13

SECTION 23 05 15

MECHANICAL PIPING, VALVES, AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. General requirements for all Mechanical piping systems This section is supplemented by other sections with additional requirements and more detail on specific systems In the case of conflict, the most stringent requirement will apply.

1.3 RELATED REQUIREMENTS

A. Section 01 91 00 - General Commissioning Requirements.
B. Section 23 00 00 - UTSW Mechanical Design Requirements.
C. Section 23 05 16 - Piping Expansion Compensation.
D. Section 23 05 29 - Supports and Anchors.
E. Section 23 05 53 - Mechanical Identification.
F. Section 23 21 13 - Hydronic Piping
G. Section 23 21 15 - Hydronic Specialties

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. AGA – American Gas Association.
C. ASME B31.1 - Power Piping.
D. ANSI B31 2 – Fuel Gas Piping.
E. ASME B31.4 – Liquid Petroleum Transportation Systems.
F. ASME B31.9 – Building service Piping.
G. ASME B16.3 - Malleable Iron Threaded Fittings Class 150 and 300.
H. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
I. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
J. AWS A5.8/A5.8M - Brazing Filler Metal.
K. AWS D1.1/D1.1M - Structural Welding Code.
L. AWWA C105/A21.5 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
M. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.
N. ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
O. ASTM A234/A234M - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
P. ASTM B32 - Standard Specification for Solder Metal.
Q. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
R. ASTM D1785 -Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
S. ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
T. ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) Composite-Sewer Piping.
U. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
V. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.5 SUBMITTALS

A. Submit product data under provisions of Division 01 and Section 23 00 00 - UTSW Mechanical Design Requirements.

1. Include data on pipe fittings, valves, and accessories.
2. Provide manufacturer's catalog information Indicate valve rating and data.

B. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 QUALITY ASSURANCE

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

B. Welding Certificates, Materials and Procedures: Conform to ANSI/ASME SEC 9 and applicable state labor regulations.

1. Welders Certification: In accordance with ASME Section 9.

C. Maintain one copy of the above listed documents on site for inspection.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Division 01 and Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Store and protect products under provisions of Division 01 and Section 23 00 00 - UTSW Mechanical Design Requirements.

C. Deliver and store valves in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.1 VALVES

A. Locate valves so removal of bonnets is possible.

B. Ball valves shall not be used for steam or steam condensate service.

C. Steam blowdown valves shall be gate valves with plugs.

D. All flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. When installation configuration does not allow any other orientation except horizontal stem, valves with stem in horizontal position shall be drilled and tapped in accordance with MSS-SP-45 at Boss G to accommodate a drain valve.

E. All valves must be true and straight at the time the system is tested and inspected for final acceptance. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings.

F. All valves must be of threaded or flanged type. No solder connected or grooved fitting valves shall be used on this project.

G. All bronze and iron body gate and globe valves shall be the product of one manufacture for each project. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacture, all ball valves shall be of the same manufacture, etc.

H. All valves used in circulating systems, plumbing shall be Class 150 SWP.

I. All steam and steam condensate valves shall be carbon steel, Class 300 gate valves.

J. Class 300 valves shall be constructed of all ASTM B61 composition.

K. All gate, globe and angle valves shall be union or screw-over-bonnet design. Metal used in the stems of all bronze gate, globe and angle valves shall conform to ASTM B371 Alloy 694, ASTM B99 Alloy 651, or other corrosion resistant equivalents. Written approvals must be secured for the use of alternative materials.

L. All iron body valves shall have the pressure containing parts constructed of ASTM designated of 126 class B iron. Stem material shall meet ASTM B16 Alloy 360 or ASTM 371 Alloy 876 silicon bronze or its equivalent.

M. Gates and globes shall be bolted bonnet with OS&Y (outside screw and yoke) and rising stem design. A lubrication fitting is preferred on yoke cap for maintenance lubrication of the yoke bushing. Gate and globe valves shall be bolted bonnet outside and screw and yoke design with pressure-temperature rating conforming to ANSI B16-34-1977. Stems shall meet ASTM designation A-186-F6 chromium stainless steel.

N. Wedge (gate valves) may be solid or flexible type and shall meet ASTM A-182-F6 chromium stainless steel on valves from 2 to 6 inches. Sizes 8 inches and larger may be A-216-WCB with forged rings or

overlay equal to 182-F6. Seat ring shall be hard faced carbon steel or 13 percent chromium A-182-F6 stainless. Handwheels shall be A47 Grade 35018 malleable iron or Ductile Iron ASTM A536.

O. All cast steel body valves shall have the pressure containing parts constructed of ASTM designation A-216-GR-WCB carbon steel.

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

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

R. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron hand wheels, except iron body valves 2-1/2 inch and larger which may have either malleable iron or ASTM A-126 Class B, gray iron hand wheels.

2.2 BALANCING AND/OR SHUTOFF VALVES FOR CLOSED WATER CIRCULATING SYSTEMS:

A. Two inches and smaller, three piece bronze body, bronze or stainless steel ball and stem, Teflon seats, packing and gasket, bronze gland follower, adjustable stuffing box, steel lever type handle, with plastic operating handle, quarter turn stops, and shall be class 150. Manufacturer shall certify ball valves for use in throttling service. Stem extensions shall be furnished for use in insulated lines.

B. Valves 2-1/2 inch and larger shall be tapped full lug butterfly valves with aluminum bronze discs of ASTM B148 Alloy C955 and 316, 416, or 420 stainless steel shafts. Design must incorporate bushing between shafts and body of material suitable to provide a bearing surface to eliminate seizing or galling. Valve must be capable of providing a bubble tight seal at 200 psi for valves up to 12 inch (150 psi for larger valves) when used for end of line service without requiring the installation of a blind flange on the downstream side. Liners shall be resilient material suitable for 225°F temperature and bodies of ductile iron.

C. Butterfly valves 8 inch inch and larger and butterfly valves used for balancing service or control, regardless of size, shall have heavy duty weather proof encased gear operators, with malleable iron handwheel. Valves 2-1/2 inch through 6 inch shall have lever handles which can be set in interim positions between full open and full closed. All butterfly valves shall be absolutely tight against a pressure differential of 150 psi.

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

2.3 STRAINERS

A. Strainers, 2 inch and smaller, bronze body, screwed ends, No 10 mesh strainer, screwed cap with bronze blow-off valve (size to be determined by standard tap size in cap)

1. Strainers shall have drain port with isolation ball valve and cap.
2. Cast iron body, 2-1/2 inch and larger, isolating type flanged ends where installed in copper lines, No 7 perforated monel strainer, flanged cap with bronze ball blow-off valve (size of blow-off valve shall be determined by standard tap size in cap).
3. Special Note: All strainers 6 inch and larger shall have studs mounted in the body flange in lieu of bolts for removal of cap Baskets for strainers 6 inch and larger shall have stainless steel reinforcing bands at ends to prevent collapsing.

B. Suction diffusers shall be Paco or approved equal, cast iron body and cover, steel diffuser, and stainless steel strainer, 125 pound ASA (flat face) flange for a working pressure of 175 psi and temperature of 300°F.

2.4 UNIONS

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of the system.

1. No unions will be required in welded lines or lines assembled with solder joint fittings except at equipment items, machinery items and other special pieces of apparatus.
2. Unions in 2 inch and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2-1/2 inch and larger shall be ground flange unions.
3. Unions in copper lines shall be Class 125 ground joint brass unions or Class 150 brass flanges if required by the mating item of equipment.
4. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items.
5. See particular Specifications for special fittings and pressure.

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

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

2.5 WELDED PIPING

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

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

C. Execution:
1. Piping and fittings shall be welded and fabricated in accordance with ASME/ANSI the latest editions of Standards B31 1 for all systems, and B31 3 for Steam and Condensate systems, from the Code for Pressure Piping Machine beveling in shop is preferred Field beveling may be done by flame cutting to recognized standards.
2. Contractor shall ensure complete penetration of deposited metal with base metal.
   a. Contractor shall provide filler metal suitable for use with base metal Contractor shall keep inside of fittings free from globules of weld metal.
   b. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process.
   c. All pipe shall have the ends beveled 37-1/2 degrees and all joints shall be aligned true before welding.
   d. Except as specified otherwise, all changes in direction, intersection of lines, reduction in pipe size and the like shall be made with factory-fabricated welding fittings.
   e. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.
3. Contractor shall 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.
4. Contractor shall not permit any weld to project within the pipe so as to restrict it Tack welds, if used, must be of the same material and made by the same procedure as the completed weld Otherwise, remove tack welds during welding operation.

5. Contractor shall not split, bend, flatten or otherwise damage piping before, during or after installation.
6. Contractor shall remove dirt, scale and other foreign matter from the inside of piping, by swabbing or flushing, prior to the connection of other piping sections, fittings, valves or equipment.
7. In no cases shall Schedule 40 pipe be welded with less than three passes including one stringer/root, one filler and one lacer Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two filler and one lacer In all cases, however, the weld must be filled before the cap weld is added.

D. Testing:
1. All welds are subject to inspection, visual and/or Xray, for compliance with specifications
   a. The owner will, at the Owner`s option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or Xray testing Initial visual and Xray inspections will be provided by the owner.
   b. The contractor shall be responsible for all labor, material and travel expenses involved in the re-inspection and retesting of any welds found to be unacceptable.
   c. In addition, the contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31 1 and B31 3 due to the discovery of poor, unacceptable or rejected welds.
2. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the Code, current edition.

E. All weld fittings shall be USA factory made wrought carbon steel butt welding fittings conforming to ASTM Spec A234 and ANSI standard B16 9-1964 as made by Grinnell, Tube Turn, Hackney, Taylor Forge, or Ladish Company.
1. Each fitting shall be stamped as specified by ANSI B16 9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties and chemical composition of the material.
2. Complete test reports may be required for any fittings selected at random.
3. Only one manufacturer of weld fittings will be approved for each project.
4. Fittings which have been machined, remarked, printed or otherwise produced domestically from imported forgings or materials will not be acceptable.
5. Each fitting shall have the manufacturer`s trademark permanently identified in accordance with MSS SP-25.
6. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process.
7. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these Specifications.

2.6 FLANGES

A. 150 lb and 300 lb ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ANSI B16 5 and ASTM A-181 Grade I or II or A-105-71 as made by Tube Turn, Hackney or Ladish Company.
1. Slip on flanges shall not be used Each fitting shall be stamped as specified by ANSI B16 9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material.
2. Complete test reports may be required for any fitting selected at random.
3. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable.
4. Flanges shall have the manufacturer`s trademark permanently identified in accordance with MSS SP-25.
5. Contractor shall submit data for firm certifying compliance with these Specifications Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions
6. Thread rods are not an acceptable for flange bolts.
7. Bolts shall have a tensile strength of 60,000 psi and an elastic limit of 30,000 psi

8. Flat faced flanges shall be furnished where required to match flanges on pumps, check valves, strainers, etc.
9. Only one manufacturer of weld flanges will be approved for each project.

B. All flanges shall be gasketed.
1. Contractor shall place gasket between flanges of flanged joints.
2. Gaskets shall fit within the bolt circle on raised face flanges and shall be full face on flat face flanges.
3. Gaskets shall be cut from 1/16 inch thick, non metallic, non asbestos gasket material suitable for operating temperatures from -150°F to +750°F, Klingerseal C-4400, Manville Style 60 service sheet packing, or equivalent.

2.7 BACKFLOW PREVENTERS

A. Backflow preventers (BFP) shall be reduced pressure type, Febco 825, or approved equal A BFP shall be installed to isolate all non-potable water requirements from the building domestic water system (All BFP`s shall be installed within the building).

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends, remove burrs, and 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 and other work.
C. Group piping whenever practical at common elevations.
D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
E. Provide clearance for installation of insulation, and access to valves and fittings.
F. Provide access where valves and fittings are not exposed.
G. Slope piping and arrange systems to drain at low points Use eccentric reducers to maintain top of pipe level.
H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
I. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Section 09 96 00 - High-Performance Coatings.
J. Install valves with stems upright or horizontal, not inverted.
K. Locate valves in readily accessible areas and where valve operation will not damage other components, materials, or devices.

3.3 FABRICATION OF PIPE

A. Piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material Lines shall also be graded for proper drainage.
B. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the site.
1. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained.
C. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines are connected.
D. All piping shall be clean when it is installed. Before installation it shall be checked, upended, swabbed, if necessary, and all rust or dirt from storage or from lying on the ground shall be removed.
E. Procedure of Assembling Screw Pipe Fittings:
1. All screw joints shall be made with taper threads, properly cut.
2. Joints shall be made tight with Teflon applied to the pipe threads only and not to fittings.
3. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs.

4. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.

F. Procedure for Assembling Other Joints:

1. Procedures for assembling joints in cast iron and copper lines have been set forth elsewhere in these Specifications.
2. For any special materials, consult the manufacturers for the recommended procedures in assembling the joints.

3.4 APPLICATION

A. Use grooved mechanical couplings and fasteners only in accessible locations.

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

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

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

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

F. Provide spring loaded check valves on discharge of condenser water pumps. Provide non-slam or other system-appropriate check valves on all other pumps.

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

H. Use butterfly valves interchangeably with gate and globe valves.

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

J. Use lug end butterfly valves to isolate equipment.

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

3.5 PIPE PRESSURE TESTS

A. The following lines shall be tested at the stated pressure for the length of time noted:

Line	TestingMedium	Testing Pressure(PSIG)	Time in Hours
Chilled Water	Water	1.5x working pressure	24
Steam M.P. & L.P.	Water	1.5x working pressure	24
Steam Condensate M.P.	Water	1.5x working pressure	24
Pumped Condensate Return	water	1.5x working pressure	24

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

END OF SECTION 23 05 15

SECTION 23 05 16

PIPING EXPANSION COMPENSATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Flexible pipe connectors.

B. Expansion joints and compensators.

C. Pipe loops, offsets, and swing joints.

1.3 RELATED REQUIREMENTS

A. Section 23 00 00 - UTSW Mechanical Design Requirements

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Product Data:

1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

C. Design Data: Submit calculations for the sizing of expansion loops and selection of expansion joints.

D. Shop Drawings:

1. Submit shop drawings indicating the exact location and calculated axial and lateral loads for all anchors, guides, expansion joints and loops.
2. Provide drawings indicating the proposed method of attachment to the building structure.

E. Manufacturer`s Installation Instructions: Indicate special procedures, and external controls.

F. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Maintenance Data: Include adjustment instructions.

1.8 QUALIFICATIONS

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

B. Design expansion compensating system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Texas.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact Inspect for damage.

C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY

A. Provide five year warranty.

B. Warranty: Include coverage for leak free performance of packed expansion joints.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide structural work and equipment required to control expansion and contraction of piping Verify that anchors, guides, and expansion joints provided, adequately protect system.

B. Expansion Calculations:

1. Installation Temperature: 50 degrees F.
2. Chilled Water: 120 degrees F.
3. Steam: 450 degrees F.
4. Steam Condensate: 250 degrees F.
5. Domestic Hot Water: 140 degrees F.
6. Safety Factor: 30 percent.

2.2 ACCEPTABLE MANUFACTURERS

A. Microflex, Inc.

B. Amber Booth Company.

C. The Metroflex Company.

D. ADSCO Manufacturing Corporation.

E. Substitutions: Under provisions of Section 01 60 00 - Product Requirements.

2.3 FLEXIBLE PIPE CONNECTORS

A. Steel Piping :

1. Inner Hose: Stainless Steel.
2. Exterior Sleeve: Double braided stainless steel.
3. Pressure Rating: 200 psig WOG and 250 degrees F.
4. Joint: As specified for pipe joints.
5. Size: Use pipe sized units.
6. Maximum offset: 3/4 inch on each side of installed center line.

2.4 EXPANSION JOINTS

A. Stainless Steel Bellows Type:

1. Pressure Rating: 200 psig WOG and 250 degrees F.
2. Joint: As specified for pipe joints.
3. Size: Use pipe sized units.
4. Application: Steel piping 3 inch and under.

B. Externally-Internally Guided (Slip Joint) Piston-Ring Type:

1. Pressure Rating: 300 psig steam and 800 degrees F.
2. Joint: Flanged.
3. Size: Use pipe sized units.
4. Accessories: Internal flow liner.
5. Application: Steel piping over 3 inch.

2.5 ACCESSORIES

A. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer`s instructions.

B. Construct spool pieces to exact size of flexible connection for future insertion.

C. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation Provide line size flexible connectors.

D. Install flexible connectors at right angles to displacement.

1. Install one end immediately adjacent to isolated equipment and anchor other end Install in horizontal plane unless indicated otherwise.

E. Rigidly anchor pipe to building structure where necessary.

F. Provide pipe guides so movement is directed along axis of pipe only.

G. Erect piping such that strain and weight is not on cast connections or apparatus.

H. Provide support and equipment required to control expansion and contraction of piping Provide loops, pipe offsets, and swing joints, or expansion joints where indicated.

3.2 MANUFACTURER`S FIELD SERVICES

A. Prepare and start systems under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Provide inspection services by flexible pipe manufacturer`s representative for final installing and certify installation is in accordance with manufacturer`s recommendations and connectors are performing satisfactorily.

END OF SECTION 23 05 16

SECTION 23 05 19

METERS AND GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Pressure gages and pressure gage cocks.
B. Thermometers and thermometer wells.
C. Pressure/temperature test plugs.
D. Ultrasonic flow meters used for balancing.

1.3 RELATED REQUIREMENTS

A. Section 23 00 00 - UTSW Mechanical Design Requirements.

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ASME B40.100 - Gages - Pressure Indicating Dial Type - Elastic Element.
C. ASTM E1 - Specification for ASTM Thermometers.
D. ASTM E77 - Verification and Calibration of Liquid-in-Glass Thermometers.
E. UL 404 - Gages, Indicating Pressure, for Compressed Gas Service.

1.5 SUBMITTALS

A. Submit under provisions of Division 1 and Section 23 00 00 - UTSW Mechanical Design Requirements.
B. Product Data: Include list for every meter and gauge to be provided which indicates use, operating range, total range, and location.
C. Samples: Submit one of each type of instrument specified upon request by Engineer.
D. Submit manufacturer’s installation instructions.
E. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Division 01 and Section 23 00 00 - UTSW Mechanical Design Requirements.
B. Accurately record actual locations of meters and gauges.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 - PRODUCTS

2.1 GAUGES AND GAUGE CONNECTIONS

A. Pressure Gauges and Accessories: Provide Ashcroft gauges or approved equal, complete with lever handle shut-off cocks, and pulsation piston type dampeners, or approved equal Porous type dampeners will not be accepted Gauges shall have stainless steel movement and 1/2 of 1% accuracy Gauges shall have back connection when used on a panel; otherwise they shall have bottom connections.
B. Pressure Gauge Connections: Provide where noted or indicated on the Drawings or called for elsewhere in the Specifications, gauge connections complete with lever handle union shutoff cocks, or approved equal All gauge connections shall be made up with brass pipe, nipples and brass screw fittings.
C. Siphon: Brass, 1/4 inch angle or straight pattern Model SY14b manufactured by Weiss.
D. Pressure Test Tap: 1/4 inch full port brass ball valve, 150 psig.

2.2 THERMOMETER AND THERMOMETER WELLS

A. Provide thermometers of not less than 9 inch length scale complete with brass separable sockets (wells) with extension neck to allow for insulation of piping These thermometers shall be mercury red reading type in one piece glass tubes extending from top of scale to sensor, and shall be located so that they may be easily read Field adjustable angle thermometers are acceptable Thermometers shall be Weksler Industrial Thermometers, or approved equal.

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

C. All thermometers shall be easily read from floor and readily visible from floor.

2.3 PRESSURE TEMPERATURE TEST PLUGS

A. Test Plug: 1/4 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe Provide test plugs rated for 400 psig with neoprene core for temperatures up to 200 degrees F: and Nordel core for temperatures up to 350 degrees F and manufactured by Fairfax or approved equal

2.4 ULTRASONIC FLOW MEASURING AND BALANCING SYSTEM (SUB-METERING)

A. Furnish and install complete transit time Balance Master Metering systems manufactured by NuSonic Flow elements shall be installed where indicated in the chilled water, heating water and condenser water systems in straight run of pipe in accordance to manufacturer`s guidance for the specific installation in order to maintain rated accuracy.

B. This shall be a coordinated system, including flow stations to work with a Portable Master Meter Each flow station shall be complete with quick mount sensor carriers mounted in the ‘transverse` arrangement, laminated or metal identification tag on chain giving pipe size, meter series, and station identification Flow stations shall be of steel construction, welded in place.

C. Furnish to the Owner a Master Meter mounted in a portable carrying case, complete with 2 (two) 6` (six foot) lengths of meter cable and attached meter sensors, and installation and operating instructions Meter shall operate on both 115 VAC and self-contained battery pack (field selectable) Meter display shall be backlit LCO, indicating instantaneous flow rate in GPM Meter full scale accuracy shall be 2% or better with a fluid operating range of 1-15 ft/sec Meter shall have built-in automatic pipe size compensation Meter shall have positive zero flow indication.

D. Unit shall accommodate the following fluid operating ranges:

1. Temperature:36° to 250°F.
2. Pressure:0 to 150 psi.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer`s instructions.

B. Pressure gauges shall be provided on the suction and discharge of base mounted pumps as indicated on the Drawings.

C. Single pressure gauges shall be installed on in-line pumps as indicated on the Drawings.

D. Install pressure gages with pulsation dampers Provide gage cock to isolate each gage Provide siphon on gages in steam systems Install thread-o-lets on piping for gage installation, do not weld nipple directly to pipe.

E. Install thermometers in piping systems in thermometer wells Enlarge pipes smaller than 2-1/2 inch for installation of -thermometer sockets.

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

G. Locate pressure/temperature test plugs on the inlet and outlet of each healing coil in air terminal units, unit heaters, duct healing coils, etc Mount short nipple with 1/4 inch ball valve Place in accessible locations.

END OF SECTION 23 05 19

SECTION 23 05 29

SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Pipe and equipment hangers and supports.
B. Equipment bases and supports.
C. Sleeves and seals.
D. Flashing and sealing equipment and pipe stacks.

1.3 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete.
B. Section 22 11 16 - Plumbing Piping.
C. Section 23 00 00 - UTSW Mechanical Design Requirements.
D. Section 23 07 13 - Ductwork Insulation.
E. Section 23 07 16 - Equipment Insulation.
F. Section 23 07 19 - Piping Insulation.
G. Section 23 21 13 - Hydronic Piping.
H. Section 23 22 13 - Steam and Steam Condensate Piping.

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ASME B31.1 - Power Piping.
C. ASME B31 2 - Fuel Gas Piping.
D. ASME B31.5 - Refrigeration Piping.
E. ASME B31.9 - Building Services Piping.
F. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
G. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
H. NFPA 13 - Standard for the Installation of Sprinkler Systems.
I. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.
J. UL 203 - Standard for Pipe Hanger Equipment for Fire Protection Services.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Division 03 Concrete Sections.

1.6 SUBMITTALS

A. Submit under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.
B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

C. Product Data: Provide manufacturers catalog data including load capacity.
D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
E. Manufacturer`s Installation Instructions: Indicate special procedures and assembly of components.
F. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for support of plumbing, hydronic, steam and steam condensate piping.
B. Supports for Sprinkler Piping: Shall be in conformance with NFPA 13.
C. Supports for Standpipes: Shall be in conformance with NFPA 14.

PART 2 – PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:
   1. Grinnell.
   2. Other acceptable manufacturers offering equivalent products.
B. Supports, hangers, anchors and guides shall be provided for all horizontal and vertical piping.
   1. Shop Drawings shall be provided, indicating locations and details of anchors, guides, expansion loops and joints, hangers, etc.
   2. The hanger design shall conform to the ASME Code for Pressure Piping.
C. All auxiliary steel required for pipe supports, anchors, guides, etc shall be provided by the Mechanical Trades unless specifically indicated to be provided by others.
D. The supports, hangers, anchors, and guides for the chilled water supply and return piping, steam piping, condensate return piping, etc of the Campus Loop System routed through utility tunnels and below buildings shall be provided as indicated on the Drawings.
E. Contractor shall review all Drawings, including Structural Drawings, for details regarding pipe supports, anchors, hangers, and guides.
   1. All pipe supports shall be of type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.
   2. This trade shall be responsible for structural integrity of all supports, anchors, guides, etc.
   3. All structural hanging materials shall have a minimum safety factor of 5 built in.
F. Anchor points as indicated on Drawings or as required shall be located and constructed to permit the piping system to take up its expansion and contraction freely in opposite directions away from the anchored points.
G. Guide points shall be located and constructed wherever required or indicated on Drawings and at each side of an expansion joint or loop, to permit free axial movement only.
H. Pipe supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.
I. Hangers supporting and contacting brass or copper lines 3-inches in size and smaller shall be Grinnell Fig CT-99c, adjustable, copper plated, tubing ring.
J. Hangers supporting and contacting brass or copper lines 4-inches and larger shall be Grinnell Fig 260, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod.
K. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Grinnell Fig 300, adjustable clevis, with a nut above and below the hanger, and approved neoprene isolating material between pipe (or tubing) and hanger on the support rod Isolate all copper or brass lines from all ferrous materials with approved dielectric materials.
L. Hangers supporting and contacting plastic or glass piping shall be of equal design, but shall be padded with neoprene material or equal The padding material and the configuration of its installation shall be submitted for approval.
M. Hangers supporting insulated lines where the outside diameter of the insulation is the equivalent of 8 inch diameter pipe or smaller in size and supporting all ferrous lines 6 inch and smaller in size shall be Grinnell Fig 260, adjustable clevis, with a nut above and below the hanger on the support rod.

N. Hangers supporting and contacting ferrous lines larger than 6 inch in size and outside of insulation on lines with the outside diameter equivalent to 10 inch diameter pipe shall be Grinnell Fig 260, adjustable clevis, with a nut above and below the hanger on the support rod.

O. Glass riser clamps shall be neoprene coated

P. Other special type of hangers may be employed where so specified or indicated on the Drawings, or where required by the particular conditions. In any case, all hangers must be acceptable to the owner.

Q. Each hanger shall be properly sized to fit the supported pipe or fit the outside of the insulation on lines where specified:

1. Hangers for dual or low temperature insulation pipes shall bear on the outside of the insulation, which shall be protected by support shields as specified in Section 23 07 19- Piping Insulation.
2. Protect insulation from crushing by means of a section of rigid insulation to be installed at hanger points.
3. Hangers for high temperature insulated pipes and all insulated hot and cold domestic water pipes shall be encased in the insulation unless supported by trapezes in which case shield and rigid insulation shall be provided as specified above for low temperature insulated pipes.

R. Hangers for large diameter steam and chilled water piping shall be roller style where thermal expansion is expected.

S. Supports for vertical piping in concealed areas shall be double bolt riser clamps, Grinnell Fig 261, or other approved equal, with each end having equal bearing on the building structure, and located at each floor.

1. Two-hole rigid pipe clamps at 4 feet on center or Kindorf channels and Grinnell Fig 261 riser clamps may be used to support pipe from vertical surfaces or members where lines are not subject to expansion and contraction.
2. Where brass or copper lines are supported on trapeze hangers or Kindorf channels the pipes shall be isolated from these supports with plastic tape with insulating qualities, or strut clamps as manufactured by Specialty Products Company, Stanton, California.

T. Supports for vertical piping in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the building structure above the top of the riser, and the underside of the penetrated structure.

1. The contractor shall use a drilled anchor as specified above, and use a Grinnell No 595 Socket Clamp with Grinnell No 594 Socket Clamp Washers, as a riser clamp.
2. The top riser hanger shall consist of two (2) hanger rods (sized as specified) anchored to the underside of the building structure, supporting the pipe by means of the material specified.
3. Risers penetrating floors shall be supported from the underside of the penetrated floor as specified for the top of the riser, but the hanger rods shall also include spring isolators (see Specification on Vibration Isolation for isolator specification).
4. Floor penetrations in exposed areas shall be finished using Grinnell Fig 395 "Ceiling Plates" painted to match the pipe if uninsulated; or if insulated, the penetration shall be covered using a chrome plated escutcheon.
5. Provide hangers at all changes in direction of pipe.

2.2 PIPE SUPPORTS IN CHASES AND PARTITIONS

A. Horizontal and vertical piping chases and partitions shall be supported by hangers or other suitable support.

B. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall.

C. Supports shall be steel plate, angles or special channels such as Unistrut mounted in vertical or horizontal position.

D. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports.

E. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method.

F. Supports may be attached to cast iron pipe with pipe clamp, or other approved method.

G. Isolate copper or brass lines from ferrous metals with dielectric materials to prevent electrolytic action.

2.3 CONDUITS

A. Electrical conduits shall be run parallel or perpendicular to adjacent building lines.

B. Single conduits running horizontally shall be supported by "Caddy" or "Minerallac" type hangers from adequately sized rods (minimum 1/4-inch) from the building structure Where multiple conduits are run horizontally, they shall be supported on trapeze of "Unistrut" type channel suspended on rods or bolted to vertical building members.

C. Conduit shall be secured to channel with galvanized "Unistrut" type conduit clamps or stainless steel "Unistrut" type "Uni-Clips".

D. All hangers shall be fastened to the building structure in the same manner as specified above for pipe hangers.

E. Spacing of hangers shall be adequate for the weight and rigidity of the conduits involved; in any case, no greater than 8-foot centers.

F. Where feasible, conduits may be fastened to the concrete by one-hole straps thoroughly anchored to the concrete in an approved manner.

G. Flexible conduit shall also be supported in an acceptable manner so as not to interfere with the maintenance of above-ceiling equipment, and to support it from touching the ceiling system.

H. Conduit shall be located so as not to inhibit removal of ceiling tiles.

I. The suspension system for the lay-in ceiling shall not be used to support electrical conduit.

J. Vertical conduits shall be supported as often as necessary for rigidity by clamps resting on adjacent beams or floor slabs; minimum of one support per floor.

K. All support hardware shall be galvanized or cadmium plated, or stainless steel.

L. Perforated strap iron or wire will not, under any circumstances, be acceptable as hanger material.

M. Vibration Isolation:

1. Resilient hangers shall be provided on all piping connected to rotating equipment (pumps, etc).
2. Piping that may vibrate and create an audible noise shall also be isolated Spring hangers or supports shall be provided where indicated on the Drawings and/or specified under Section 22 05 48 - Vibration Isolation.

N. Attachment:

1. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete, which holds the inserts.
2. Reinforcement at inserts shall be provided as required to develop the strength required.
3. Inserts for piping shall be of a type which will not interfere with reinforcing as shown on the structural Drawings and which will not displace excessive amounts of structural concrete.
4. Design and install pipe supports to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc.
5. Install piping with due regard to expansion and contraction and the type of hanger method of support, location of support, etc shall be governed in part by this Specification.
6. Pipe hangers shall be attached to the structure as follows:
   a. Poured In Place Concrete:
      1) Where pipes and equipment are supported under poured in place concrete construction, each hanger rod shall be fitted with a nut at its upper end, which nut shall be set into an Underwriters` Laboratories, Inc. listed universal concrete insert placed in the form work before concrete is poured.
      2) Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly or where a larger insert would require displacement of the bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, etc. spanning across two adjacent joists.
      3) The horizontal support shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel.
   b. Steel Bar Joists:
      1) Where pipes and loads are supported under bar joists, hanger rods may be run through the space between the bottom angles and secured with a washer and two nuts.
      2) Where larger lines are supported beneath bar joists, hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded to the joists or otherwise permanently fixed.

c. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.
d. Wood Framing: Where pipes and loads are supported from wood framing, hanger rods shall be attached to framing with side beam brackets or angle clips.
e. Pre-Cast Tee Structural Concrete:
1) Hanger supports, anchors, etc. required for mechanical systems attached to the precast, double tee, structural concrete system are to be installed in accord with approved shop Drawings only.
2) Holes required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances.
3) Core drilling in the "stem" portions of the double tee is not allowed.
4) Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4" larger than the diameter of the hanger rod.
5) Hanger rods shall be supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate.
6) Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15 inches of each stem and in the "shadow" of the stem on the top side of the "double tees".

O. Trapezes:
1. Where multiple lines are run horizontally at the same elevation and grade, they may be supported on trapezes of Kindorf, Elcen, or approved equal, channel-suspended on rods or pipes.
2. Trapeze members including suspension rods shall each be properly sized for the number, size, and loaded weight of the lines they are to support.

P. Finishes:
1. All hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, brackets, shall be dipped in Zinc Chromate Primer before installation.
2. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate
3. Universal concrete inserts shall be cadmium plated.

Q. Ductwork:
1. Support ductwork in accordance with the SMACNA recommendation for the service involved; however, all horizontal ductwork shall be supported at intervals not to exceed 8 feet.
2. Horizontal ducts shall be supported using galvanized steel bands extending up both sides and onto the construction above, where they shall turn over and be secured with bolts into nuts fitted in inserts set in the concrete bolted to angles secured to the construction above, or secured in another approved manner.
3. For attaching methods for precast double tee structural concrete, refer to details on the Drawings and as specified.
4. All ductwork over 36 inches wide shall be supported with vibration isolation integral with the hangers or supports.

R. Terminal units weighing less than 150 lbs shall be supported by four 16 gauge, 1 inch wide sheet metal straps with ends turned under bottom of box at corners and secured by one not over 3/4 inch in length, 1/4 inch diameter sheet metal screw per strap.
1. The other strap end shall be attached to the structure by 1/4 inch diameter threaded bolt into the concrete insert or into drilled-hole threaded concrete expansion anchor.
2. Boxes over 150 lbs in weight shall be supported the same as described above except two 1/4 inch diameter sheet metal screws through turned end of strap box shall be provided.
3. Where interferences occur, overhead of the box, not allowing direct vertical support by straps, provide trapezes of Kindorf, Unistrut, or Elcen channel suspended by 1/4 inch diameter galvanized threaded rods providing such channels do not block access panels of boxes.
4. Threaded rods shall be supported from structure by concrete insert or by drilled-hole threaded concrete expansion anchor.

S. Miscellaneous:
1. Provide any other special foundations, hangers and supports indicated on the Drawings, specified elsewhere herein; or required by conditions at the site.

2. Hangers and supporting structures for suspended equipment shall be provided as required to support the load from the building structure in a manner acceptable to the Architect/Engineer.

T. Standpipe Systems: All hangers and supports for fire standpipe systems and fire sprinkler systems shall be Factory Mutual and Underwriters` Laboratories, Inc listed and labeled Construction of hangers shall be as described above for common piping, except for the above mentioned requirements.

2.4 ACCESSORIES

A. Hanger Rods: Galvanized mild steel threaded both ends, galvanized threaded one end, or galvanized continuous threaded.

2.5 INSERTS

A. Inserts: 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 hanger rods.

2.6 FLASHING

A. Metal Flashing: 26 gage galvanized or stainless steel.

B. Metal Counterflashing: 22 gage galvanized or stainless steel.

C. Roofing Flashing: See specifications for Roofing, elsewhere in these Specifications.

D. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer`s instructions.

3.2 INSERTS

A. Provide inserts for placement in concrete formwork.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.3 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping in accordance with recognized standard practices, minimum spacing as required by piping materials and size In addition to minimum requirements, hangers and supports must be provided at the following locations:

1. Within 12 inches of any change in direction.
2. Each side of 6 inches and larger valves.
3. Each side of in-line pumps.

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place hangers within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

F. Support vertical piping at every floor Support vertical cast iron pipe at each floor at hub.

G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

H. Support riser piping independently of connected horizontal piping.

I. Provide copper plated hangers and supports for copper piping.

J. Design hangers for pipe movement without disengagement of supported pipe.

K. Prime coat exposed steel hangers and supports Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed, but shall be corrosion protected with galvanized plating.

L. Hanger Rods: (NOTE: All hanger rods shall be trimmed neatly so that no more than 1 inch of excess hanger rod protrudes beyond the hanger nut In the event a rod is intentionally but temporarily left

excessively long (for sloped or insulated lines for example), the contractor shall take appropriate measures to protect the pipe or other materials from damage).

3.4 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked one inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size.

1. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size Fasten flashing to drain clamp device.

D. Seal floor, shower, mop sink, and drains watertight to adjacent materials.

E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer`s instructions for sound control.

F. Adjust storm collars tight to pipe with bolts; caulk around top edge Use storm collars above roof jacks Screw vertical flange section to face of curb.

3.5 SLEEVES

A. Set sleeves in position in formwork Provide reinforcing around sleeves.

B. Size sleeves large enough to allow for movement due to expansion and contraction Provide for continuous insulation wrapping.

C. Extend sleeves through floors four inches above finished floor level Caulk sleeves.

D. Where piping, ductwork or conduit penetrates floor, ceiling, or wall, close space between pipe or duct and adjacent work with fire stopping insulation and caulk air tight.

1. Provide close fitting metal collar or escutcheon covers, as appropriate, at both sides of penetration.

E. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

3.6 SCHEDULES

PIPE SIZE INCHES	MAX HANGER SPACING FEET	HANGER ROD DIAMETER INCHES
1/2 TO 1-1/4	6.5	3/8
1-1/2 TO 2	10	3/8
2-1/2 TO 3	10	1/2
4 TO 6	10	5/8
8 TO 12	14	7/8
14 AND OVER	20	1
PP & PPDV (ALL SIZES)	4	3/8
C I BELL AND SPIGOT (OR NO HUB) AND AT ALL jOINTS	5	5/8
GLASS AND AT ALL JOINTS	4	1/2

A. Notes: Insulated piping support spacing shall be reduced as necessary to meet the requirements of "bloc king" or insulation at the support and at all joints.

END OF SECTION 23 05 29

SECTION 23 05 53

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Nameplates.
B. Stencils.
C. Pipe Markers.

1.3 RELATED REQUIREMENTS

A. Section 09 91 13 - Exterior Painting.
B. Section 09 91 23 - Interior Painting.
C. Section 09 96 00 - High-Performance Coatings.
D. Section 23 00 00 - UTSW Mechanical Design Requirements

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.5 SUBMITTALS

A. Submit under provisions of Division 01 and Section 23 00 00 - UTSW Mechanical Design Requirements.
B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
C. Obtain new equipment identification numbers from the Drawings or the Superintendent of Utilities.
D. Product Data: Provide manufacturers catalog literature for each product required.
E. Samples: Submit two of each type of label, tag, etc., of the approximate size specified or implied in the specification.
F. Manufacturer`s Installation Instructions: Indicate special procedures, and installation.
G. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01 and Section 23 00 00 - UTSW Mechanical Design Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Contractor shall make it possible for the personnel operating and maintaining the new equipment and systems in this project to readily identify the various pieces of equipment, major valves, piping, etc., by marking them.
   1. All items of equipment such as pumps, etc., shall be clearly marked using engraved nameplates as hereinafter specified.
   2. The item of equipment shall indicate the same number as shown on the Drawings. For example, pumps will be identified as 3A, 3B, 3C, etc.
   3. The equipment identification will be shown on the Drawings or provided by the Superintendent of Utilities.
   4. All piping shall be identified with pipe markers including pipe type, direction, and pipe diameter with colors to match UTSW requirements.
   5. Color coded pipe jacketing and fitting covers (to match jacketing type) shall match UTSW colors for mechanical and piping.

2.2 MECHANICAL SPACE AND PIPING COLORS

A. UTSW Colors in mechanical and exposed spaces shall be as follows:

1. Colors shown are with Sherwin Williams paint and approved equivalent are allowed per Section 09 96 00 - High-Performance Coatings.

ITEM	COLOR	PAINT NUMBER
Structural Elements and Railing	Gray	Structural Gray SW 4031
Equipment Supports	Light Gray	Nickel SW 4030
Floor	Gray	Slate Gray SW 4026
Housekeeping Curbs (Face)	Yellow	Safety Yellow SW 4084
Equipment Curbs (Face)	Color to Match Equipment	Confirm with Utilities
Clearances and Safety Marking on Floors and Walls	Yellow	Safety Yellow SW 4084
Walls	White	Extra White LRV 86%
Gantry Crane	Yellow	Safety Yellow SW 4084
Fire Sprinkler / Fire Safety	Red	Safety Red SW 4081
Boiler (Existing)	Match Existing Equipment	Match Existing Color
Boiler (New)	Manufacturer Standard Colors	Confirm with Utilities
Steam	Aluminum Lagging	Aluminum
Condensate Return	Aluminum Lagging	Aluminum
Hot Water (Supply)	Dark Orange	International Orange SW 4082
Hot Water (Return)	Orange	Safety Orange SW 4083
Natural Gas	Yellow	Safety Yellow SW 4084
Natural Gas Vent	Yellow	Safety Yellow SW 4084
Fuel Oil	Yellow	Junction Yellow SW 4034
City Water	Light Blue	Polymer Blue SW 4055
Exterior Water	Aluminum Lagging	Aluminum Lagging with Heat Trace
Chiller (Supply)	Dark Blue	Safety Blue SW 4086
Chiller (Return)	Blue	Turbine Blue SW 4064
Chiller Refrigerant Vent	Aluminum Lagging	Aluminum
Condensing Water (Supply)	Dark Green	Safety Green SW 4085
Condensing Water (Return)	Light Green	Generator Green SW 4070
Condensing Water (Exterior)	Aluminum Lagging	Aluminum
Compressed Air	Green	Green Byte SW 4076
Refrigerant Recovery	Purple	Plumb SW 4080
Vents / Roof Vents	Gray	Galvino SW 4027
Hanger Rods	Same as Related Pipe	Confirm with Utilities
Storm Water	White	Ultra White LRV 88%
Atmospheric Relief Lines	Sames as Related Pipe	Confirm with Utilities
Ductwork, AHU, Fans, and Insulation	Aluminum Lagging	Aluminum

2.3 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.4 TAGS

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

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

2.5 PIPE MARKERS

A. Color: Conform to ASME A13.1.

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

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

D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0 10 mm) thick, manufactured for direct burial service.

E. PVC Jacketing and Fitting Covers: Colors to match UTSW requirements and installed as required per Section 23 07 19 - Piping Insulation.

2.6 CEILING LABELS

A. Description: 1/2 inch minimum diameter color sticker with separate clear label, identifying item above ceiling, attached to ceiling grid.. Lettering on label shall be black.
   1. Color code as follows:
      a. Yellow - HVAC equipment.
      b. Red - Fire dampers/smoke dampers.
      c. Blue - Heating/cooling valves.

2.7 GENERAL

A. The Contractor shall make it possible for the personnel operating and maintaining the new equipment and systems in this project to readily identify the various pieces of equipment, major valves, piping, etc , by marking them.
B. All items of equipment such as fans, pumps, etc , shall be clearly marked using engraved nameplates as specified.
C. The item of equipment shall indicate the same number as shown on the Drawings.
D. The equipment identification will be shown on the Drawings or provided by the Superintendent of Utilities.

2.8 MECHANICAL

A. Identify new mechanical equipment by the attachment of engraved nameplates constructed from laminated phenolic plastic, at least 1/16 inch thick, 3-ply, with black surfaces and white core.
B. Engraving shall be condensed Gothic, at least 1/2 inch high, appropriately spaced.
C. Nomenclature on the label shall be in accordance with UTSW standards.
   1. Nomenclature shall be as described in this section Equipment to be labeled shall include but not be limited to the following:
      a. Fan and Coil Units.
      b. Condensing Units.
      c. Compressors.
      d. Air Conditioning Control.
      e. Miscellaneous - similar and related items.

2.9 PIPING

A. Pipe markers and arrow markers also shall be provided on but not limited to the piping of the following systems affected by the project:
   1. Primary Chilled Water Supply.
   2. Steam Condensate.
   3. Primary Chilled Water Return.
   4. Secondary Chilled Water Supply.
   5. Atmospheric Relief.
   6. Secondary Chilled Water Return.
   7. Low Pressure Steam.
   8. Medium Pressure Steam.

2.10 MARKERS

A. In addition, pipe runs throughout the building including those above lift out ceilings, under floor, and those exposed to view when access doors or access panels are opened shall be identified by means of Seton Setmark or Brady Mechanical Pipe Markers.
B. Concealed areas, for purposes of this identification section, are those areas which cannot be seen except by demolition of the building elements.
C. In addition to the pipe markers, arrow markers shall be used to indicate direction of flow.
D. The following specific instructions shall apply to the application of these markers:
   1. Provide a pipe marker at each valve to indicate proper identification of pipe contents Where several valves exist on one header, it is necessary to mark only the header.
   2. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.
   3. Provide a double ended arrow marker when flow can be in either or both directions.
   4. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where line goes through a wall or service column.

5. Provide pipe markers and arrow markers at intervals not exceeding 50 feet.
6. Markers shall be located on the two lower quarters of the pipe where view is unobstructed.

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

F. Pipe Markers shall conform to ANSI A 13 1-1981 "Scheme for the Identification of Piping Systems"

G. Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.

2.11 NOMENCLATURE

A. Building designators for the project:
1. NB.

B. UTSW Energy Management system Naming and Numbering Specification: The purpose of this document is to define the standard for naming items that become part of the EMS system as well as numbering the BACnet networks and devices.
1. Network Numbering: The UTSW BACnet configuration utilizes two of the defined Local Area Network (LAN) technologies for its interconnection of devices Ethernet is used for Management level and Integration level device communication That is to say that front-end servers and workstations (Management level devices) talk to floor and building controllers, routers, and BACnet Broadcast Management Devices (Integration level devices). The Field level controllers such as Room Controllers, Air Handler Controllers, and other building system controllers communicate to the Integration level devices via the Master Slave/Token-Passing MS/TP LAN. Including both of these LAN types, the UTSW BACnet control system can contain up to 65,535 (64K) interconnected networks each of which are required to have a unique network number At UTSW, network numbers shall be assigned as follows:
a. NBBSS
b. Where: N = Network Type
1) 0 = Ethernet
2) 1 = MS/TP
3) 2 = P1
4) 3 = >6 not used
5) SS = 00 to 35 for individual I/P segments in a building
6) BB = the building number
7) 00 = EB (only for JCI)
8) 01 = UH
9) 02 = WC
10) 03 = UW
11) 04 = BE
12) 05 = Unused
13) 06 = Unused
14) 07 = NTEP
15) 08 = V
16) 09 = BTEP
17) 10 = NA
18) 11 = NB
19) 12 = NC
20) 13 = ND
21) 14 = NE
22) 15 = JA
23) 16 = NF
24) 17 = NL
25) 18 = MT - Moncrief Ft. Worth
26) 19 = ZL
27) 20 = XA (2929 Stemmons/Irving)
28) 21 = HA, Annex K
29) 22 = HP, POB1
30) 23 = WA, ASC, Ambulatory Surgical Center

31) 24 = WB
32) 25 = EQ
33) 26 = WD
34) 27 = EB
35) 28 = EC
36) 29 = EF
37) 30 = HQ, POB2
38) 31 = LC - Empire Plaza
39) 32 = A
40) 33 = B
41) 34 = C
42) 35 = D
43) 36 = E
44) 37 = F
45) 38 = G
46) 39 = H
47) 40 = J
48) 41 = K
49) 42 = L
50) 43 = M
51) 44 = MA
52) 45 = P
53) 46 = N1 (Brain/Cancer Garage)
54) 47 = S
55) 48 = U
56) 49 = X
57) 50 = Y
58) 51 = CS
59) 52 = PE, STEP
60) 53 = NM Brain
61) 54 = NN
62) 55 = NP Cancer
63) 56 = NR
64) 57 = JB
65) 58 = RK
66) 59 = LD - Empire Plaza

2. For example, a BACnet Ethernet network in P building on the primary segment would be:
   a. NBBSS.
   b. 04300 or simply network number 4300.

C. Device Numbering: A BACnet control system can contain up to 4,194,303 devices each of which are required to have a unique value for the Object Identifier property of the Device object. At UTSW, device numbers shall be assigned as follows:

1. VBBYYY
   a. Where: V = Vendor
   b. 0 = JCI Controls
   c. 1 = Alerton Controls
   d. 2 = Siemens Controls
   e. 3 = Trane
   f. 4 = not used
   g. BB = Building number as defined in Section above.
   h. YYYY = 0000 to 9999 for devices
2. For example, for the 112th Siemens device in NB building the device number would be:
   a. 2110112
3. Or for the 86th Alerton device in CS building the device number would be:
   a. 1490086

D. System Naming Convention: To create a consistent naming structure across legacy, proprietary, new/remodel construction, and open protocol implementations at UTSW, the following sections specify conventions for naming buildings and equipment as it relates to the EMS system Deviation from this scheme requires prior approval in writing.

1. All buildings shall be designated by a one-letter or two-letter name Reference construction documents for the most current designation The current exception to this rule is Thermal Energy Plants, whose names can contain TEP.
2. All items not specifically identified in this document shall be named as BB NNN…N Where BB is the one or two letter building designation and NNN…N is the industry standard designation for that equipment type For example S BBMD-01 is the name for BACnet Broadcast Management Device BBMD number 1 in S building, and described as S BBMD number one.
3. Rooms shall be designated BBF NNN Where BB is the one or two letter designation, F is the floor number and is always a decimal value; NNN is the actual room number as designated on the official drawings and signage For example, NB10 403 is the name for room 403 on the 10th floor of NB building In the event of multiple room controllers in a large area, they shall be designated as -1, -2… and their relative positions in the room shall be described in the description For example, NB10 403-2 described as NB 10 Room 403, TEC 2 in NW corner.
    a. Environmental rooms, Refrigerators, and Freezers shall have that designation as part of the name. For example, CY3.333 Refrigerator 33 is described as CY 3 333 Refrigerator #33. Or, F5.222 Freezer #2 is described as F 5 222 UL Freezer #2, NB8.408 Warm Room is described as NB 8 408 Warm Room.
    b. In a master/slave configuration of room controllers, the master and slave designations shall be added to the description, i.e., NB10.403-02 described as NB 10 Room 403, TEC 02 slaved to TEC 01 in NW corner.
    c. In the event that corridors or hallways do not have a room number designated, they shall be named as follows: BBF.N Corridor. Where BB is the one or two letter building designation, F is the floor number and N is an incrementing decimal value for controllers throughout that corridor or hallway. The relative location for the controller shall be described in the description. For example, X2.3 Corridor described as X 2, Corridor TEC 3 outside room X2.100.
    d. ARC rooms shall be designated as BBF.NNN ARC. For example J1.116 ARC described as J 1 116 ARC Room.
4. Air Handlers shall be designated BB.AHU-NN Where BB is the one or two letter building designation, AHU is a designation for the air handler, and NN is an incrementing decimal value that designates the air handler number in that particular building.
    a. Air Handler Fans shall be designated BBF.AHUNN Type Fan Where BB is the one or two letter building designation, F is the floor number, AHU is a designation for the air handler, and NN is an incrementing decimal value that designates the air handler number in that particular building, and Type is either Supply Air or Return Air For example, NC AHU1 Supply Air Fan shall be described as NC AHU 1 Supply Air Fan.
    b. Air Handler Valves shall be designated BBF.AHUNN Type VLV Where BB is the one or two letter building designation, F is the floor number, AHU is a designation for the air handler, NN is an incrementing decimal value that designates the air handler number in that particular building, and Type is CD for Cold Deck, HD for Hot Deck, PC for Precool, PH for Preheat or HUM for Humidity For example, NC.AHU1 CD VLV shall be described as NC AHU 01 Cold Deck VLV.
    c. Air Handler Dampers shall be designated BBF.AHUNN Type Damper Where BB is the one or two letter building designation, F is the floor number, AHU is a designation for the air handler, NN is an incrementing decimal value that designates the air handler number in that particular building, and Type is OA for Outside Air, MA for Mixed Air, RA for Relief Air or EA for Exhaust Air For example, L.AHUB2 OA Damper shall be described as L.AHU B2 Outside Air Damper.
    d. Air Handler Safeties shall be designated BB.AHUNN Type Where BB is the one or two letter building designation, AHU is a designation for the air handler, NN is an incrementing decimal value that designates the air handler number in that particular building, and Type is Freeze Stat, High Static, Low Static, Smoke, and High Duct Temp For example, NA.AHU4 Low Static shall be described as NA.AHU 4 Low Static Pressure.

e. Air Handler Temperatures and set points shall be designated BB.AHUNN Type Where BB is the one or two letter building designation, AHU is a designation for the air handler, NN is an incrementing decimal value that designates the air handler number in that particular building, and Type is SAT for Supply Air, CD for Cold Deck, HD for Hot Deck, PH for Preheat, MAT for Mixed Air, OAT for Outside Air Temp and RAT for Return Air For example, NA AHU4 SAT shall be described as NA AHU 4 Supply Air Temperature.

5. Valves shall be designated BBF.T.FunctionVLV Where BB is the one or two letter building designation, T is Valve type such as:
   a. RHW = Reheat Water
   b. DHW = Domestic Hot Water
   c. CHW = Chilled Water
   d. HUM = Humidity
   e. SCHW = Secondary Chilled Water
   f. PCHW = Process Chilled Water
   g. CW = Condenser Water
   h. GLY = Glycol
   i. Function indicates any special purpose such as Sup for Supply, Ret for Return, BP for Bypass, ISO for Isolation. VLV is the designation for Valve. For example, NE.CHW.BPVLV shall be described as NE CHW Bypass VLV. Or, NL.HX1.1/3VLV shall be described as NL HX1 1/3 VLV.
6. Exhaust Fans shall be designated BB.Type EFNN Where BB is the one or two letter building designation, Type is EF will be used for general purpose building exhaust, L for Lab, A for Animal, MRI for MRI. EF is a designation for the exhaust fan, NN is an incrementing decimal value that designates the exhaust fan number in that particular building For example, NA AEF13 shall be described as NA Animal EF 13 NE MRIEF17 shall be described as NE MRI EF 17
7. Fire Status shall be designated BB.Fire Type Where BB is the one or two letter building designation, Type is either Fire Trouble or Fire Alarm or Fire Supervisor
8. Fire/Smoke Dampers shall be designated BBF.FSD.NN Where BB is the one or two letter building designation, F is the floor number and is always a decimal value, FSD is a designation for the fire smoke damper, NN is an incrementing decimal value that designates the smoke damper number in that particular building
9. All other items shall be described as BB (ITEM DESCRIPTION) Where BB is the one or two letter building designation, (ITEM DESCRIPTION) is the complete name/description of the item For example J Control Air HI Press shall be described as J.Control Air High Pressure, or NB LAB VAC PMP STATUS shall be described as NB Lab Vacuum Pump Status

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.
B. Prepare surfaces in accordance with Division 9 for stencil painting.

3.2 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Apply stencil painting in accordance with Division 09 Painting Sections.
C. Install plastic pipe markers in accordance with manufacturer`s instructions.
D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer`s instructions.
E. Identify air handling units, and fan coil units with plastic nameplates.
F. Identify control panels and major control components outside panels with plastic nameplates.
G. Install ceiling labes in accordance with manufacturer's instructions.

END OF SECTION 23 05 53

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Work required to prepare the building HVAC systems for testing, adjusting and balancing indicated by the Contract Documents as follows:
   1. Responsibilities of project contractor.
   2. Preparation for balancing of air systems.
   3. Preparation for balancing of hydronic and steam systems.

1.3 RELATED REQUIREMENTS

A. Section 01 91 00 - General Commissioning Requirements.
B. Section 23 00 00 - UTSW Mechanical Design Requirements.
C. Section 23 05 94 - System Testing, Adjusting and Balancing.
D. Section 23 08 00 - Commissioning of HVAC Systems
E. Section 23 09 55 - Control Sequence.
F. Section 23 31 00 - Ductwork.
G. Section 23 33 00 - Ductwork Accessories.
H. Section 23 36 00 - Air Terminal Devices.
I. Section 23 37 00 - Air Inlets and Outlets.

1.4 SCOPE OF WORK

A. Testing, adjusting, and balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by an impartial technically qualified TAB firm selected and employed directly by the Owner, separate and apart from the Construction Contract.
   1. Preparation for and corrections necessary for the Testing, Adjusting and Balancing of these systems, as described herein, are the responsibility of the Contractor.
B. As a part of this project Construction Contract, the Contractor shall make any changes or replacements to the sheaves, belts, dampers, valves, etc required for correct balance as advised by the TAB firm, at no additional cost to the Owner.
C. The Contractor shall provide and coordinate the services of qualified, responsible Subcontractors, suppliers, and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting and balancing period.
D. In order that all systems may be properly tested, balanced, and adjusted as required by these Specifications, the Contractor shall operate said systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB This length of time shall be subject to the approval of the Owner's Representative.
E. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy.
F. The contractor shall allow adequate time for the completion of testing and balancing activities of the owner provided services, during the construction period, and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.
G. The Drawings and Specifications indicate valves, dampers and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable.
   1. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB firm.

2. Malfunction encountered by TAB personnel and reported to the Contractor or the Owner's Representative shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.

1.5 RESPONSIBILITIES OF THE PROJECT CONTRACTOR

A. The Contractor shall:
   1. Have the building and air conditioning systems in complete operational readiness for TAB work to begin.
   2. The contractor shall allow sufficient time for the TAB firm to perform the contracted work within the construction schedule.
      a. The contractor shall complete his work by systems or floors whichever is the most efficient for scheduling.
      b. After award of the contract and the contractor has developed a construction schedule, a TAB coordination meeting shall be held with the TAB firm, the general contractor and his primary subcontractors (i e mechanical, electrical, building automation etc) to develop a testing schedule for the project.
      c. The contractor shall submit copies of the proposed schedule two (2) weeks prior to this meeting to the Owner and TAB firm.
   3. Promptly correct deficiencies of materials and workmanship identified as delaying completion of TAB work.
   4. The Contractor shall be responsible for any added costs to the Owner resulting from failure to have the building and air conditioning systems ready for TAB when scheduled, or from failure to correct deficiencies promptly.

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

C. Complete operational readiness of the air conditioning systems also requires that the following be accomplished:
   1. Air Distribution Systems:
      a. Verify installation for conformity to design All supply, return and exhaust ducts terminated and pressure tested for leakage as required by the Specification.
      b. All volume, smoke and fire/smoke dampers are properly located and functional.
      c. Dampers serving requirements of minimum and maximum outside, return and relief air shall provide tight closure and full opening, smooth and free operation.
      d. All supply, return, exhaust and transfer grilles, registers, diffusers and terminal devices installed.
      e. Air handling systems, units and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc , shall be blanked and/or sealed to eliminate excessive bypass or leakage of air.
      f. All fans (supply, return and exhaust) operating and verified for freedom from vibration, proper fan rotation and belt tension; heater elements in motor starters to be of proper size and rating; record motor amperage and voltage on each phase at start-up and running, and verify they do not exceed nameplate ratings.
      g. All single and/or double duct variable and constant volume terminal units ("mixing boxes") shall be installed and functional (i e controls functioning).
   2. Water Circulating Systems:
      a. Open all valves to their full open position, close bypass stop valves Set mixing valves to full-flow through systems components.
      b. After the system is flushed and checked for proper operation, remove and clean all strainers.
      c. The Contractor shall repeat the operation until circulating water is clean.
      d. Record each pump motor amperage on each phase and voltage after reaching rated speed Readings shall not exceed nameplate rating.
      e. Verify that the electrical heater elements are of the proper size and rating.
      f. In preparation of TAB all water circulating systems shall be full and free of air, expansion tanks shall be set for proper water level, and all air vents shall be installed at high points of systems and operating freely.

g. Systems shall be cleaned and flushed Chemicals shall be added to closed systems to treat piping and inhibit corrosion.
h. Check and set operating parameters of the heat exchangers and control devices to the design requirements.

3. Automatic Controls:
   a. The Contractor shall schedule a meeting with the Engineer, Control Contractor, TAB firm, Commissioning Provider (if applicable) and Owner`s representative for a pre-submittal review to establish that his interpretation of the sequences of operation are correct.
   b. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, dampers sequences, air and water resets, fire and freeze stats, high and low temperature thermostats, safeties, etc.
   c. Verify that all controlling instruments are calibrated and set for design operating conditions with the exception of room thermostats or sensors, which shall be calibrated at the completion of TAB services with cooperation between the TAB firm and Control Contractor.
   d. The Automatic Temperature Control Contractor and/or Energy Management System Contractor shall thoroughly check all controls, sensors, operators, sequences, etc before notifying the TAB agency that the Automatic Temperature Controls and Energy Management System are operational.
   e. The Automatic Temperature Contractor and/or Energy Management System Contractor shall provide technical support (technicians and necessary computers) to the TAB firm for a complete check of these systems.
4. Tabulated Data: The motor amperages, voltages shall be recorded showing "actual" and "nameplate" voltage and amperage and submitted and actual RPM. This applies to each piece of electrically driven air conditioning equipment in the system including supply and exhaust fans, fans of fractional horsepower, pumps, etc. Include any additional relevant start-up information or documentation.

D. Notification of System Readiness:
1. After completion of the work above, the Contractor shall notify the Owner in writing, certifying that the work has been accomplished and that the building and the air conditioning systems are in operational readiness for testing, adjusting, and balancing; include a copy of the tabulated data described above.
2. The Owner will, in turn, notify the TAB firm of the readiness for balancing and forward copies of the Contractor`s certification.
3. Should the TAB firm be notified as described above, and the TAB work commenced and the systems are found NOT to be in readiness or a dispute occurs as to the readiness of the systems, the Contractor shall request an inspection be made by duly appointed representative of the Owner, Architect, TAB firm and the Contractor.
4. This inspection will establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for TAB services.
5. Should the inspection reveal the TAB services notification to have been premature, all cost of the inspection and wasted work accomplished by the TAB firm shall be reimbursed to the appropriated parties by the Project Contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 23 05 93

SECTION 23 05 94

SYSTEM TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

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 selected and employed by the Owner, separate and apart from the construction contract.

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

1.3 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.

1. 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.

C. The firm shall submit their full incorporated name, Charter Number and Taxpayer`s I D Number for proper verification of the firm`s status.

D. 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.

1. 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.

E. The Firm shall maintain current insurance coverages in the minimum amounts indicated below.

1. 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:
   a. Worker`s Compensation as required by law.
   b. General Liability for not less than $2,000,000 aggregate.
   c. Fire Damage, and Extended Coverage, Vandalism and Malicious Mischief, in the full amount of Contract.
2. The above policies shall be carried with companies satisfactory to the Owner.
3. 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.

F. 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.

G. 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.

1. 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.
2. The supervisory personnel for the TAB firm shall be registered engineers in the mechanical field and all of the employees used in the TAB firm shall be permanent, full-time employees of the firm.

1.4 RELATED REQUIREMENTS

A. Section 01 91 00 - General Commissioning Requirements.
B. Section 23 00 00 - UTSW Mechanical Design Requirements.
C. Section 23 05 93 - Testing, Adjusting, and Balancing.
D. Section 23 08 00 - Commissioning of HVAC Systems.
E. Section 23 36 00 - Air Terminal Devices.

1.5 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. AABC (NSTSB) - National Standards for Total System Balance, seventh edition, 2007.
C. ASHRAE 90.1 - HVAC Applications Chapter 37: Testing, Adjusting and Balancing.

1.6 DOCUMENTS

A. The Owner or Owner's Representative shall arrange with the Architect to provide one set of mechanical specifications, all pertinent change orders, and the following:
    1. One complete set of Digital Drawings less the structural sheets.
    2. One digital set of mechanical floor plans of the conditioned spaces
B. Approved submittal data on equipment installed, and related changes as required to accomplish the test procedures outlined in this Specification will be available through the Owner's Representative.

1.7 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.
B. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents.
C. 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 Standard 2016, Seventh Edition.
D. 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 Firm:
        a. During the early design stages of the project, review the mechanical drawings and specifications for balance-ability and provide commentary.
        b. During construction, review all HVAC submittals such as control diagrams, air handling devices, etc , that pertain to commissioning work and balance-ability.
        c. Allow for a fixed number of trips to the project site, over and above those required for testing and balancing for inspection of installation of the mechanical piping systems, sheet metal work, temperature controls and other component parts of the heating, air conditioning and ventilating systems during the construction stage.
        d. These inspections shall be made prior to and/or at the above ceiling inspection Commentary will be provided to the Owner's Representative of each observation.
        e. Test one (1) 8 inch single duct terminal box for performance capability and leakage as described in Section 23 36 00 - Air Terminal Devices. The shipment of the box to the TAB Firm's lab will be at the manufacturer's cost and the test period will be for 3 weeks from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason, the subsequent testing will be at the Contractor's cost and the time allowed will restart when the box is received at the TAB Firm.
        f. Test one (1) 8 inch dual duct box for performance capability and leakage as described in Section 23 36 00 - Air Terminal Devices. The shipment of the box to the TAB Firm's lab will be at the manufacturer's cost and the test period will be for 3 weeks from receipt of the box. Submittal data will not be approved until box testing passes. If the sample box is rejected for any reason, the subsequent testing will be at the Contractor's cost and the time allowed will restart when the box is received at the TAB Firm.
        g. Test 10 percent of the single and dual duct boxes for casing and damper leakage when the shipment arrives at the project site.

1) All testing (except for the initial boxes) shall be performed on site.
2) Boxes requiring re-testing will be charged to the Contractor at the unit price provided to the Owner.

h. Test one (1) lab configuration including fume hood with air valve, general exhaust air with air valve and supply air with air valve for performance capability through a full range of inlet pressures

i. The tracking capability of the exhaust air versus the supply air will be with the submitted hood sash fully open and as the sash is closed in 2 inch increments until fully closed.

j. Track the three (3) valve`s response time in relation to sash movement and the lab differential.

k. Attend Commissioning meetings, as required, to support UTSW during all HVAC Commissioning phases.

2. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the Owner's Representative shall be advised in writing so that the condition can be corrected by the Contractor.
   a. The written document need not be formal, but must be understandable and legible.
   b. Data from malfunctioning equipment shall not be recorded in the final TAB report.
   c. 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.

1.8 FINAL AIR BALANCE

A. General: When systems are complete and ready for operation, the TAB firm will perform a final air balance for all air systems and record the results.

B. 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 plus or minus 5 percent of the value shown on the drawings.

C. Air handling unit and fan volumes shall be adjusted by changing fan speed and adjusting volume dampers associated with the unit.

D. 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.

E. Air distribution devices shall be balanced with air patterns as specified.

F. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are shown.

G. 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:
      a. 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.
      b. 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.
      c. 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:
      a. Set controls for full cooling and for full heating loads.
      b. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil and HVAC terminal unit.
      c. 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:

a. Adjust each exhaust inlet and supply diffuser, register and grille to within plus or minus 5 percent of design air CFM.
b. Include all terminal points of air supply and all points of exhaust.

9. Pitot Tube Traverses:
a. 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.
b. Locations of these traverse test stations shall be described on the sheet containing the data.

10. Maximum and minimum air flow on terminal boxes.

1.9 FINAL CHILLED 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.

B. The general scope of balancing by the TAB Consultant will include, but not be limited to, the following:

1. Adjusted System Tests:
a. Adjust balancing valves at each coil for design flow, plus or minus 5 percent. Adjust balancing valves at pumps to obtain design water flow.
b. 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:
a. Read and record entering and leaving water temperature at each water coil.
b. Adjust as necessary to secure design and conditions.
c. Provide final readings at all thermometer well locations.

3. Pressure Readings:
a. Water pressure shall be recorded at all gauge connections.
b. 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.
c. 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.
d. For coils equipped with 3 way valves, the rated pressure drop shall first be adjusted through the coils.
e. 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.

1.10 SOUND AND VIBRATION

A. Sound:

1. Read and record sound levels at up to 15 locations in the building designated by the Engineer.
2. All measurements shall be made using an Octave Band Analyzer.
3. All tests shall be conducted when the building is quiet in the presence of the Engineer, if they so desires.

B. Vibration:

1. Witness vibration testing as specified in other sections. Provide test results to UTSW Representative.
2. Readings will be made using portable IRD (or approved equal) equipment capable of filtering out various unwanted frequencies and standard reporting forms.
3. Maximum vibration at any point listed above, or specified, shall not exceed 1 mil on fans and 1 mil on pumps unless otherwise specified.
4. Equipment manufacturers shall rectify all systems exceeding vibration tolerances.

1.11 TESTING OF TEMPERATURE CONTROL SYSTEMS

A. In the process of performing the TAB work, the TAB Firm 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 space 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 Firm.
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 setpoints 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. Each system will be tested in accordance with written control sequence verification procedures.
2. The written control sequence verification will document the performance of the specified control sequence and the control manufacturers as built drawings.
3. The written control sequence verification will identify each components sequence, safety devices and alarms.

C. List all the control points of each system Verify back to the front end graphics that the point is calibrated and the graphics indicate a change in value with the correct point name.

1.12 REPORTS

A. The activities described in this section shall culminate in a report to be provided in an electronic report to the Owner's representative. Comply with requirements in Section 01 77 00 - Closeout Procedures and Submittals.
1. Neatly type and arrange data.
2. 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.
3. Record all failures and corrective action taken to remedy incorrect situation.
4. The intent of the final report is to provide a reference of actual operating conditions for the Owner`s operations personnel.
5. The report will be organized in the following manner:
   a. Title Sheet.
   b. Table of Contents (Per system).
   c. AHU Data (Numerical sequence).
   d. Air Distribution Data, Traverse Data, All Supporting Data, etc.
   e. FCU, CRAC, etc. with supporting data.
   f. Fan Data with supporting data.
   g. Chilled Water System Data (Heat Transfer Equip., Pumps, etc.).
   h. Heating Water System Data (Heat Transfer Equip., Pumps, etc.).
   i. Control Verification (Sequences, Sensor Calibration, Point to Point, Graphics, etc).
   j. 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.
   k. At the option of the Owner’s Representative, all data sheets tabulated each day by TAB personnel shall be submitted for initial by the Owner’s Representative Those work sheets so initialed, or copies thereof, shall be presented as a supplement to the final TAB report.

B. Submit reports in electronic 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. 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.

7. 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.
8. 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.
9. 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.
10. Heating Coil Data:
    a. Identification/number.
    b. Location.
    c. Service.
    d. Manufacturer.
    e. Air flow, design and actual.
    f. Entering water or steam temperature, design and actual.
    g. Entering air temperature, design and actual.
    h. Leaving air temperature, design and actual.
    i. Air pressure drop, design and actual.
11. 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.
12. 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. Alarms.
    f. Sequences of Operation.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 23 05 94

SECTION 23 07 13

DUCTWORK INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Ductwork insulation.

B. Insulation jackets.

1.3 RELATED REQUIREMENTS

A. Section 09 91 23 - Interior Painting.

B. Section 23 00 00 - UTSW Mechanical Design Requirements.

C. Section 23 31 00 - Ductwork.

D. Section 23 33 00 - Ductwork Accessories.

1.4 REFERENCE STANDARDS

A. ASHRAE 90.1 - Energy Standards for Buildings Except Low-Rise Residential Buildings.

B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

D. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

E. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.

H. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

J. Texas Government Code Chapter 2252.001-005 - Texas Government Code Chapter 2252.001-005.

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Product Data: Provide product description, list of materials and thickness for each service, and locations.

C. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

D. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 QUALITY ASSURANCE

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

1.7 QUALIFICATIONS

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

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic. In no instance shall ductwork insulation be stored outdoors or where subject to moisture damage.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.9 ENVIRONMENTAL REQUIREMENTS

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

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

PART 2 - PRODUCTS

2.1 INSULATION A - GLASS FIBER SEMI-RIGID INSULATION

A. Three pound per cubic foot minimum density glass fiber semi-rigid board insulation with fiber perpendicular to the surface and with factory applied white foil reinforced vapor barrier jacket (ASJ). Insulation shall be equal to E.O. Woods Company "Rigid-Wrap".

B. The insulation shall be secured to the ducts with mechanical fasteners; "Stick-clips", Graham Pins or Speed Clips, and shall be spaced approximately 12 inches on center on bottom of duct and where required elsewhere to hold insulation securely against the duct per the Insulation Manufacturer recommendations. Stick pins welded to ductwork are not acceptable.

1. Insulation on the bottom of duct and on vertical sections shall be coated with an adhesive and pushed firmly against the ductwork as well as being secured with mechanical fasteners. Adhesives shall be approved by the insulation manufacturer for use with the insulation and shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. After insulation is in place, all joints and seams shall be sealed with Foster 30-90 white vapor barrier mastic (water based) applied over a 3 inches wide strip of Duramesh Glass Fabric. All protrusions through the vapor barrier shall be thoroughly sealed.

D. On ducts that are reinforced with standing seams or angle iron stiffeners 1 inch and over in height, the Contractor shall apply a strip of fiberglass board 1 inch thick by 6 inches wide, sealing same to the other insulation with mastic.

2.2 INSULATION B - GLASS FIBER RIGID BOARD INSULATION

A. Three pound per cubic foot minimum density glass fiber rigid board insulation with factory applied white foil reinforced All Service Jacket (ASJ).

B. Insulation B shall be applied as specified for Insulation A.

C. Contractor at option may substitute Insulation A where Insulation B is called for.

2.3 INSULATION C - GLASS FIBER BLANKET INSULATION

A. Blanket insulation with a thermal conductivity (K) of 0.27 or less similar in construction to Owens-Corning Fiberglass Series one pound per cubic foot minimum density with foil reinforced Kraft (FRK) vapor barrier facing. Insulation shall be applied flat on the ductwork with all circumferential joints butted. longitudinal joints overlapped a minimum of 2 inches and per manufacturer’s recommendations. Adhere insulation to metal with 4 inches strips of insulation bonding adhesive at 8 inches on center. On circumferential and longitudinal joints, the 2 inch flange of the facing shall be secured using 9/16 inch flare door staples applied 6 inches on center and taped with 4 inch wide fiberglass tape embedded in Foster 30-90 white vapor barrier Emulsion and covered with Foster 30-90 white vapor barrier Emulsion until the tape is completely covered. All pin penetrations or punctures in facing shall also be taped.

2.4 PROTECTIVE JACKETING

A. Jacketing and fitting covers shall be 0.016 inches aluminum smooth as manufactured by Premetco or Childers. The jacket shall be pre-cut, pre-rolled and lapped a minimum of 2 inches in all directions to shed water. The metal shall be secured at each joint with a minimum of one each 3/4 inch wide 0.020 inch aluminum or stainless steel band and seal. The metal jacketing and fitting covers shall be fabricated of 0.016 inch aluminum or stainless steel with a smooth finish.

2.5 SCOPE OF DUCT INSULATION

A. All ductwork in the building and in the crawl spaces except toilet exhaust and fume hood exhaust ducts shall be insulated externally unless specifically excluded. Only sound attenuated return ducting may be insulated internally, if specifically designated as such. Refer to Section 23 33 00 - Ductwork Accessories for duct liner specifications.

B. Where ducts are lined internally, (see Drawings for Scope) no exterior insulation will be required, except where specifically stated otherwise. Where internal and external insulation join, they shall lap at least 24 inches.

C. Low pressure supply duct taps to ceiling diffusers shall be externally insulated including top of ceiling diffuser with 2 inches Insulation C.

D. Flexible round ducts are specified in Section 23 31 00 - Ductwork as factory insulated.

E. All kitchen hood exhaust ductwork connected to both inlet and discharge sides of Fans shall be insulated.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 INSTALLATION

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

B. Insulated ductwork conveying air below ambient temperature:

1. Finish with tape and vapor barrier jacket.
2. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
3. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Insulated ductwork conveying air above ambient temperature:

1. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

D. For ductwork exposed in mechanical equipment rooms or in finished spaces, finish with aluminum jacket.

E. For exterior applications, provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.

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

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

H. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least 3 inches. Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the duct has been successfully leak tested. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable.

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

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

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

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

3.3 TOLERANCE

A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 DUCT INSULATION SCHEDULE

Duct Type	Duct Location	Insulation Type	Insulation Thickness (inches)	R Value	Jacketing
Medium pressure supply ductwork	Concealed, Conditioned and plenum	C	2.2	6.0	ASJ
Low pressure supply ductwork	Concealed	C	2.2	6.0	ASJ
Return air ductwork		C	2.2	6.0	ASJ
Supply diffuser housing / plenum		C	1.5	4.2	ASJ

END OF SECTION 23 07 13

SECTION 23 07 19

PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.3 RELATED REQUIREMENTS

A. Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Section 23 05 29 - Supports and Anchors.

C. Section 23 05 53 - Mechanical Identification.

D. Section 23 20 10 - Piping, Valves, and Fittings.

E. Section 23 21 13 - Hydronic Piping

1.4 REFERENCE STANDARDS

A. ASHRAE 90.1 - Energy Standards for Buildings Except Low-Rise Residential Buildings.

B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

C. ASTM C165 - Standard Test Method for Measuring Compressive Properties of Thermal Insulations.

D. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

E. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

F. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

G. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

H. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

I. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

J. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.

K. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.

L. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

M. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

N. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.

O. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

P. ASTM C1695 - Standard Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service.

Q. ASTM C1775 - Standard Specification for Laminate Protective Jacket and Tape for Use Over Thermal Insulation for Outdoor Applications.

R. ASTM D1056 - Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.

S. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.

T. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

U. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials.

V. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C.

W. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

X. Texas Government Code Chapter 2252.001-005 - Texas Government Code Chapter 2252.001-005.

Y. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

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

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

D. Manufacturer’s Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

E. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 QUALITY ASSURANCE

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

B. All surfaces to be insulated shall be clean and dry before applying the insulation. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least 3 inches. Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. Piping, flexible connections, flanges, valves, strainers, and unions shall be covered unless specifically noted otherwise. Flexible connections on duct shall not be covered. All materials used shall be fire retardant or nonflammable. Refer to Section 23 00 00 - UTSW Mechanical Design Requirements.

C. All piping shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

D. To be considered, alternate materials shall have equivalent thermal and moisture resistance of the specified materials.

1.7 QUALIFICATIONS

A. The company performing the work of this section shall have a minimum of three years’ experience specializing in the trade.

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

C. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned.

D. Unsightly, inadequate, or sloppy work will not be acceptable, and all such work shall be removed and replaced as many times as necessary to achieve an acceptable installation.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

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

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

1.9 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.
C. All insulation materials to be asbestos free.

PART 2 - PRODUCTS

2.1 TYPE A: CALCIUM SILICATE

A. Manufacturers:
   1. Johns Manville Corporation.
   2. Substitutions: See Section 01 60 00 - Product Requirements.
B. Insulation:
   1. Manville Thermo-12 or equal calcium silicate sectional piping insulation with a “K” factor of 0.40 BTU-In/Hr.- degree F at 100°F and 0.50 BTU-In/Hr.-degree F at 400°.
   2. Rated maximum service temperature of 1200°F (650°C).
   3. Maximum density of 15 lbs/ft³.
   4. Compressive strength of 100 psi minimum when tested in accordance with ASTM C165.
   5. Rated as 0 flame spread and 0 smoke developed when tested in accordance with ASTM E84, UL 723, NFPA 255.
   6. Certified to meet the requirements of ASTM C795 for use over stainless steel.
   7. Rated as noncombustible when tested in accordance with ASTM E136.
   8. Effective corrosion inhibitor is equal to or better then DI water standard.
   9. Install product using manufacturer’s recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.
   10. Installation:
      a. Joints shall be sealed with aluminum snap straps provided, fastened in place with 3/4 inch wide x 0.020 inch stainless steel bands. Fittings and valves shall be insulated with the same thickness as that applied to the adjacent pipe and shall have an outer removable covering of aluminum.
      b. Pipe insulation shall be firmly wired in place by the use of no less than six (6) loops of No. 16 annealed copper clad iron wire per three foot section of insulation. These sections shall be staggered. The ends of these loops shall be twisted together tightly and bent over and hammered into the insulation so as to leave no projection. Bands shall be 0.020 inch thick, 3/4 inch wide, 3 bands per section of insulation. Fittings, valves, etc., shall have bands on each side.
      c. All fittings on pipe 4 inch and larger shall be covered with the same material as the pipe, mitered and smoothed, and securely wired to the pipe.
      d. Fittings and valves for pipe smaller than 4 inches shall be insulated with Calcoat-127 insulating finishing cement and each application shall be in layers not thicker than 1/2 inch. Each layer shall be allowed to dry before the next layer is applied.
      e. All cracks and voids in this insulation shall be filled carefully with Calcoat-127 insulating finishing cement so that the resulting surface is smooth and continuous.
      f. At all pipe flanges, the insulation shall be beveled in such a manner that access may be had to the bolt studs and nuts without injuring the insulation where removable covers have been specified.
      g. A layer of 40 pound rosin-size paper or 3/4 pound deadening felt shall be wrapped around the insulation before an 8 ounce canvas jacket is pasted in place. This canvas jacket shall be pasted onto the covered pipe valves and fittings (where insulated) in a neat and workmanlike fashion, using adhesive.
      h. All flanges, valves, pressure regulating valves, strainers, and any other hot surfaces shall be covered with a built-up removable covering made of Thermo-12 Pipe Covering with a finishing coat of Calcoat-127 insulating finishing cement. This removable covering shall be banded on the valve or joint in such a fashion that it can readily be removed and replaced; it shall be of the same thickness as the insulation on the adjoining pipe.
      i. Piping insulated with calcium silicate pipe insulation and finished with canvas outer jacket shall be painted in accordance with campus paint scheme.

2.2 TYPE B: CELLULAR GLASS THERMAL INSULATION

A. Manufacturers:
   1. Owens Corning Corporation.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation:
   1. Foamglas One Insulation with a “K” factor of 0.29 BTU-In/Hr.-degree F at 75°F 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 C552 Type II, furnished in half sections up to 36 inches long or segments 18 inches long.
   2. Rated maximum service temperature of 900°F.
   3. Maximum density of 7.3 lbs/ft³.
   4. Compressive strength of 90 psi minimum when tested in accordance with ASTM C165.
   5. Rated as 0 flame spread and 0 smoke developed when tested in accordance with ASTM E84, UL 723, NFPA 255.
   6. Certified to meet the requirements of ASTM C795 for use over stainless steel.
   7. Rated as noncombustible when tested in accordance with ASTM E136.
   8. Install product using manufacturer’s recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.
   9. Installation:
      a. Prior to application of any insulation, all metal surfaces shall be thoroughly cleaned.
      b. The metal shall then be primed with an asphaltic primer consisting of one (1) coat of Foster No. 60-26 Primer or Pittcote 300 Primer. Cleaning and priming specified in this paragraph is not included in requirements for “Cleaning and Painting” specified in other sections of the Specifications.
      c. Regular Foamglas or phenolic foam insulation shall be applied to the piping with butt joints staggered and all joints tightly butted and sealed with a 1/4 inch bead of joint sealer 1/2 inch from outside edge. Hold in place with 14 gauge copper clad wire 9 inches o.c. After insulation has been wired in place, a 1/16 inch minimum thick, 3 inch wide band of asphaltic vapor seal mastic shall be brushed or troweled on the outside of the Foamglas or phenolic foam insulation at the approximate location of the aluminum bands. (Note that the asphaltic material specified in this paragraph is intended to be an exception to the flame spread and smoke generation limitations found elsewhere in this specification.) An aluminum jacketing 0.016 inch thickness equal to Gasco, Papco RPR Metals, or other precast, pre rolled Z-lock Kraft paper lined pipe covering with zee type closure and 3/4 inch wide snap straps with permanent sealant shall then be fitted to O.D. of insulation and applied over the insulated pipe with 3 inch end and side caps secured with aluminum bands on 12 inch centers. Longitudinal joint of aluminum jacketing shall be placed with overlap directed to bottom of pipe. Any voids in the completed installation of the insulation shall not be filled with vapor seal coating but shall be eliminated by refitting or replacing insulation.
      d. Foamglas or phenolic foam insulation on flanges, valves and other fitting shall consist of prefabricated fitting covers of the same thickness as specified for adjoining pipe insulation.
      e. Fitting covers shall be applied in same manner as pipe application except that 16 gauge aluminum wire may be used to secure screwed fitting covers. Protruding metal parts (such as valve stems) shall be completely sealed off. Fitting cover jacketing shall be equal to Gasco, Papco or RPR Metals prefabricated fitting covers of 0.016 inch paper coated aluminum, secured as recommended by the manufacturer.
      f. The insulation thickness shall be as scheduled.
      g. Fitting covers shall be built up of shaped segments of Foamglas or phenolic foam. These fitting covers shall be adhered in place using “Foster No. 30-35 water based vapor seals, then smoothly covered by a 1/4 inch thick application of one coat white insulating cement. All this piping and fittings shall be finished with an eight ounce canvas jacket neatly applied using adhesive.
      h. Valves, fittings, etc., in congested areas around coil and heat exchanger equipment, etc., shall be insulated by building up fitting segments and pre-molded sections, plus white vapor seal mastic, plus Manville Calcoat-127 insulating finishing cement to smooth surfaces, plus canvas applied and sized for painting with fire resistant adhesive. In addition, all manufactured vapor

barrier jacketing in mechanical rooms and finished spaces shall be finished with canvas applied and sized for painting with fire resistant adhesive.

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

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

k. All insulation joints (longitudinal and butt) shall be buttered with vapor sealant mastic then pressed firmly together.

2.3 TYPE C: PHENOLIC FOAM

A. Manufacturers:

1. Johns Manville.
2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation:

1. Phenolic Foam by ITW Trymer or equal with a “K” factor of 0.19 BTU-In/Hr.-degree F at 75°F.
2. Rated maximum service temperature of 257°F.
3. Maximum density of 3.75 lbs/ft³
4. Compressive strength of 45 psi minimum when tested in accordance with ASTM C165.
5. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84 , UL 723, NFPA 255.
6. Certified to meet the requirements of ASTM C795 for use over stainless steel.
7. Rated as noncombustible when tested in accordance with ASTM E136.
8. Install product using manufacturer’s recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.
9. Installation: As Type B, above.

2.4 TYPE D: FIBERGLASS

A. Manufacturers:

1. CertainTeed Corporation
2. Johns Manville Corporation
3. Knauf Insulation
4. Owens Corning Corporation
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation:

1. Owens Corning or equal glass fiber insulation piping insulation with a “K” factor of 0.23 BTU-In/Hr.-degree F at 75°F and 0.32 BTU-In/Hr.-degree F at 250°
2. Rated maximum service temperature of 850°F.
3. Maximum density of 3.5-5.5 lbs/ft³.
4. Compressive strength of 28.5 psi minimum when tested in accordance with ASTM C165.
5. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, NFPA 255.
6. Certified to meet the requirements of ASTM C795 for use over stainless steel.
7. Rated as noncombustible when tested in accordance with ASTM E136.
8. Insulation treated with water resistant resin on the surface and within each layer of the insulation.
9. Install product using manufacturer’s recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.

2.5 TYPE E: CLOSED CELL ELASTOMERIC

A. Manufacturers:

1. Armacell.
2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation:

1. Closed cell elastomeric piping insulation with a “K” factor of 0.25 BTU-In/Hr.-degree F at 75 F as manufactured by Armacell or equal.
2. Rated maximum service temperature of 220°F.

3. Rated as 25 flame spread and 50 smoke developed when tested in accordance with ASTM E84, UL 723, NFPA 255.
4. Certified to meet the requirements of ASTM C795 for use over stainless steel.
5. Rated as noncombustible when tested in accordance with ASTM E136.
6. Elastomeric products shall be supplied in a pre-slit tubular form with a pressure sensitive adhesive system for closure and vapor sealing of the longitudinal joint.
7. Install product using manufacturer's recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.

2.6 TYPE F: HIGH TEMPERATURE FIBERGLASS

A. Manufacturers:
1. Eslin.
2. Knauf Insulation.
3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation:
1. ESLIN EG-SCUI or equal glass fiber insulation piping insulation with a "K" factor of 0.30 BTU-In/Hr.-degree F at 200°F and 0.48 BTU-In/Hr.-degree F at 600°.
2. Rated maximum service temperature of 1200°F (650°C).
3. Maximum density of 12.5 lbs/ft³
4. Compressive strength of 28.5 psi minimum when tested in accordance with ASTM C165.
5. Rated as 0 flame spread and 0 smoke developed when tested in accordance with ASTM E84, UL 723, NFPA 255.
6. Certified to meet the requirements of ASTM C795 for use over stainless steel.
7. Rated as noncombustible when tested in accordance with ASTM E136.
8. Insulation treated with water resistant resin on the surface and within each layer of the insulation.
9. Install product using manufacturer's recommended methods and accessories unless alternate methods are specified in Part 3 – Installation (General) or in this section.

2.7 SILICA AEROGEL

A. Manufacturers:
1. Aspen Aerogels Pyrogel XT-E.
2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation shall be a high-temperature, flexible, hydrophobic insulation blanket formed of silica aerogel and reinforced with a non-woven, glass-fiber batting. Insulation shall be provided in blanket form for wrapping of straight pipe sections, equipment, and tanks. Prefabricated insulation sections shall be provided for piping elbows. Insulation shall be available in 0.20 inch and 0.40 inch thickness.
1. Insulation shall be the following performance requirements:
a. Thermal Conductivity:
1) 0.14 Btu-in/hr-ft²-°F at 32°F
2) 0.16 Btu-in/hr-ft²-°F at 212°F
3) 0.19 Btu-in/hr-ft²-°F at 392°F
b. Flame Spread: ≤ 5
c. Smoke Production: ≤ 10
d. Average Density: 12.5 lb/ft³
e. Maximum Temperature: 1,200 °F
f. Compressive Strength: 14.8 lb/in² (Stress at 10 percent strain).
2. Insulation shall be secured to pipe using bands per Manufacturer's recommendations.

2.8 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

A. Manufacturers:
1. Auburn Manufacturing Inc; Ever Green Cut 'n Wrap.
2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: ASTM C553 Type V; flexible, noncombustible.
1. Comply with ASTM C1695.
2. K (Ksi) Value: 0.37 at 100 degrees F (0.053 at 38 degrees C), when tested in accordance with ASTM C177 or ASTM C518.
3. Minimum Service Temperature: 32 degrees F (0 degrees C).

4. Maximum Service Temperature: 500 degrees F (260 degrees C).
5. Maximum Water Vapor Absorption: 5.0 percent by weight.
6. Color: Gray, Green.
7. Weight: 7.65 oz/sq ft (2334.4 g/sq m).
8. Effective Thickness: 1.25 +/- 0.25 inch (0.032 +/- 0.0064 m).

2.9 PROTECTIVE JACKETING

A. General:
1. All jacketing shall be installed with the seam located along the bottom.
2. At valves and special fittings, provide removable jackets to nearest flange in both direction for maintenance and removal of fittings.

B. Aluminum Jacketing and fitting covers: 0.016 aluminum smooth . The jacket shall be pre-cut, pre-rolled, and lapped a minimum of 2 inches in all directions to shed water. The metal shall be secured at each joint with a minimum of one each (1 ea.)
1. Manufacturers:
a. Gasco.
b. Papco RPR Metals.
c. Childers.
d. Substitutions: See Section 01 60 00 - Product Requirements.
2. 3/4 inch wide 0.020 aluminum or stainless steel band and seal. The metal jacketing and fitting covers shall be fabricated of 0.016 inch aluminum or stainless steel with a smooth finish.

C. Aluminum-Foil Laminate Jacket:
1. Manufacturers:
a. H.B. Fuller Construction Products, Inc; Foster - Vapor-Fas.
b. Ideal Tape Co., Inc; _____.
c. Substitutions: See Section 01 60 00 - Product Requirements.
2. Finish: Aluminum smooth.
3. Comply with ASTM C1775.

D. PVC Jacketing:
1. Manufacturers:
a. Johns Manville Corporation; _____.
b. Substitutions: See Section 01 60 00 - Product Requirements.
2. PVC jacketing and fitting covers.
a. Material shall have 25/50 rating and shall be limited to piping systems operating at 140 degrees or below.
b. Thickness: 10 mil, 0.010 inch (0.25 mm).
3. PVC color jacketing is required on all piping and shall match color requirements in Section 23 05 53 - Mechanical Identification.

E. Stainless Steel Jacket: ASTM A666, Type 304 stainless steel.
1. Thickness: 0.010 inch (0.25 mm).
2. Finish: Smooth.
3. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

2.10 INSULATED UNDERGROUND PIPING

A. See Section 23 20 10 - Piping, Valves, and Fittings.

PART 3 - INSTALLATION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer’s instructions in the absence of specific instruction herein.
B. On exposed piping, locate insulation and cover seams in least visible locations, but not higher than at the side of the pipe at the “90°” position, with the seam lapped such that the lap is directed down.
C. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.

D. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory applied, or field applied.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
   3. Finish with glass cloth and vapor barrier adhesive.
   4. Continue insulation through walls, sleevs, pipe hangers, and other pipe penetrations.
   5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. For insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
   3. If PVC fitting covers are used they shall have 25/50 rating.
   4. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
   5. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions, including those at equipment, but label the insulation to indicate a concealed flange or union.

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

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

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

3.3 INSTALLATION OF SILICA AEROGEL INSULATION

A. Follow the manufacturer’s installation guidelines where they differ from the following directions.

B. Install insulation in the longest sections feasible to reduce the quantity of circumferential joints.

C. Install multiple layers of installation to achieve the specified thickness by wrapping the pipe multiple times. Overlap circumferential joints for lower layers of insulation with the following layer a minimum of 6 inches. Avoid placing longitudinal joints of multiple layers at the same circumferential location.

D. Cover pipe elbows using pre-fabricated “gore-style” insulation fittings.

E. Follow manufacturer’s detailed instructions for the installation over pipe ends, reducers, tees, piping shoes, valves, and flanges.

F. Secure insulation in place with metal banding before installing finished jacketing.

3.4 INSERTS, SUPPORTS AND SHIELDS

A. Application: Piping 3/4 inch diameter or larger for all systems except direct buried.

B. Shields: Install between pipe hangers or pipe hanger rolls and inserts. Hangers shall be on the outside of the insulation and shall not be in contact with the pipe. Shields shall be installed at all locations of support. Curved metal shields shall be used between the hangers or support points and the bottom of the insulated pipe for insulated pipes 3/4 inch and larger. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi and shall be curved to fit up to mid-perimeter of the insulated pipe. Shields shall be made of galvanized iron, or black iron painted on both sides with two coats of aluminum paint. Required metal shield sizes are as follows:

Nominal IPS (inches)	Metal Thickness of Shield	Lengths (inches)
up thru 2	14 gauge	12
thru 6	12 gauge	16
and above	10 gauge	20

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

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

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

F. The shields at support points shall be secured with 1/2 x 0.016 inch stainless steel bands and seals.

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

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

1. At the pipe support positions, the insulation and vapor barrier shall be continuous and shall not be punctured by the support. The insulation at the support shall be the full circumference of 5lbs/ft3 phenolic foam material to withstand the bearing loads transmitted from the pipe to the support; it shall extend for at least 1 inch on either side of the support to allow sealing of the joints with the pipe insulation jacket.
2. The load bearing insulation at the support shall be capable of withstanding the maximum static compressive loads generated by pipe supported at the centers shown in Table Variations: Pipe loads greater than those generated at the support centers shown in Table 1 shall be referred to the manufacturer to establish the length and density of the insulated support block. The support centers are based on the weight of Sch 80 pipe filled with water and covered with 1inch thickness of 2.2 lbs/ft3 standard insulation including FSK/ASJ vapor barrier.
3. Table 1: K Block Support Centers

Nominal Pipe Size (Inches)	3/4	1	1-1/4	2	2-1/2	3	4	6	8	10	12	14	16	18	20	24
Max support centers (feet) Sch 80 pipe filled with water covered with 1 inch of Standard Insulation	6.5	6.5	6.5	10	10	10	10	10	14	14	14	20	20	20	20	20
Metal Saddle Gauge (Galvanized Steel)	22	22	22	20	20	20	16	14	14	14	14	14	14	14	14	14
Length of HLB Block (inches)	6	6	6	6	6	6	6	9	9	9	9	9	9	12	12	12

4. The Insulation at supports shall be Foamglas HLB Blocks. HLB Blocks shall be faced with factory applied FSK/ASJ vapor barrier and fitted with a galvanized steel 1800 saddle bonded to the bottom section of the HLB Block, for all pipe sizes 1 1/2 inch and larger.
5. The vapor barrier shall be completed by the use of a FSK/ASJ overlap and factory applied self-seal lap tape and sealed with vapor barrier adhesive.
6. At all support positions, other than those where the insulated pipe support block is surrounded by a clip or saddle in direct contact with the block, a block designed to accept the loads generated by the pipe shall be presented to the engineer for approval.
7. In all cases where roller supports are used the length of the insulation and the wearing plate where fitted shall extend beyond the limits of the pipe movement.

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

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

K. Insulation minimum thickness shall be as scheduled; however, additional thickness shall be provided to prevent condensation on the cold surfaces and to provide a maximum exterior insulation surface of 140 degrees F on the hot surfaces.

L. Special Protection: All insulated piping in the mechanical rooms within 8’-0” of the floor shall be encased in a protective jacket, and where applicable, finish at top with nickel-plated brass flange plate with set screws or end joint sealing butt strips.

3.5 PAINTING

A. Prepare exposed insulation receive painting in accordance with Section 09 91 23 - Interior Painting.

3.6 INSULATION APPLICATION SCHEDULE

A. All insulation R-Values shall be the greater of what is scheduled below or required to meet ASHRAE 90.1.

B. Where minimum scheduled thickness exceeds the thickness required to meet the minimum R-Value, provide the minimum scheduled thickness. Insulation Thickness depends upon insulation type used.

C. All insulation R-Values shall be the greater of what is scheduled above or required to meet ASHRAE 90.1.

D. Use the following jacket types: in concealed interior spaces: All Service Jacket; in interior mechanical spaces: Aluminum Jacket up to 8 feet above floor and All Service Jacket above 8 feet above floor; in tunnel and exterior spaces: Aluminum Jacket.

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

F. A minus 15 percent tolerance on the insulation performance listed shall be permitted for manufacturers' standard insulation systems.

3.7 PIPING INSULATION SCHEDULE

A. Insulation thickness for underground piping systems: See Section 33 60 00.

B. Steam and Steam Condensate:

1. Indoors and in vaults: Minimum Insulation shall be one of the following:
    a. Pipe sizes 2 inch and smaller: Cellular glass: 3 inches thick.
    b. Pipe sizes 2.5 inch to 4 inch: Cellular glass: 4 inches thick.
2. Equipment and accessories:
    a. All valves and flanges: Removable insulation jacket.
    b. Steam trap stations: Removable insulation jacket.
        1) Substitutions: See Section 01 60 00 - Product Requirements.
        2) Steam trap stations shall be insulated from the upstream side of the shutoff valve immediately upstream of the steam trap to the downstream side of the shutoff valve immediately downstream of the steam trap station. All components in the steam trap station shall be insulated with one continuous insulation blanket. Strainer blowdown drains and trap drain test ports shall be stubbed through the

C. Chilled Water

1. Indoors and in vaults: Minimum Insulation shall be one of the following:
    a. Pipe sizes 2.5 inch and smaller: Cellular glass: 2 inches thick.
    b. Pipe sizes over 2.5 inch: Cellular glass: 2.5 inches thick.
2. Equipment and accessories:
    a. All valves and flanges: Removable insulation jacket.

D. Hot Water

1. Indoors and in vaults: Minimum Insulation shall be one of the following:
    a. Pipe sizes 2.5 inch and smaller: Cellular glass: 2 inches thick.
    b. Pipe sizes over 2.5 inch: Cellular glass: 2.5 inches thick.
2. Concealed or plenum spaces: Minimum insulation shall be one of the following:
    a. Pipe sizes 2.5 inch and smaller: Fiberglass: 2 inches thick.
    b. Pipe sizes over 2.5 inch: Fiberglass: 2.5 inches thick.
3. Equipment and accessories:
    a. All valves and flanges: Removable insulation jacket.

E. Pumped Condensate:

1. Indoors and in vaults: Minimum Insulation shall be one of the following:
    a. Pipe sizes 2 inch and smaller: Cellular glass: 3 inches thick.
    b. Pipe sizes 2.5 inch to 4 inches: Cellular glass: 4 inches thick.
2. Equipment and accessories:
    a. All valves and flanges: Removable insulation jacket.
3. Coil Condensate Drain and City Water Make-up:
    a. For pipe sizes 1-1/2 inch and smaller"
        1) Interior: Fiberglass: 1/2 inch thick.
        2) Exterior: Cellular Glass Foam Insulation: 1/2 inch thick.
4. Chilled Water Pumps, Chilled Water Valves:
    a. All Foamed Plastic Equipment Insulation or Flexible Elastomeric Insulation: 1 inches thick.

3.8 INDOOR OR OUTDOOR, FIELD-APPLIED JACKET SCHEDULE:

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping:

1. Steam and Condensate:

a. Indoors:

1) Aluminum .016 inch thick.

END OF SECTION 23 07 19

SECTION 23 08 00

COMMISSIONING OF HVAC SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes commissioning process requirements for HVAC systems, assemblies, controls, and equipment.

B. This project will have selected building systems commissioned. The equipment and systems to be commissioned are specified in Section 01 91 00 - General Commissioning Requirements .

1.2 RELATED SECTIONS

A. Section 01 91 00 - General Commissioning Requirements.

B. Section 22 08 00 - Commissioning of Plumbing Systems.

C. Section 26 08 00 - Commissioning of Electrical Systems.

1.3 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements

1.4 DEFINITIONS

A. Refer to 01 91 00 - General Commissioning Requirements.

1.5 SUBMITTALS

A. Certificate Of Readiness, signed by the Contractor, certifying that systems, assemblies, equipment, components, and associated controls are ready for testing.

B. Manufacturer’s completed start-up reports for equipment and systems.

C. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 CONTRACTOR'S RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 - General Commissioning Requirements for details of HVAC contractor’s responsibilities related to commissioning.

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

C. Attend commissioning meetings.

D. Provide information requested by the CxA for functional testing and for final commissioning documentation.

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

F. Functional testing of systems will be carried out solely by Mechanical contractor’s personnel, under the direction of CxA. Provide experienced personnel, familiar with the systems being installed under this project.

1.7 COMMISSIONING AUTHORITY RESPONSIBILITIES

A. Reference Project Specification Section 01 91 00 - General Commissioning Requirements.

B. CxA will direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete. Review and comment on testing, adjusting, and balancing report.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Equipment Testing and Acceptance Procedures: Testing requirements are specified in Division 23 Sections. Provide submittals, test data, inspector record, and certification to the CxA.

B. Reference Project Specification Section 01 91 00 - General Commissioning Requirements for detailed requirements of commissioning of Mechanical systems.

C. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
D. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
E. Tests will be performed using design conditions whenever possible.

3.2 SYSTEM START-UP

A. Contractor is solely responsible for system start-up. CxA may, at his discretion, witness start up procedures, but will not perform any Functional Testing of systems until Contractor has completed start-up and resolved all operating deficiencies, and has so certified.

3.3 TESTING PREPARATION

A. Certify that HVAC and controls systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
B. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
C. Certify that testing, adjusting, and balancing procedures have been completed and submitted, discrepancies corrected, and corrective work approved.
D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
E. Inspect and verify the position of each device and interlock identified on checklists.
F. Check safety cutouts, alarms, and interlocks with life-safety systems during each mode of operation.
G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.4 FUNCTIONAL TESTING / GENERAL

A. Reference Project Specification Section 01 91 00 - General Commissioning Requirements for detailed requirements of commissioning of Mechanical systems.
B. Provide measuring instruments and logging devices to record test data as directed by the CxA.

3.5 CONTROLS TESTING

A. Submit to CxA all documentation and reports called for in Section 23 09 00 - Instrumentation and Control for HVAC.
    1. Verify communications interface with Central Data Acquisition System (CDAS).
    2. Verify communications interface with central operator station, all controllers on LAN, and remote communications devices, if applicable.
    3. Verify operation of web browser interface.
    4. Verify page navigation functions correctly.
    5. Verify BAS contractor has calibrated all analog sensors per specifications. Verify sensor accuracy and reasonableness.
    6. Verify correctness of graphics: schematics reflect actual installation, all specified all specified input and output points are displayed, spelling is correct, proper units (e.g., deg F, psi, etc.) are used, layout is logical and consistent, floor plans are accurate and identify locations of equipment, thermostats, etc.
    7. Verify auxiliary items (printers, screens, computers, etc.) are supplied and functioning.
    8. Verify operation of all input and output points, including all safeties, by forcing point, changing setpoints and observing reaction, etc.
    9. Verify correct operating sequences, including setpoints.
    10. Verify communications with / points display of Modbus and Bacnet controllers of stand-alone equipment items.
    11. Verify that equipment alarms register at BAS, and are stored in history log.
    12. Verify operation of all condensate drains.
B. Trend Logging:
    1. Set up historical trend logs to record data points from any and all systems as directed by CxA. The logging frequency and duration of logging will be set up as directed by CxA, and all logged data will be permanently stored, and transmitted to CxA at intervals as directed by CxA.

3.6 TESTING AND BALANCING VERIFICATION

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

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

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

1. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
2. Failure of an item (other than sound) includes a deviation of more than 10 percent from reported value, or other more stringent requirement if called for elsewhere in this project manual. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
3. Remedy the deficiency and notify CxA who will re-verify failed portions of test.

3.7 PIPING SYSTEMS

A. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Include sequence of testing and testing procedures, description of equipment for flushing operations, drawings for each pipe sector, showing the physical location of each designated pipe test section, minimum flushing water velocity, and chemical treatment plan.

3.8 DEFERRED TESTING

A. Initial commissioning will be done as soon as contract work is completed, though building may not be at full occupancy and equipment may not be at full loading.

B. If adequate load may be artificially placed upon heating or cooling equipment, CxA, at his discretion, may perform functional testing during non-peak load periods. If testing cannot be carried out under these conditions to adequately verify system performance, testing will be deferred until such time as conditions are more satisfactory.

1. Contractor is to provide services of personnel and participate in deferred or seasonal testing process in the same manner as he would in non-seasonal testing.
2. If tests cannot be completed because of a deficiency outside the scope of the Mechanical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

3.9 RE-TESTING

A. Reference Project Specification Section 01 91 00 - General Commissioning Requirements for detailed requirements of re-testing of Mechanical systems.

3.10 SYSTEMS TO BE COMMISSIONED

A. Reference Project Specification Section 01 91 00 - General Commissioning Requirements for list of Mechanical systems to be commissioned.

END OF SECTION 23 08 00

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. This Section includes control equipment for HVAC systems, components and other systems shown to be controlled by the Building Automation System (BAS), including, but not limited to, all computer software and hardware, controllers, sensors, transmission equipment, local panels, installation, engineering, supervision, commissioning, acceptance testing, training and warranty service necessary for a complete and working system.

1.3 RELATED REQUIREMENTS

A. Section 26 32 13 - Standby Power Generator Systems.

B. Section 26 33 53 - Uninterruptible Power Systems.

1.4 SCOPE OF WORK

A. The Contractor shall furnish and install a complete direct digital control (DDC) building automation system (BAS) including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as specified herein.

B. All components of the system – workstations, network controllers, local controllers, etc. shall communicate using a standard protocol, as defined by ASHRAE Standard 135-2001 and as specified herein.

1. Level 1 communication protocol shall be BACnet IP.
2. Level 2 communication protocol shall be BACnet IP, BACnet MS/TP Modbus IP or Modbus RTU, Ethernet IP.
3. Proprietary communications is allowed as an alternate based on the project with owner approval.
4. LON communication protocol is not acceptable at any level in the BAS system.

C. The BAS contractor shall review and study all HVAC drawings and the entire specification to become familiar with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.

D. All interlocking, wiring and installation of control devices associated with the equipment described in the sequence of operations, points list and control diagrams shall be provided under this Contract.

E. Provide services and manpower necessary for commissioning of system in coordination with the Commissioning Authority, HVAC Contractor, Testing and Balancing Contractor, Electrical Contractor and Owner's Representative. Refer to Section 23 08 00 - Commissioning of HVAC Systems.

F. All work performed under this section of the specifications will comply with all codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Controls Contractor shall obtain and pay for all necessary construction permits and licenses associated with this scope of work.

1.5 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. The control system components shall be new and in conformance with the following applicable standards for products specified:

1. American Society for Testing and Materials, ASTM.
2. Institute of Electrical and Electronic Engineers, IEEE.
3. National Electrical Manufacturers Association, NEMA.
4. Underwriters Laboratory, UL (UL 916 & 864).

5. FCC Regulation, Part 15, Section 156.
6. National Fire Protection Association, NFPA.
7. Local Building Codes.

1.6 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.

1.7 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for system architecture, operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, communication methods and operator interface equipment.
   2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications including all software licensing agreements.
   3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic control diagram.

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. Riser diagram of main network architecture depicting all controllers, workstations and associated network wiring.
   2. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   3. Schematic flow/control diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   4. Wiring Diagrams: Power, signal, and control wiring.
   5. Details of control panel faces, including controls, instruments, and labeling.
   6. Floor plans indicating control panel locations.
   7. Written description of sequence of operation.
   8. Schedule of dampers including size, leakage, and airflow characteristics.
   9. Schedule of valves including flow characteristics.

C. Schedule of airflow monitoring stations including airflow characteristics.
   1. DDC System Hardware:
      a. Wiring diagrams for control units with termination numbers.
      b. Schematic diagrams and floor plans for field sensors and control hardware.
      c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
   2. Control System Software: Graphics outline and “Print Page” examples of final product indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
   3. Controlled Systems:
      a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
      b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
      c. Written description of sequence of operation including schematic diagram.
      d. Points list.

D. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE Standard 135-2001 for each protocol.

E. Samples for Initial Selection: For each type of sensor cover with factory-applied color finishes.

F. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On CD, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.
5. Software license required by and installed for operator workstations and control systems.

G. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

H. Field quality-control test report forms.

I. Operation and Maintenance Data: Include emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

J. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Warranty: Controls Contractor shall guarantee all system components and installations to be free from defects for one (1) year from the date of acceptance as determined by the Owner. Any defects found during this period shall be repaired and/or replaced at no cost to the Owner. The Controls Contractor shall provide maximum of 24-hour response time for trouble calls or maintenance.

C. Upon completion of the installation, the Contractor shall thoroughly inspect, check, adjust, calibrate, and make ready for use all devices/sensors comprising the control system and certify that they are installed in accordance with "Record" Drawings.

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.

E. Data Communications Protocol: Certify that each proposed DDC system component complies with ASHRAE Standard 135-2001 for each protocol.

F. DDC system component testing: Comply with ASHRAE 135.1-2001 for all DDC controllers.

G. All controllers used to control or monitor equipment and/or field devices shall be tested, compliant with and carry a testing seal:

1. Building Controllers.
2. Advanced Application Controllers.
3. Application Specific Controllers.

H. System Software: Provide latest version of software at Project completion. Provide all software updates for one (1) year after date of acceptance as determined by the Owner.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment in other Sections, arrange for shipping of control devices to equipment manufacturer. Upon delivery the equipment manufacturer shall inspect shipment for visual damages. The Controls Contractor shall replace any damaged control equipment at no cost to the Owner.

B. Provide factory shipping containers for each piece of equipment. Provide factory applied plastic end caps on each length of pipe and tube. Maintain cartons and end caps through shipping, storage and handling as required to prevent equipment and pipe-end damage, and to eliminate dirt and moisture from equipment and inside of pipe and tube. Where possible store equipment and materials inside and protected from weather. When necessary, to store outside, elevate well above grade and enclose with durable water-proof wrapping.

1.10 WORK BY OTHERS

A. The installation of motor starters that are not factory installed, thermal overload switches, and power wiring to motors, starters, and thermal overload switches, is specified in another section. This section

includes the furnishing and installing of all controls, devices, interlocks, and wiring to provide a complete operating system as outlined in the sequence of operation.

B. The following general work scope of Contractors requiring coordination by the Controls Contractor includes, but is not limited to:
   1. The Piping Contractor shall:
      a. Install automatic valves, flow meters and separable wells that are specified to be supplied by the Controls Contractor.
      b. Furnish and install all necessary pressure taps, wells, as directed by the Controls Contractor.
      c. Furnish and install all necessary drain and overflow connections and piping.
      d. Furnish and install all necessary fittings and piping connections required for flow devices.
   2. The Sheet Metal Contractor shall:
      a. Install all automatic dampers and provide necessary blank-off plates or transitions required to install dampers that are smaller than duct size.
      b. Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper motors.
      c. Furnish and install necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation. Affix and seal permanently in place once stratification problems have been eliminated.
      d. Furnish and install access doors or other approved means of access through ducts for service to control equipment.
      e. Install duct mounted airflow monitoring stations.
      f. Install AHU and duct mounted heat and smoke detectors.
   3. The General Contractor shall:
      a. Provide access doors or other means of access through ceilings and walls for services to control equipment.
      b. Provide necessary housekeeping pads and, where required, concrete inertia bases.
   4. Air Terminal Box Manufacturers shall.
      a. Factory mount, wire and configure the terminal box DDC controller and actuator.
      b. Furnish static pressure probes.
      c. Furnish 24 volt transformers for terminal box controller power.
   5. Electrical Contractor shall:
      a. Furnish fire alarm system compatible duct mounted heat and smoke detectors and wire to Fire Alarm System. Coordinate with the mechanical contractor the exact placement of duct mounted detectors.
      b. Provide relay cabinets, required for lighting control and wiring/conduits to the EMS panels.
   6. Provide dedicated 120VAC circuits in j-boxes throughout all building areas for control panel and terminal box control power.

PART 2 - PRODUCTS

2.1 ACCEPTABLE BIDDERS

A. The specifications are intended to describe the microprocessor based Energy Management System – System 600 APOGEE and Siemens Building Technologies is the acceptable manufacturer/installer.

B. Alternate bidders are acceptable with ownership approval. Any alternate bidder must be able to demonstrate to UTSW the ability to integrate with the existing Siemens Building Technologies Energy Management System prior to bidding.

2.2 NETWORKING

A. The design of the EMS shall network operator workstations and stand-alone DDC Controllers. The network architecture shall consist of three levels, a campus-wide (Management Level Network - MLN) Ethernet network based on TCP/IP protocol, high performance peer-to-peer Building Level Network (BLN) and Application Specific Controller Floor Level Networks (FLN) with access being totally transparent to the user when accessing data or developing control programs.

B. The design of EMS shall allow the co-existence of new DDC Controllers with existing DDC Controllers in the same network without the use of gateways or protocol converters.

C. All operator devices either network resident or connected via remote connection shall have the ability to access all point status and application report data or execute control functions for any and all other

devices via the peer-to-peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.

D. All Networks shall be dynamically connected to allow access to points on different BLN's simultaneously.

2.3 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
2. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
3. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
4. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
5. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
6. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
   a. Water Temperature: Plus or minus 1 deg F.
   b. Water Flow: Plus or minus 5 percent of full scale.
   c. Water Pressure: Plus or minus 2 percent of full scale.
   d. Space Temperature: Plus or minus 1 deg F.
   e. Ducted Air Temperature: Plus or minus 1 deg F.
   f. Outside Air Temperature: Plus or minus 2 deg F.
   g. Dew Point Temperature: Plus or minus 3 deg F.
   h. Temperature Differential: Plus or minus 0.25 deg F.
   i. Relative Humidity: Plus or minus 5 percent.
   j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
   k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
   l. Airflow (Terminal): Plus or minus 10 percent of full scale.
   m. Air Pressure (Space): Plus or minus 0.01-inch wg.
   n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
   o. Carbon Monoxide: Plus or minus 5 percent of reading.
   p. Carbon Dioxide: Plus or minus 50 ppm.
   q. Electrical: Plus or minus 5 percent of reading.

B. Graphics User Interface:

1. Menu: Selectable for command entry, information management, network alarm management, and database management functions including, but not limited to:
   a. Configuration.
   b. Data Archiving.
   c. Commanding.
   d. System Diagnostics.
   e. Graphic Display Tree.
   f. Alarm Logs.
   g. Reports.
   h. Schedules.
2. Graphic Display: Display graphic with current state of the art dynamic points and refresh speed. As a minimum provide the following graphics pages:
   a. Overall Building Level: Display building, building name and all exterior equipment.
   b. Floor Level: Display floor level derived from CAD drawing, active links to monitored and/or controlled equipment on that floor.
   c. AHU System Level: Similar to floor level but displaying the area of a single AHU system and embedded links for all associated equipment including, but not limited to:
      1) AHU.
      2) Terminal boxes.
      3) Exhaust fans.

4) Dampers.
5) Thermostats.
6) Field sensors.

d. Equipment Level: Display associated equipment setpoints and real-time sensor readings as defined by the Owner.

e. Equipment Support Data: Link the following information directly from the Equipment Level graphic display or menu graphic display tree:
1) Operation and Maintenance manual.
2) Equipment schedules.
3) Sequence of operations.

f. Other graphic displays
1) Alarm log.
2) Energy overview: costs, consumption, production.
3) Equipment runtimes.

2.4 OPERATOR INTERFACE EQUIPMENT (AS APPLICABLE, CONFIRM CURRENT TECHNOLOGY REQUIREMENTS)

A. Operator Workstation (OWS): One desktop in tower case with configuration commercially available three months before substantial completion:
1. Intel Dual-Processor: 3.0 GHz (ea. processor), 2 MB L2 cache, 800 MHz (min.) front side bus, 64-bit.
2. Random-Access Memory: 6 GB.
3. Graphics Video Adapter: 256 MB video memory.
4. Hard-Disk Drive: 1 TB, 7200 RPM.
5. DVD/CD Combo Read/Write Drive: DVD+R 8X, DVD+RW 8X, DVD-RW 6X, CD-R 24X, CD-RW 16X.
6. Communications Card: 10/100bT Ethernet, integral to motherboard or compatible with expansion slot.
7. Audio Card: Integral to motherboard or compatible with expansion slot, 1-3.5mm microphone input, 1-3.5mm headphone output.
8. Media Drive: Multi-in-1 (SD/XD/CF).
9. USB Connections: 2 front side, 4 back side, version 2.0 compliant.
10. Monitor 24 inch flat panel LCD: 1920 x 1080 (1080p) resolution, DVI & VGA input, 50,000:1 contrast ratio, 300 cd/m2 brightness, 5 ms response time. 2 per OWS.
11. Keyboard: QWERTY, 105 keys in ergonomic shape.
12. Mouse: Three button with scroll wheel, optical.
13. 2 kVA UPS.
14. Speakers: compatible with audio card.
15. Operating System: Microsoft Windows XP or 7.
    a. Protocol Compliance: Control units shall use BACnet or Modbus protocol.
16. Application Software:
    a. I/O capability from operator station.
    b. System security for each operator via software password and access levels.
    c. Automatic system diagnostics; monitor system and report failures.
    d. Database creation and support.
    e. Automatic and manual database save and restore.
    f. Dynamic color graphic displays with up to 10 screen displays at once.
    g. Custom graphics generation and graphics library of HVAC equipment and symbols.
    h. Alarm processing, messages, and reactions.
    i. Trend logs retrievable in spreadsheets and database programs.
    j. Alarm and event processing.
    k. Object and property status and control.
    l. Automatic restart of field equipment on restoration of power.
    m. Data collection, reports, and logs. Include standard reports for the following:
        1) Current values of all objects.
        2) Current alarm summary.

3) Disabled objects.
4) Alarm lockout objects.
5) Logs.

n. Custom report development.
o. Utility and weather reports.
p. Workstation application editors for controllers and schedules.
q. Maintenance management.

17. Custom Application Software:
a. English language oriented.
b. Full-screen character editor/programming environment.
c. Allow development of independently executing program modules with debugging/simulation capability.
d. Support conditional statements.
e. Support floating-point arithmetic with mathematic functions.
f. Contains predefined time variables.

B. Portable Diagnostic Unit (PDU) (Laptop): Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network via Ethernet cable.
1. System: With one integrated USB 2.0 port, integrated Intel Ethernet, integrated audio, bios, and hardware monitoring.
2. Processor: Intel 2.13 GHz, dual-core.
3. Random-Access Memory: 6 GB, DDR3.
4. Graphics: 512 MB video memory.
5. Monitor: 14 inches, LCD color.
6. Keyboard: QWERTY 105 keys in ergonomic shape.
7. Hard-Disk Drive: 500 GB, 5400 RPM.
8. Audio: Integral sound card with 1-3.5mm microphone input, 1-3.5mm headphone output.
9. Media Drive: Multi-in-1 (SD/XD/CF)
10. USB Drives: 2 side, 2 back, version 2.0 compliant.
11. DVD/CD-ROM Read/Write Combo Drive: DVD+R 8X, DVD+RW 8X, DVD-RW 6X, CD-R 24X, CD-RW 16X.
12. Pointing Device: Touch pad, 2-button.
13. Communications Card: 10/100bT Ethernet, Bluetooth 2.1, IEEE 802.11b/g/n wireless.
14. Operating System: Windows XP or 7.

C. Archive Server: Provide servers that will provide archive locations for all historical data such as trends, alarm and event histories and transaction logs.
1. Server shall reside on the Campus Network.
2. Equip servers with the same tool set that is located in the network level controllers for the system configuration and custom logic definition and graphic configuration.
3. Access to all information on the server will be through the OWS.
4. The hardware platform for servers will, at minimum, consist of:
a. PC processor with minimum 64-bit word structure.
b. Minimum 4.0 GHz processor speed.
c. Minimum 8 GB RAM.
d. Hard drive or equal high-speed data storage, minimum 50 gigabytes.
e. OS shall be Windows 2008 Professional.
f. Removable high-speed data storage and export device(s) such as Read/Write CD ROM or approved equal.
g. Full ASCII keyboard and digital Mouse or equal pointing device.
h. Full color, flat screen monitor, minimum 22 inches diagonal screen, minimum 1280 x 1024 resolution, and minimum 72 Hz refresh rate.

2.5 DDC CONTROLLERS

A. DDC Controllers shall be stand-alone, multi-tasking, multi-user, real-time digital control processors with a minimum word size of 16 bits, minimum 16MHz clock and 4MB memory consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point

modules. Each controller shall support a minimum of 96 FLN Devices. Floor Level Network Controllers (FLNC) are DDC Controllers that only support 96 FLN Devices.

B. Each DDC Controller shall support its own operating system and databases, including:
   1. Control processes.
   2. Energy management applications.
   3. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
   4. Historical/trend data for points specified.
   5. Maintenance support applications.
   6. Custom processes.
   7. Operator I/O.
   8. Dial-up communications.
   9. Manual override monitoring.

C. Each DDC Controller shall support any combination of industry standard inputs and outputs.

D. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

E. DDC Controllers shall be provided with one RS-232C serial data communication port for the portable laptop operator's terminal. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

F. As indicated in the point I/O schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
   1. Switches shall be mounted within the DDC Controllers key-accessed enclosure.
   2. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

G. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LED’s for analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door (MBC only).

H. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

I. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.

J. In the event of loss of all power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 100 hours.
   1. Battery Backup: Basis of Design
      a. Basis of Design: Uninterruptible Power Supply In Kit PSH850-UPS-STAT as manufacturered by Functional Devices, Inc.
      b. Product to include 850 VA UPS, 10 amp switch/circut breaker, two - 120 Vac outlets, terminals, 120 VAC input.
   2. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
   3. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via remote connection or automatically from the network workstation PC.

K. As a minimum, a separate DDC Controller shall be provided for each mechanical room. There should only be one DDC Controller for each system.

L. All DDC controllers will be provided with a UPS backup. UTSW will approve acceptable UPS products from APC / Schneider Electric.

2.6 DDC CONTROLLER RESIDENT SOFTWARE

A. General:
   1. The software programs specified in this Section shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer for execution.

B. Control Software Description:
   1. The DDC Controllers shall have the ability to perform the following pre-tested control algorithms:
      a. Two-position control.
      b. Proportional control.
      c. Proportional plus integral control.
      d. Proportional, integral, plus derivative control.
      e. Automatic tuning of control loops.

C. DDC Controllers shall have the ability to perform any or all the following energy management routines:
   1. Time-of-day scheduling.
   2. Calendar-based scheduling.
   3. Holiday scheduling.
   4. Temporary schedule overrides.
   5. Start-Stop Time Optimization.
   6. Automatic Daylight Savings Time Switchover.
   7. Night setback control.
   8. Enthalpy switchover (economizer).
   9. Peak demand limiting.
   10. Temperature-compensated duty cycling.

D. DDC Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
   1. A single process shall be able to incorporate measured or calculated data from any and all other DDC Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC Controllers on the network.
   2. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of connection to a remote device such as a printer or pager.

E. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
   1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
   2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
   3. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs.
   4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
   5. In remote alert applications, operator-selected alarms shall initiate a call to a remote operator device.

F. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.
   1. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of l minute to 7 days shall be provided. Each DDC Controller

shall have a dedicated RAM-based buffer for trend data. All trend data shall be available for use in 3rd party personal computer applications such as Excel.

2. DDC Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
    a. Loop tuning shall be capable of being initiated either locally at the DDC Controller, from a network workstation or remotely using dial-in modems. For all loop-tuning functions, access shall be limited to authorized personnel through password protection.

G. DDC Controllers shall automatically accumulate and store run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O summary.

H. DDC Controllers shall be password protected. The user's Password and Privileges shall be identical to the Password and Privileges used at the EMS Workstation.

2.7 APPLICATION SPECIFIC CONTROLLERS

A. Terminal Equipment Controllers (TEC)

1. Provide for control of each piece of equipment, including, but not limited to, the following:
    a. VAV and CAV Dual Duct Boxes.
    b. VAV Terminal Units with and without heating coils.
    c. Fan Coil Units.
2. The controllers shall include all inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be 24 volt floating.
3. Each controller performing space temperature control shall be provided with a matching room temperature sensor with a setpoint adjustment between 55 Degrees F and 95 Degrees F.
4. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the respective controller.
5. Setpoint adjustment and override function shall have the ability to be locked out, overridden, or limited as to time or temperature through software by an authorized operator at the central workstations, at the DDC Controller, or via the portable operator's terminal.
6. Each controller shall perform its primary control function independent of the DDC Controller. The controller shall receive its real-time data from the DDC Controller time clock. Each controller shall include algorithms incorporating proportional, integral, and derivative (PID) gains for all applications. All PID gains and biases shall be adjustable by the user via terminals as specified herein. This functionality shall allow for tighter control and shall facilitate optimal occupant comfort and energy savings.
7. Provide each terminal equipment controller with sufficient memory to accommodate point databases and operating programs. All databases and programs shall be stored in non-volatile EEPROM, EPROM, and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure. Operating programs shall be selectable and may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility.
8. Controllers shall be powered from a 24 VAC source, and shall function normally under an operating range of 18 to 28 VAC (-25 percent to plus 17 percent), allowing for power source fluctuations and voltage drops. The controllers shall also function normally under ambient conditions of 32 Degrees to 122 Degree F and 10-95 percent RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
9. Pressure independent controllers shall include differential pressure transducers that shall connect to the terminal unit manufacturer's standard averaging air velocity sensor to measure the average differential pressure in the duct. The controller shall convert this value to actual airflow. The differential pressure transducer shall have a measurement range of 400 to 4,000 FMP and measurement accuracy of plus or minus 5 percent at 400 FPM insuring primary air flow condition shall be controlled and maintained to within plus or minus 5 percent of setpoint at the specified parameters. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift overtime. The controller requiring 24 hours a day operation shall calibrate the airflow sensor every 24 hours with the use of an auto-zero module to eliminate the requirement of closing the supply

damper to calibrate the flow sensor. It shall not be necessary to remove the controller to remove the damper actuator.

B. LABORATORY CONTROLS

1. FUME HOOD CONTROLLER (FHC)
   a. The DDC controller shall control Variable Air Volume laboratory fume hoods.
   b. The controller will maintain constant face velocity as the sash is raised and lowered.
   c. An operator display panel will provide the user the operating status of the hood, alarm horn, and emergency purge function.
   d. The hood controller will interface with the energy management system.
2. BIO-SAFETY CABINET CONTROLLER (BSCC)
   a. Ducted bio-safety cabinets will be controlled to a constant CFM specified by the cabinet's manufacturer.
   b. Alarms and flows will be reported to the EMS.
3. ROOM PRESSURE CONTROLLER (RPC)
   a. The DDC controller will provide room pressurization and temperature control to rooms or labs without fume hoods where positive or negative room pressure is critical.
   b. The RPC will maintain differential flow between the supply and exhaust terminal boxes.
   c. The Room Pressurization Controller shall operate as a networked component of the EMS.
4. LABORATORY ROOM CONTROLLER (LRC)
   a. The DDC controller will provide control for laboratory space pressurization and temperature control wit h control sequences for both single duct and dual duct supply systems.
   b. The controller will maintain user defined differential airflow between lab supply air and fume hood controller exhaust and general exhaust terminals by measuring the airflow and controlling the damper position of the supply and general exhaust terminals.
   c. Lab temperature control will be maintained by measuring the room temperature and controlling he reheat valve and adjusting the air flow.
   d. Closed loop PID control will be used to maintain tighter air volume and temperature control.
   e. All air flows will be reported in CFM's from physical air flow stations or flow sensors and not calculated base on valve or damper position.
   f. The Laboratory Room Controller shall operate as a networked component of the EMS. The LRC shall communicate differential pressure values, air flow values, temperature values and alarm status.
5. DIFFERENTIAL PRESSURE MONITOR (DPM)
   a. The monitor measures and displays the differential pressure between a room and its adjoining space.
   b. The Differential Pressure Monitor (DPM) shall operate as a networked component of the LCS. The DPM shall communicate alarm status, differential pressure values, and door status. The alarm setpoint shall be adjustable from the LCS Workstation.
   c. The Differential Pressure Transmitter shall have an accuracy of plus or minus 0.001 inches of water over a range of - 0.2 to + 0.2 inches of water.
6. CAV FUME HOOD MONITOR
   a. The DDC Fume Hood Monitor shall continuously monitor the fume hood face velocity.
   b. Monitor shall be mounted to accurately monitor the face velocity.
   c. Monitor will be visible to the fume hood user and display the actual face velocity.
   d. Monitor will issue an audible alarm when the face velocity is below operating parameters.
   e. The monitor will connect to the EMS system so fume hood face velocity and alarms can be monitored remotely.

2.8 VALVES, DAMPERS AND ACTUATORS

A. VALVES:

1. Water valves shall be sized by the control manufacturer to produce the required capacity at a pressure loss of 15 psi. Nominal body rating shall be not less than ANSI Class 125. However, the valve body and packing selected shall be designed to withstand the system static head plus the maximum pump head and the maximum temperature of control medium and hot water. Single-seated valves shall have close-off ratings equal to 125 percent of the system pressure encountered that is the maximum upstream pressure. The valve body and packing selected shall be designed to

withstand the system static head plus the maximum pump head and the maximum temperature of control medium without leakage for hot water.

2. Two-Way and Three-Way Valves:
    a. Valves used for control of hot and chilled water shall be of the modulating globe type.
    b. Valve sizes two inch and smaller shall be screwed and supplied with union fittings. The valves shall be constructed of bronze with stainless steel trim with equal percentage flow characteristics and have a rangeability of 50:1 or greater.
    c. Valve sizes 2.5 inch and larger shall be flanged. The valves shall be constructed of cast iron ASTM A126 Class B. The trim shall be stainless steel with equal percentage flow characteristics. The valve rangeability shall be 100:1 or greater.
    d. Valves shall be of the straight-through type as required by the sequence or indicated on the drawings.
3. Low Pressure Steam Valves: Shall be rated to 338 Degrees F at a maximum inlet pressure to the valve of 100 psig. Valves for low-pressure steam shall be sized for 80 percent pressure drop of inlet pressure. Valves shall be equipped with stainless steel trim and disc with linear flow characteristics. Applications, which require steam valves larger than 2 inches, shall utilize two valves in a 1/3 - 2/3 parallel arrangement.
4. Butterfly Valves: Where butterfly valves are indicated to be used as automatic control valves, they shall be line size and designed for motorized control operation with upper disc steam keyed or machined square for mating with the control operator's linkage. All butterfly control valves over 8 inches shall be equipped with a manual, mechanical control actuator override, gear box operator for emergency manual control of the valve position. Provide required accessories to mechanically disengage automatic control actuator linkage and engage manual gear operator without dismantling the valve stem and stem extensions during changeover. Valves 4-20 inches and larger shall be tapped, full lug, cast iron body butterfly valves with aluminum bronze discs, stainless steel stem and EPDM seat. Design must incorporate top and bottom bushings between shafts and body of material suitable to provide a bearing surface to eliminate seizing or galling. Valves 4-20 inches must provide bubble-tight seal at 150 PSIG. Liners are to be resilient material suitable for 250 Degrees F temperature.
5. Valve Constant (Cv) Charts: Control drawings shall indicate the valve constant (Cv rating) of all valves used so that the valve pressure drop may be used for balancing and performance tests. Submittal data shall also state calculated shut-off pressure for each valve size.

B. DAMPERS:

1. The Temperature Control Manufacturer shall provide control dampers of the types and sizes indicated on the drawings, including but not limited to outside air, return, relief air dampers, isolation and exhaust system bypass dampers.
2. Damper frames shall be 5 inches X 1 inch 6063T5 extruded aluminum hat channel with .125 inch minimum wall thickness with mounting holes for flange and enclosed duct mounting.
3. Dampers shall be available in two-inch size increments from 8 inches horizontal and vertical to 48 inches. Requirements over 48 inches shall be standard modules with interconnecting hardware (jack shafting).
4. All damper blades shall be 6 inches 6063T5 heavy gage extruded aluminum airfoil for high velocity performance. Blades on all dampers must be not over 6 inches wide. Blade bearing shall be molded synthetic with 1/2 inch hex plated steel shafts. All blade linkage hardware shall be of corrosion-resistant finish and readily accessible for maintenance after installation.
5. Extruded vinyl edging seals for outdoor dampers and flexible metal compressible type side seals for all dampers shall be provided.
6. Dampers and seals shall be suitable for temperature ranges of -50 Degrees F. to +250 Degrees F. at specified leakage ratings.
7. Dampers used for proportional control shall have opposed blades.
8. Leakage rates shall not exceed 6.25 CFM/Sq. Ft. at 4 inches wg. differential rated in accordance with AMCA 500.
9. Acceptable manufacturers are Ruskin, Arrow United Industries, American Warming and Ventilating, Inc. or approved equal.

C. DAMPER AND VALVE ACTUATORS:

1. Electronic actuators shall be of 0-10 VDC type. The minimum actuator impedance shall be 800 ohms even when more than one actuator is connected in parallel. Spring return shall be required for two-position (NO/NC) control sequence or for steam valve control. Non-spring return actuators shall be used for all modulating sequence of control. They shall conform to all requirements of sequence descriptions specified or scheduled. Main mechanical equipment actuators shall have a manual position dial to allow manual positioning of valve in absence of control power.
2. Valve actuators shall be of sufficient size to close valves at system pressure drop across the valve plus 50.
3. Actuators for Terminal Equipment Controllers shall be 24V floating point, 0-10Vdc or pneumatic depending on Sequence of Operation and required speed of response. Regardless of actuator type, they shall be modulating and their position shall be readable in percentage open at the Workstation.
4. Actuators for VAV Laboratory Applications shall be provided for Laboratory Supply Air Terminals, Laboratory General Exhaust Terminals and Fume Hood Exhaust Terminals. The actuators shall be maintenance free high-speed actuators capable 1.0 second from minimum flow to 90 percent of maximum flow. The actuators shall have a fail safe position based on Sequence of Operation. The actuators shall be capable of accepting either 3-position floating point or 0-10 Vdc.

2.9 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
B. Thermistor, Temperature Sensors and Transmitters:
   1. Sensor Types: Provide one of the following:
      a. 100 ohm (plus or minus 0.12 percent) platinum resistance temperature detectors having a coefficient of resistivity of 0.00385 ohms/ohm/°C. Provide RTD temperature transducers with of 4-20 mA output signal variations of less than 0.2 percent of full scale output for supply voltage variations plus or minus 10 percent and integral and accessible zero and span adjustment.
      b. 10,000 ohm thermistor having an accuracy of .5°F at calibration point of 75°F may be used for room temperature only.
   2. Accuracy: Plus or minus 0.5°F (0.3°C) at calibration point.
   3. Wire: Twisted, shielded-pair cable.
   4. Insertion Elements: Single point in center of duct or coil face area, use where not affected by temperature stratification or where airflow cross sectional area is smaller than 9 square feet.
   5. Averaging Elements: Twice the diagonal length of coil or duct. Use where prone to temperature stratification or where airflow cross sectional area is larger than 10 square feet.
   6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches or 75 percent of pipe inside diameter, whichever is less.
   7. Room Thermostats: Off-white enclosure capable of being mounted on a standard single gang electrical back box. Provide each with:
      a. Local display of current space temperature.
      b. Local setpoint adjustment (plus or minus 5 deg F) and temporary override button, both of which can be overridden by BAS at OWS.
      c. RJ45 connection for connection to PDU.
   8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
C. RTDs and Transmitters:
   1. Accuracy: Plus or minus 0.2 percent at calibration point.
   2. Wire: Twisted, shielded-pair cable.
   3. Insertion Elements in Ducts: Single point; use where not affected by temperature stratification or where ducts are smaller than 9 square feet.
   4. Averaging Elements in Ducts: Use where prone to temperature stratification or where ducts are larger than 9 square feet; length as required.
   5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2 1/2 inches.
   6. Room Sensor Cover Construction: Off-white enclosure capable of being mounted on a standard single gang electrical back box.
D. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated. Accuracy of 2 percent of full scale with repeatability of 0.5 percent. Linear output of 4 to 20 mA.
    a. Building Static-Pressure Range: 0- to 0.25-inch wg.
    b. Duct Static-Pressure Range: 0- to 5-inch wg.
2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 Ma.
6. Solenoid Air Valves (EP). The valve shall be a 3-way solenoid valve for two-position operation of pneumatic valve and damper actuators. Coil voltage shall be 120VAC or 24

2.10 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. 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.

C. Low Limit Temperature Switch: Minimum 20 feet element for freeze protection. Serpentine across the face of the coil and of sufficient length or number for three passes across the width of the coil it is protecting. Connect in series with other safety devices to de-energize fans serviced when a drop in temperature below setpoint is detected.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury 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.

2.11 GAS DETECTION EQUIPMENT

A. 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 32 to 104 deg F; with 2 factory-calibrated alarm levels to be determined by OSBC and UTSW CDAS.

B. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output, for wall mounting.

C. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

2.12 FLOW METERS

A. BTU Meters (Water): Meters shall be complete with integral brass body flow meter, temperature sensor and standard brass thermowell.
    1. Accuracy
        a. Flow: plus or minus 0.5 percent of reading at calibrated velocity
        b. Differential Temperature: plus or minus 0.15 deg F over calibrated temperature range
        c. Computational Error: plus or minus 0.05 percent
    2. Output Signal: Factory selectable for flow rate, energy rate or delta-T (4-20mA or 0-10V)
    3. Operating Temperature & Pressure: 32 deg F to 200 deg F.

4. Calibration: N.I.S.T. traceable standards.

B. Thermal Mass Flow Meters (Natural Gas): Meters shall be insertion style complete with wetted materials to be stainless steel.
   1. Accuracy: plus or minus 1.0 percent of reading.
   2. Output Signal: Scalable pulse output for totalization and analog output (4-20mA)
   3. Operating Temperature & Pressure: -40 deg F to 200 deg F.
   4. Calibration: N.I.S.T. traceable standards.

C. Vortex Flow Meters (Steam): Meters shall consist of a vortex shedding mass flow measurement device, 1000 ohm platinum RTD for temperature measurement and pressure transducer for pressure measurement. Sensor bodies shall be 316 stainless steel.
   1. Accuracy: Volumetric, plus or minus 1.0 percent.
   2. Repeatability: plus or minus 0.1 percent.
   3. Output Signal: Scalable pulse output for flow rate and analog output (4-20mA)
   4. Operating Temperature & Pressure: -40 deg F to 464 deg F.
   5. Calibration: N.I.S.T. traceable standards.

2.13 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

2.14 LOCAL CONTROL PANELS

A. Provide control panels with suitable brackets for wall mounting, for each miscellaneous control system. Locate panel adjacent to systems served.

B. Fabricate panels of 14-gauge furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color. Provide UL listed cabinets for use with line voltage devices.

C. Panel Mounted Equipment: Include temperature controllers, relays, and other devices excluded in the sequence of operation. Mount devices with adjustments accessible through the fronts of panels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that power supply is available to control units and OWS.

3.2 COORDINATION

A. Coordinate location of temperature sensors, humidistats, and other exposed control sensors with plans and room finish details before installation.

B. Coordinate equipment with Division 28 Section "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system and with building master clock.

C. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate equipment with Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" to achieve compatibility with equipment that interfaces with that system.

E. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

F. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

G. Coordinate supply of conditioned electrical branch circuits for control units and OWS.

H. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

I. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

J. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

K. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

3.3 INSTALLATION

A. Install software in control units and OWS. Implement all features of programs to specified requirements and as appropriate to achieve sequence of operations.
B. Connect and configure equipment and software to achieve sequence of operations specified.
C. Mount all wall thermostats, humidistats, and other exposed control sensors on dedicated electrical backboxes.
D. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
I. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
K. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."
L. Air flow stations shall be installed in serviceable locations.
M. Pressure transducer must be mounted outside air stream.

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install systems and materials in accordance with manufacturer's instructions, rough-in drawings and equipment details. Install electrical components and use electrical products complying with requirements of applicable Division 26, 27, & 28 Sections of these Specifications except where specifically stated in this Section.
B. The term "control wiring" is defined to include providing of wire, conduit, and miscellaneous material as required for mounting and connecting electric or electronic control devices.
C. Install all control wiring in conduit for electric/electronic control systems. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. UL plenum rated cable shall be allowed above accessible lift out ceiling, in air plenums, and in other areas as approved by Architect and local and NEC codes.
D. Stub conduit to above lift out ceilings. Plastic bushing shall be installed where the sensor wire exits the conduit to prevent damage.
E. Number-code or color-code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.
F. This section shall provide all line voltage power wiring required because of substitution of equipment specified in this section.
G. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
H. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
I. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
    1. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
    2. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
    3. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
    4. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
J. Connect manual-reset limit controls independent 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.

L. Serve only one DDC controller from any 24V control power transformer.

3.5 FIELD QUALITY CONTROL

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

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

1. 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 sequence of operation.
6. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop 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 operating in the correct direction.
8. Check dampers. Verify that proper blade alignment, either parallel or opposed, has been provided.
9. 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.

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

3.6 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 digital inputs using jumper wire.
    b. Check digital outputs using ohmmeter to test for contact making or breaking.
    c. 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.

3.7 AIRFLOW MONITORS

A. Setup output control signal to be derived from a 5 minute running average airflow monitor input.

3.8 SYSTEM EXCEPTANCE

A. General: The system installation shall be complete and tested for proper operation prior to acceptance testing for the Owner's authorized representative. A letter shall be submitted to the Architect requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of request. When the field test procedures have been demonstrated to the Owner's representative, the system will be accepted. The warranty period will start at this time.

B. Field Equipment Test Procedures: DDC control panels shall be demonstrated via a functional end-to-end test. Such that:

1. All output channels shall be commanded (on/off, stop/start, adjust, etc.) and their operation verified.
2. All analog input channels shall be verified for proper operation.
3. Changing the state of the field device and observing the appropriate change of displayed value shall verify all digital input channels.
4. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.
5. Introducing an error into the system and observing the proper corrective system response shall verify automatic control operation.
6. Changing the schedule and observing the correct response on the controlled outputs shall verify selected time and setpoint schedules.

C. Workstation Test Procedures: The system workstation test procedures shall be as follows:

1. Communication with each DDC control panel shall be demonstrated.
2. Operator commands will be explained and demonstrated.
3. Control sequences shall be demonstrated for proper operation.
4. All available system reports and logs shall be demonstrated at the system workstation.
5. Correct system start-up and shutdown procedures shall be demonstrated.
6. All controllers shall be demonstrated to operate in a standalone mode.

D. Record Documentation: After a successful acceptance demonstration, the Contractor shall submit as-built drawings of the completed project for final approval. After receiving final approval, supply "3" complete 11 x 17 as-built drawings sets as well as digital "pdf" copies.

E. Operation and Maintenance Manuals: Submit three copies of operation and maintenance manuals. Include the following:

1. Manufacturer's catalog data and specifications on sensors, transmitters, controllers, control valves, damper actuators, gauges, indicators, terminals and any miscellaneous components used in the system.
2. An operator's manual that will include detailed instructions for all operations of the system.
3. An operator's reference table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
4. A programmer's manual that will include all information necessary to perform programming functions.
5. A language manual that will include a detailed description of the language used and all routines used by the system.

6. Complete program listing file and parameter listing file for all programs.
7. A copy of the warranty.
8. Operating and maintenance cautions and instructions.
9. Recommended spare parts list.

3.9 TRAINING

A. Contractor shall provide to the engineer a training class outline prior to any scheduled training.

B. Factory trained control engineers and technicians shall provide training sessions for the Owner's personnel.

C. The control contractor shall conduct five six-hour training sessions on the DDC System for the designated Owner's personnel in the maintenance and operation of the Systems. The class shall be given upon system acceptance.

D. The course shall include instruction on specific systems and instructions for operating the installed system to include as a minimum:

1. HVAC system overview.
2. Operation DDC Systems.
3. Function of each Component.
4. System Operating Procedures.
5. Programming Procedures.
6. Maintenance Procedures.

3.10 SERVICE AND GUARANTEE

A. This system specified under this Section of the Specifications shall be guaranteed from defects in workmanship and material under normal use and service for a period of twelve (12) months from the date of acceptance. If, during the one year period, any of the factory equipment or materials provided in the system is found to be defective in materials or workmanship, it shall be replaced or repaired by the DDC Manufacturer at no additional cost to the Owner.

B. Upon completion of the installation, the Contractor shall thoroughly inspect, check, adjust, calibrate, and make ready for use all devices/sensors comprising the control system and certify that they are installed in accordance with "Record" Drawings.

END OF SECTION 23 09 00

SECTION 23 09 55

CONTROL SEQUENCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Control sequence is hereby defined to mean the manner in which, and methods by which, the controls function. The requirements for each type of operation are specified in this section

B. The operating equipment, devices, and system components required for the automatic control system are specified by Section 23 09 00 - Instrumentation and Control for HVAC of these specifications.

1.3 RELATED REQUIREMENTS

A. Section 23 09 00 - Instrumentation and Control for HVAC.

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.5 SUBMITTALS

A. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. All HVAC systems shall be controlled with Direct Digital Control (DDC) according to the point list contained in this section of the Specifications and shall be stand-alone.

B. Additional points or software programming not listed in the point list but which are required to meet the following sequence of operation shall be provided.

PART 3 – EXECUTION -- NOT USED

END OF SECTION 23 09 55

SECTION 23 20 10

PIPING, VALVES, AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Pipe and Pipe Fittings
B. Valves

1.3 RELATED REQUIREMENTS

A. Section 08 31 13 - Access Doors and Frames.
B. Section 09 91 23 - Interior Painting.
C. Section 23 00 00 - UTSW Mechanical Design Requirements.
D. Section 23 05 16 - Piping Expansion Compensation
E. Section 23 05 29 - Supports and Anchors.
F. Section 23 05 53 - Mechanical Identification.
G. Section 23 07 19 - Piping Insulation.
H. Section 23 21 13 - Hydronic Piping
I. Section 23 21 15 - Hydronic Specialties.
J. Section 23 22 13 - Steam and Steam Condensate Piping.
K. Section 23 22 23 - Steam and Steam Condensate Specialties.
L. Division 31 – Trenching and Back Filling.

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ASME BPVC – Boiler and Pressure Vessel Code (BPVC).
C. ASME BPVC-IX – Welding and Brazing Qualifications.
D. ASME B16.1 – Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
E. ASME B16.3 – Malleable Iron Threaded Fittings: Classes 150 and 300.
F. ASME B16.4 – Grey Iron Threaded Fittings: Classes 125 and 250.
G. ASME B16.5 – Pipe Flanges and Flanged Fittings NPS ½ through 23 Metric/Inch Standard.
H. ASME B16.9 – Factory-Made Wrought Buttwelding Fittings.
I. ASME B16.18 – Copper Alloy Solder Joint Pressure Fittings.
J. ASME B16.22 – Wrought Copper and Bronze Solder-Joint Pressure Fittings.
K. ASME B16.26 – Copper Alloy Fittings for Flared Copper Tubes.
L. ASME B16.34 – Valves Flanged, Threaded, and Welding End.
M. ASME B31.1 – Power Piping.
N. ASME B31.3 – Process Piping.
O. ASME B31.9 – Building Service Piping.
P. ASTM A47/A47M - Ferric Malleable Iron Castings.
Q. ASTM A53/A53M – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
R. ASTM A105/A105M – Standard Specification for Carbon Steel Forgings for Piping Applications.
S. ASTM A106/A106M – Specification Standard for Seamless Carbon Steel Pipe for High-Temperature Service.
T. ASTM A126 – Standard Specification for Grey Iron Castings for Valves, Flanges, and Pipe Fittings.
U. ASTM A135/A135M – Standard Specification for Electric-Resistance-Welded Steel Pipe.
V. ASTM A181/A181M – Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.

W. ASTM A182/A182M – Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

X. ASTM A234/A234M - Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

Y. ASTM B32 – Standard Specification for Solder Metal.

Z. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.

AA. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes for Steam or Valve Bronze Castings.

BB. ASTM B75/B75M - Standard Specification for Seamless Copper Tube.

CC. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

DD. ASTM B251/B251M - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.

EE. ASTM B302 – Standard Specification for Threadless Copper Pipe (TP), Standard Sizes.

FF. AWS A5.8M/A5.8 - Brazing Filler Metal.

GG. MSS SP-25 – Standard Marking System for Valves, Fittings, Flanges, and Unions.

HH. NCPWB (SPS) - Procedure Specifications for Pipe Welding.

1.5 SUBMITTALS

A. Submit under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

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

C. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Record actual locations of valves, etc. and prepare valve charts.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

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

1.8 QUALITY ASSURANCE

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

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

C. Welder’s Certification: In accordance with ASME BPVC-IX. Submit welder’s certifications prior to any shop or field fabrication. Welder’s certifications shall be current within six months of submission.

D. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

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

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

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

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

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

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

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

1.11 ENVIRONMENTAL REQUIREMENTS

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

1.12 ATTIC STOCK

A. Furnish under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.
B. Provide two repacking kits for each size valve.

PART 2 - PRODUCTS

2.1 STEEL PIPING

A. Section applies to all piping systems providing for welded piping, fittings, and other appurtenances. Specific systems requiring welded piping include, but are not limited to: chilled water, hot water, steam, and steam condensate.
B. Pipe: Unless otherwise indicated, chiller and boiler plant piping shall be Schedule 40, and underground and building piping shall be Standard weight, Grade A or B, seamless black steel pipe conforming in all details to Standard ASTM A53/A53M ASTM A106/A106M, and ASTM A135/A135M, latest revisions. Steam condensate shall be Schedule 80.
C. Fittings:
    1. All weld fittings shall be domestic made wrought carbon steel butt-welding fittings conforming to ASTM A234/A234M and ASME B16.9, latest edition, as made by Weldbend, Tube Turns, or Hackney Ladish Inc. Attach only to pipe with a hole for the entire length. Each fitting shall be stamped as specified by ASME B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fittings selected at random. Fittings which have been machined, remarked, printed, or otherwise produced domestically from non-domestic forgings or materials will not be acceptable. Each fitting is to be marked in accordance with MSS SP-25. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these specifications.
    2. All screwed pattern fittings specifically called for shall be Class 150 malleable iron fittings of Grinnell Company, Crane Company, or Walworth Company manufacture (Class 300 for unions).
D. Fabrication:
    1. Piping shall be fabricated according to the latest ASME/ANSI B31 Code for Pressure Piping. Welded piping and fittings in chiller and boiler plants shall be fabricated in accordance with ASME/ANSI Standard ASME B31.1 – Power Piping. Direct buried piping mains shall be fabricated in accordance with ASME/ANSI Standard ASME B31.3 – Process Piping. Standard ASME B31.9 – Building Services Piping may be used within buildings. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.
    2. Ensure complete penetration of deposited metal with base metal in welds. Contractor shall provide filler metal suitable for use with base metal. Contractor shall keep inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process. All pipe shall have the ends beveled 37-1/2 degrees and all joints shall be aligned true before welding. Except as specified otherwise, all changes in direction, intersection of lines, reduction in pipe size, and the like shall be made with factory-fabricated welding fittings. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.
    3. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.
    4. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.
    5. Do not split, bend, flatten or otherwise damage piping before, during or after installation.
    6. Remove dirt, scale and other foreign matter from the inside of piping, by swabbing or flushing, prior to the connection of other piping sections, fittings, valves or equipment.
    7. In no cases shall Schedule 40 pipe be welded with less than three passes, including one stringer/root, one filler, and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two filler, and one lacer. In all cases, the weld must be filled before the cap weld is added.

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

E. Weld Testing:

1. All welds are subject to inspection, visual, X-ray and/or Ultrasound, for compliance with specifications. The owner will, at the owner's option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing. Initial visual and X-ray inspections will be provided by the owner. The contractor shall be responsible for all labor, material and travel expenses involved in the re-inspection and re-testing of any welds found to be unacceptable. In addition, the contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards ASME B31.1, ASME B31.3 , and ASME B31.9, due to the discovery of poor, unacceptable, or rejected welds.
2. Welds lacking penetration, containing excessive porosity or cracks, or found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the ASME/ANSI B31 Code for Pressure Piping, current edition.

2.2 VALVES:

A. All valves must be of threaded or flanged type. No solder connected or grooved fitting valves shall be used on this project. All valves shall be located such that the removal of their bonnets is possible. All flanged valves shown in horizontal lines with the valve stem in a horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested and inspected for final acceptance. Valves shall be installed as nearly as possible to the locations indicated in the Construction Drawings. Any change in valve location must be so indicated on the Record Drawings.

B. All bronze and iron body gate and globe valves shall be the product of one manufacturer for each project. Manufacturers of other types may not be mixed on the same project; i.e., all butterfly valves shall be of the same manufacturer, all ball valves shall be of the same manufacture, etc.

C. All bronze valves used in circulating systems and steam systems (low and medium pressure) shall be Class 150 SWP. Bronze valves used in high pressure steam systems shall be Class 300 SWP. Iron valves used for low and medium pressure steam systems shall be Class 125. Iron valves used for high pressure steam systems shall be Class 250.

D. All gate and globe valves shall be union bonnet design.

E. Metal used in the stems of all bronze gate, globe and angle valves shall conform to ASTM B371/B371M Alloy 694, or other corrosion resistant equivalents. Written approvals must be secured for the use of alternative materials. Alloys used in all bronze ball, gate, globe, check, or angle valves shall contain no more than 15percent zinc. No yellow brass valves will be allowed.

F. Class 300 valves shall be constructed of all ASTM B61 composition.

G. All cast steel body valves shall have the pressure containing parts constructed of ASTM A216/A216M - GR-WCB carbon steel. Gate and globe valves shall be bolted bonnet outside and screw and yoke design with pressure-temperature rating conforming to ASME B16.34 . Stems shall meet ASTM designation ASTM A182/A182M -F6 chromium stainless steel. Wedges on gate valves may be solid or flexible type and shall meet ASTM A182/A182M -F6 chromium stainless steel on valves from 2 to 6 inches. Sizes 8 inches and larger may be A216-WCB with forged rings or overlay equal to 182-F6. Seat ring shall be hard faced carbon steel or 13 percent chromium ASTM A182/A182M -F6 stainless. Handwheels shall be A47 Grade 35018 malleable iron or ductile iron ASTM A536.

H. All forged steel body valves shall have the pressure containing parts constructed of ASTM A105, grade 2 forged carbon steel. Seat and wedges shall meet ASTM A182/A182M F6 chromium stainless steel. Seat rings shall be hard faced. Valves shall conform to ASME B16.34 pressure-temperature rating.

I. All valves shall be repackable under pressure, with the valve in the full open position. All gate valves, globe valves, angle valves and shutoff valves of every character shall have malleable iron hand wheels,

except iron body valves 2 1/2 inches and larger which may have either malleable iron or ASTM A126 Class B, gray iron hand wheels.

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

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

L. Balancing and/or shutoff valves for hot water systems 2 inches inches and smaller shall be three piece, full port, bronze body ball valves with stainless steel ball and stem. They shall have PTFE seats, packing and gasket, bronze gland follower, adjustable stuffing box, steel lever type handle with plastic sheathed operating handle, adjustable memory stops, and shall be class 150 SWP/600 WOG, screwed pattern. Manufacturer shall certify ball valves for use in throttling service. Stem extensions shall be furnished for use on insulated lines.

M. Shutoff valves for chilled water 2 inches and smaller shall be two piece, full port, bronze body ball valves with stainless steel ball and stem. They shall have PTFE seats, packing and gasket, bronze gland follower, adjustable stuffing box, steel lever type handle with plastic sheathed operating handle, adjustable memory stops, and shall be class 150 SWP/600 WOG, screwed pattern. Manufacturer shall certify ball valves for use in throttling service. Stem extensions shall be furnished for use on insulated lines.

N. All balancing and/or shutoff valves 2 1/2 inches and larger shall be tapped full lug butterfly valves with aluminum bronze discs of 316, 416, or 420 stainless steel shafts. Design must incorporate bushing between shafts and body of material suitable to provide a bearing surface to eliminate seizing or galling.

O. All balancing and/or shutoff valves must be capable of providing a bubble tight seal at 200 psi for valves up to 12 inches, and 150 psi for larger valves, when used for end of line service, without requiring the installation of a blind flange on the downstream side.

P. All butterfly valves shall be absolutely tight against a pressure differential of 150 psi. Liners shall be resilient material suitable for 225 °F temperature and bodies of ductile iron. Butterfly valves 2 1/2 inches through 6 inches shall have lever handles which can be set in interim positions between full open and full closed. Butterfly valves 8 inches and larger, and butterfly valves used for balancing service, regardless of size, shall have heavy duty weather proof encased gear operators with malleable iron handwheel or crank.

Q. Check Valves for Water Systems: Valves 2 inches and smaller shall have bronze bodies and a regrinding disc and seat with screw-in cap. Valves 2 1/2 inches and larger shall have iron bodies and be non-slam wafer type with stainless pins and springs, and bronze or stainless steel plates.

2.3 STANDARDS OF QUALITY FOR VALVES

SIZE (INCHES)	SERVICE	MEDIA	CLASS	MILWAUKEE	NIBCO	CRANE CO. STOCKHAM OR AS NOTED
2 & SMALLER	GATE VALVE	L.P. STEAM	150	--	T-134	B-120
2-1/2 & LARGER	GATE VALVE	L.P STEAM	125	F-2885A	F-617-O	G-623
* 2 & SMALLER	BALL VALVE FOR SHUTOFF	RECIRCULATING CHILLED WATER	150	BA-400S	T-585-70-66	APOLLO 82-140
* 2 & SMALLER	BALL VALVE FOR SHUTOFF	RECIRCULATING HOT WATER	150	BA-300S	T-595-Y-66	APOLLO 77-140
2 & SMALLER	GLOBE & BALANCING VALVE	CHILLED WATER, HOT WATER	150	590T	T-235-Y	B-22T

2-1/2 & LARGER	GLOBE & BALANCING VALVE	CHILLED WATER, HOT WATER	125	F-2981A	F-718-B	G-512
2-1/2 & LARGER	BUTTERFLY VALVE FOR SHUTOFF	RECIRCULATING CHILLED AND HEATING WATER	150	ML233E (LEVER); ML333 (GEAR)	LD-2000	DEZURIK BHP SERIES
2 & SMALLER	CHECK VALVE	ALL WATER SYSTEMS	150	510T	T-433-Y	B-345
2-1/2 & LARGER	CHECK VALVE	ALL WATER SYSTEMS	125	8800*	W-920-W	CRANE “DUO-CHEK” SERIES

A. * Requires extended stem in insulated lines.

B. Note: Valves 8 inches and larger, and valves used for balancing service regardless of size, shall have heavy-duty weatherproof encased gear operators.

2.4 UNIONS

A. Provide and install two-piece unions at proper points to permit removal of pipe, valves and various equipment and/or machinery items without injury to other parts of the system. No unions will be required in welded lines or lines assembled with solder joint fittings except at all valves, equipment items, machinery items and other special pieces of apparatus. Unions 2 inches and smaller in ferrous lines shall be Class 300 AAR malleable iron unions with iron to brass seats, and 2 1/2 inches and larger shall be ground flange unions. Unions in copper lines shall be Class 125 ground joint brass unions or Class 150 brass flanges if required by the mating item of equipment. Companion flanges on lines at various items of equipment, machines and pieces of apparatus shall serve as unions to permit removal of the particular items. See particular Specifications for special fittings and pressure.

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

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

2.5 FLANGES

A. All 150 lb. and 300 lb. ANSI flanges shall be weld neck and shall be domestically manufactured, forged carbon steel, conforming to ASME B16.5 and ASTM A181/A181M Grade I or II or ASTM A105/A105M as made by Tube Turns or Hackney Ladish Inc. Slip on flanges shall not be used. Each fitting shall be stamped as specified

B. by ASME B16.9 and, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. Allthread rods will not be an acceptable for flange bolts. Steam system flange bolts shall have a tensile strength of 105,000 psi and an elastic limit of 81,000 psi and be rated at least ANSI Grade V. Other bolts shall have a tensile strength of 80,000 psi and an elastic limit of 36,000 psi and be rated at least ANSI Grade I.

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

D. Flange Gaskets

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

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

E. Flange Bolt Installation:
1. Bolt Lubrication: Bolts shall be well lubricated with a heavy graphite and oil mixture.
2. Torque Requirements - Bolts shall be stressed to 45,000 psi.

Nominal Bolt Dia. (Inch)	Torque (Foot-Pounds)
0.25	6
0.3125	12
0.375	18
0.4375	30
0.5	45
0.5625	68
0.625	90
0.75	150
0.875	240
1.0	368
1.125	533
1.25	750
1.375	1020
1.5	1200

1. Torque shall be checked with a calibrated breaking action torque wrench on the final torque round. Bolts shall be cold and hot torqued.
2. Torque Pattern - Shall be a cross or star pattern with at least four passes. Limit each pass to 30 percent of full torque increases.
3. Hot Torque - Re-torque the flange bolts with system at normal operating pressure and temperature for at least four hours.
4. Inspection - Owner shall verify hot torqueing of all medium and high pressure steam flange bolts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify excavations under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.
B. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

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

3.3 INSTALLATION

A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
B. Route piping in orderly manner and maintain gradient.
C. Install piping to conserve building space and not interfere with use of space.
D. Group piping whenever practical at common elevations.
E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
F. Provide clearance for installation of insulation and access to valves and fittings.
G. Coordinate access door location with architectural features.
H. Establish elevations of buried piping outside the building to ensure a minimum of cover. Refer to Section 23 00 00 - UTSW Mechanical Design Requirements .

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

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

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

L. Excavate in accordance with Section 23 00 00 - UTSW Mechanical Design Requirements for work of this Section.

M. Backfill in accordance with Section 23 00 00 - UTSW Mechanical Design Requirements for work of this Section.

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

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

3.4 ERECTION TOLERANCES

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

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

END OF SECTION 23 20 10

SECTION 23 21 13
HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping and pipe fittings for:
   1. Chilled Water Piping
   2. Heating Water Piping
   3. Steam Piping
   4. Steam Condensate Piping
   5. Food Service Heat Rejection Piping

1.2 RELATED REQUIREMENTS

A. Section 23 05 00 - UTSW Mechanical Design Requirements

B. Section 23 21 15 - Hydronic Specialties

C. Section 23 20 10 - Piping, Valves, and Fittings

D. Section 23 07 19 - Piping Insulaiton

E. Section 23 22 23 - Steam and Steam Condensate Specialties

1.3 REFERENCE STANDARDS

A. ASME B1.1 - Unified Inch Screw Threads.

B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.

C. ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard.

D. ASME B16.9 - Factory-Made Wrought Buttwelding Fittings.

E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.

F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.

G. ASME B31.1 - Power Piping.

H. ASME B31.3 - Process Piping.

I. ASME B31.9 - Building Services Piping.

J. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

K. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

L. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.

M. ASTM A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.

N. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

O. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

P. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

Q. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.

R. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.

S. MSS SP-25 - Standard Marking System for Valves, Fittings, Flanges and Unions.

T. ASME B18.2 - Square, Hex, Heavy Hex, and Askew Head bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws; 2013.

U. ASTM A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2010.

V. ASTM A21.51 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water; 2002.

W. ASTM A193 - Standard Specification for alloy Steel and Stainless Steel Bolting Materials for High Temperature Service; 2014.

X. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for bolts for High Pressure or High Temperature Service, or Both; 2014.

Y. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts; 2014.

1.4 SUBMITTALS

A. Submit product data for review on piping and fittings. Submittal data shall include:
   1. Manufacturer of pipe.
   2. Tests or listings by recognized testing laboratory that certifies material composition is in accordance with ANSI/ASTM requirements.
   3. Product data for pipe and fittings to be used on each piping system.
   4. Welding procedures for steel pipe.
   5. Solder and brazing product data and installation procedures for copper pipe.

PART 2 - PRODUCTS

2.1 STEEL PIPE

A. Black steel: Electric resistance welded or seamless, ASTM A53 or ASTM A106 Grade B. Mill wrap uninsulated underground steel pipe with Republic X-Tru-Coat or equal.
   1. Through 10" standard weight Schedule 40
   2. 12" pipe and larger: standard weight with 0.375" wall thickness

B. Provide for the following services:
   1. Chilled water supply and return piping, 1-1/4" diameter and larger. (Contractor option: copper up to 2" diameter; see "COPPER PIPE" below.)
   2. Heating water supply and return piping, 1-1/4" diameter and larger. (Contractor option: copper up to 2" diameter. See "COPPER PIPE" below.)
   3. Food service heat rejection supply and return piping, 1-1/4" diameter and larger (Contractor Option: Copper up to 2" diameter: See "Copper Pipe herein")

C. Schedule 40, seamless: ASTM A53 or ASTM A106, Grade B. Provide for the following services:
   1. Steam piping

D. Schedule 80, seamless: ASTM A53 or ASTM A106, Grade B. Provide for the following services:
   1. Steam Condensate piping
   2. Boiler blowdown piping
   3. Pumped condensate piping

E. Schedule 40, A53 or A106 galvanized pipe for:
   1. Cooling Coil condensate drain piping. (Contractor option: Copper; see "COPPER PIPE" below.)
   2. Drain piping from equipment 1-1/2" diameter and smaller.

2.2 STEEL PIPE FITTINGS

A. Flanges, Fittings, and Unions: Mark in accordance with MSS-SP-25.

B. Fittings:
   1. 2-1/2" and larger: Class 150, wrought steel, butt welded fittings, ASME B16.9
   2. 2" and Smaller
      a. Water Service: Class 150, malleable iron, screwed.
      b. Steam, 125 psi (861.84 kPa) and less: Class 150, A53 malleable iron, screwed, ASME B16.3
      c. Condensate: Class 150 malleable iron, A53 screwed, ASME B16.3

C. Flanges, 2-1/2" and larger: Class 150, A53 wrought forged steel, slip-on or weld neck, ASME/ANSI B16.5. Flange faces shall match equipment or mating flanges (i.e. flat-faced flanges shall be used adjacent to equipment with integral flat-faced flanges, such as pumps, control valves, etc.)

D. Gaskets:
   1. Inorganic fibers, 1/16 or 1/8 inch (3.18 mm) thick, reinforced EPDM binder, 550 degrees Fahrenheit (287.78 degrees Celsius) and 700 psig (4826.33 kPa) operation, Garlock 5507 or equal:
      a. Chilled water
      b. Heating water
   2. Spiral wound "chevron" metallic gaskets, flexible graphic filler, class 150 and 300 service, Flexitallic LS, CG or equal
      a. Steam

E. Unions, 2" and smaller: Material as specified under fittings, screwed with brass seat.

F. Branch connections from mains or headers, 2-1/2" and larger: Welded tees or welding outlets, Bonney Forge Weldolets or Threadolets. Use forged outlets only if branch line is at least one pipe size smaller than main or header.

G. Galvanized steel pipe fittings: Same as above, except galvanized coated.
   1. Provide drainage pattern type fittings for drain piping.

H. Bolting Materials: Torque all bolts to 50% of yield strength or per equipment manufacturer's recommendation, whichever is lower. Use anti-seize lubricant on all bolt threads. Same finished carbon steel bolts and hex nuts, ASTM A307. Threads and Dimensions: ASME/ANSI B1.1 and B18.2.
   1. Systems 210 degrees Fahrenheit (98.89 degrees Celsius) and less: Use ASTM A449 studs or bolts and ASTM-A563 Grade B hex nuts
   2. Systems above 210 degrees Fahrenheit (98.89 degrees Celsius): Use ASTM-A193 Grade B7 studs or bolts and ASTM-A194 Grade 2 Heavy Hex Nuts
   3. Use galvanized bolts and nuts on piping outside outide the building, inside tunnels, and inside manholes.

I. Thread Lubricant: Similar to Crane "Formula 425".

2.3 IPS GROOVED PIPING SYSTEM

A. Grooved piping shall only be allowed in EXPOSED locations and for straight run piping only. Example: Mechanical rooms where piping is visible above/below ductwork.
   1. Applicable Systems:
      a. Chilled Water Supply/Return
      b. Heating Hot Water Supply/Return
      c. Secondary Chilled Water Supply/Return

B. Grooved mechanical pipe couplings, fittings, valves and other grooved components may be used as an option to welding, threading or flanged methods as specified herein. All grooved components shall be of one manufacturer and conform to local code approval and as listed by ASME/ANSI B-31.1, B-31.3, B-31.9, ASME, UL/ULC, FM, IAPMO or applicable Building Code. Grooved end product manufacturer to be ISO-9001 certified. Grooved couplings shall meet the requirements of ASTM F-1476.

C. Grooved Pipe: Carbon Steel, as specified with roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends shall be grooved in accordance with manufacturer's current listed standards conforming to ANSI/AWWA C-606.

D. Mechanical Couplings for Steel Pipe
   1. Acceptable manufacturers: Victaulic. Victaulic model numbers are used to establish product type, quality and performance.
   2. Mechanical couplings shall be manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183. Couplings shall comply with ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

a. Rigid Type: coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity, support, and hanging in accordance with ANSI B31.1, B31.9, with Victaulic Style 107H/107N (Quick-Vic) installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM designed for operating temperature from -30 deg. F (-34 deg. C) to 250 deg. F (120 deg. C).
b. Victaulic AGS mechanical couplings, 14 inch (355.6 mm) through 60 inch (1524 mm): Couplings shall consist of two ASTM A-536 ductile iron housing segments with lead-in chamfer on housing key and a wide-width elastomer pressure responsive gasket. Victaulic Style W07 AGS Rigid and Style W77 AGS Flexible Coupling.

2.4 COPPER PIPE

A. Conform to ASTM B-88 specification for wrought seamless copper.

B. Type L, hard for:
1. HVAC reheat water pipe, 1" and smaller; Contractor option for copper or steel pipe 1-1/4" to 2".
2. HVAC chilled water pipe, 1" and smaller. Contractor option for copper or steel pipe 1-1/4" to 2".
3. Food service heat rejection supply and return water piping, 1" and smaller. Contractor option for copper or steel pipe 1-1/4" to 2".

C. Type M, hard for:
1. For non-pressurized drain piping.
2. Fan coil unit condensate piping.
3. Cooling coil condensate piping.

2.5 COPPER PIPE FITTINGS

A. Sweat type, wrought copper, ASTM B62, with dimensions conforming to ASTM/ANSI B16.22 and sweep patterns for copper tubing.

B. Dielectric Connections:
1. Provide at junction of copper pipe and equipment with steel piping systems.
2. Central, Dielectric insulating unions, and insulating flange unions, as manufactured by Central Plastic Company or CTS Fabrication USA (1-1/2" thru 8").
3. Provide copper solder joint to plated female iron pipe for sizes 1/2" through 2".
4. Provide insulating flange unions, malleable female iron pipe thread to copper solder joint flange unions for sizes 2-1/2" through 4".
5. Brass fittings and valves may not be used for dielectric union locations.

C. Unions: Brass ground joint, 250 lb. working pressure.

D. Nipples: Brass.

2.6 MISCELLANEOUS PIPE ACCESSORIES

A. Escutcheons: Chrome pipe escutcheons, slip-on or split type where pipe passing through finished walls or ceiling may be visible.

B. Exposed Metal Pipe and Trim: Chrome plated.

C. Control System Connectors: Crane No. 386, 1" steel half couplings, or 1" female pipe thread connectors.

D. Install 18 gauge sheetmetal or galvanized steel pipe saddles to protect insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Clean inside of pipe before installation. Keep installed piping clean, and protect ends from foreign matter by capping or plugging them.

B. Install pipe so that it does not interfere with opening of doors or apparatus, access to equipment, or to electrical equipment.

C. Do not install pipes in such a way that they will apply torque to pumps. After pumps have been installed and pumps have been operated, recheck and realign pumps if necessary.

D. Run pipes in straight lines and square with building. Install risers plumb. Make offsets only where indicated and where necessary.

E. Install branch connections using separate tee or lateral fittings for each branch. Do not combine branches into "bullhead tee" arrangement.

F. Do not install water pipes in electric rooms, tele/data rooms, transformer rooms, audio/visual rooms or elevator equipment rooms. Fire protection piping runouts serving only these rooms shall be installed in these rooms.

G. Do not install piping above electrical equipment such as starters, variable frequency motor controllers, motor control centers, or disconnects. Maintain code required clearance above, below and to sides of electrical equipment.

H. Provide flanges or unions throughout the pipe systems at all equipment. Make provisions for servicing and removal of equipment without dismantling piping.

I. In so far as possible, drainage piping shall not be installed overhead, whether exposed or above ceiling, in operating rooms, delivery rooms, nurseries, food preparation or serving areas, or in rooms listed above. Where unavoidable, provide drain troughs or other means to carry away leakage.
   1. Slope cooling coil condensate drains at 1/8" per foot.

J. Slope steam pipes and steam condensate drain pipes at 1/4" per 10 feet (304.8 cm). Do not raise condensate pipe except at ends of main drips.

K. Branch Lines:
   1. Where possible branch lines shall come off top of mains to prevent sediment, welding slag, or pipe burrs from entering the branch lines and causing valve leakage or failure.

3.2 PIPE JOINTING

A. Preparing Pipe Ends:
   1. Machine cut pipe ends square.
   2. Ream pipe ends, after cutting, to full diameter.
   3. Where pipe is to be threaded, secure pipe in pipe stand, die cut, full depth, right hand threads. Threads to be taper type.
   4. All threaded pipe joints to have suitable pipe sealant applied to threads prior to assembly of joint. Joints shall be leak proof.
   5. Where pipe is to be welded, die-cut end of butt joints at 30 degree taper. Weld should have a full penetration with no bubbles or holes. Remove all slag.

B. Welded Steel Piping:
   1. Where welded piping is specified, make welds by oxy-acetylene process or electric process in accordance with ASME/ANSI B31.1.
      a. Welding Rods: Grade recommended for purpose by manufacturer's and identification.
   2. Line welds, single V-butt type:
      a. Mill or machine bevel pipe at 37 1/2 degrees to within 1/16" of inside wall, except that in field limited amount of pipe may be flame beveled.
      b. Pipe with a wall thickness of 3/16" or less need not be beveled but may be welded by melting down into building up over abutting ends.
      c. Separate abutting ends of joints before welding to permit complete fusion to bottom without overlapping.
      d. Tack in two or more points to maintain alignment, and fusion weld.
   3. Make all welds of sound weld metal, thoroughly fused into ends of pipe, and to bottom of vee.
      a. Build in excess of pipe wall to give reinforcement to one fourth pipe wall thickness.
      b. Weld metal shall present a gradual increase in thickness from surface of pipe to center of weld.
      c. Minimum weld width: Two and one half times thickness of pipe wall.
   4. Use welding ells at turns in welded lines

5. Do not weld pipe couplings in place of welding fittings for any branch connections.
6. Weld-o-lets and thread-o-lets:
    a. Scribe and cut openings in main pipes for welded branches accurately taking care to remove all of plugs and cuttings from main pipe.
    b. Full weld fillet welds for full depth of fillet, with additional beads to form well rounded connection as recommended by weld-o-let manufacturer.
7. Cut openings into pipe for welded connections accurately to give matched intersections.
8. Make welded fittings of same material with same pressure and temperature rating as pipe with which they are used.
9. Make flanged connections to control valves, pump suction and specialties with ANSI standard welding neck flanges. All other flange connections may be made with slip-on flanges provided they are seal welded on inside.
10. Fuse all fillet welds for flanges or fittings into pipe and plate for minimum distance of 1-1/2 times pipe wall thickness and depth weld on 1-1/4 times pipe wall thickness.

C. Grooved Coupling Installation:
1. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.
2. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
3. All grooved components (couplings, fittings, valves, gaskets, bolts and nuts) shall be of one manufacturer.
4. Grooved joints shall be installed in accordance with manufacturer's latest published installation instructions.
5. Grooved ends shall be clean and free from indentations, projections, and roll marks.
6. A factory trained field representative (direct employee) of the mechanical joint manufacturer shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. The factory trained representative shall periodically review the product installation and ensure best practices are being followed. Contractor shall remove and replace any improperly installed products at their cost. A distributor's representative is not considered qualified to conduct the training.

D. Soldered and Brazed Joints:
1. Make Type L and M copper pipe joints with suitable flux and 95/5, lead free solder.
2. Make Type K copper pipe joints with silver (BAg Series) brazing filler material with flux or copper-phos (BCup Series) brazing filler material without flux per the recommendations of the Copper Development Association.

E. "T" Drill Branch Connections are not allowed.

F. Bracing Joints:
1. Provide braces and bridle rods as required to reinforce joints.
2. If mechanical lock type couplings are used, then prepare pipe ends and make joints in accordance with pipe coupling manufacturer's printed instructions.
3. Where large pipes underground are subject to shock because of sudden changes in liquid flow rate, provide concrete "kicker" blocks at joints, fittings, and changes of pipe direction. Provide "kicker" blocks in accordance with applicable pipe industry trade or research organization recommendations.
    a. For example, for ductile iron pipe follow recommendations of Ductile Iron Pipe Research Association.

3.3 ESCUTCHEONS

A. Provide chrome plated escutcheons where uninsulated pipes penetrate walls or ceilings of finished spaces.

3.4 STRAINERS

A. Install strainers so the strainer basket can be removed without spilling water on motors and electrical equipment.

3.5 AIR VENTING

A. Provide manually operated air vents at high points in vertical risers and at water coils to eliminate air from systems. Air vents are not required at reheat coils.

B. Use ball valves for manual air vents.

3.6 VALVE ACCESS

A. Locate ceiling/wall access panels at shut-off and control valves for proper access and operation. Furnish and install access doors in accordance with Section 23 05 00 and other Divisions as applicable.

3.7 CONTROL SYSTEM CONNECTORS

A. Weld connectors at points indicated, and at other points where necessary for installation of thermometers, sensors, and automatic controls.

3.8 TESTING

A. Before piping is concealed or insulated, recheck it for leaks.

B. Rework or replace defective and leaking joints, and joints which are otherwise unsatisfactory. Peening, caulking, and doping are not permitted.

END OF SECTION 23 21 13

SECTION 23 21 15

HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Air vents.
B. Strainers.
C. Water flow measuring and balance system.

1.3 RELATED REQUIREMENTS

A. Section 01 91 00 - General Commissioning Requirements .
B. Section 22 00 10 - Basic Plumbing Requirements.
C. Section 23 00 00 - UTSW Mechanical Design Requirements.
D. Section 23 21 13 - Hydronic Piping.

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ASME BPVC - Boilers and Pressure Vessels Code.
C. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels.

1.5 REGULATORY REQUIREMENTS

A. Conform to ASME BPVC-VIII-1for manufacture of tanks.

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 under provisions of Section 22 00 10 - Basic Plumbing Requirements.
    1. Submit shop drawings and product data for manufactured products and assemblies required for this project.
B. Include component sizes, rough-in requirements, service sizes, and finishes Include product description, model and dimensions.
C. Submit inspection certificates for pressure vessels from authority having jurisdiction.
D. Submit manufacturer`s installation instructions under provisions of Section 22 00 10 - Basic Plumbing Requirements.
E. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Include installation instruction, assembly views, lubrication instructions, and replacement parts list.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 22 00 10 - Basic Plumbing Requirements.
B. Store and protect products under provisions of Section 22 00 10 - Basic Plumbing Requirements.

PART 2 - PRODUCTS

2.1 AUTOMATIC AIR VENTS

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

2.2 STRAINERS

A. Strainers, 2 inches and smaller, bronze body, screwed ends, No 10 mesh strainer, screwed cap with bronze blow-off valve (size to be determined by standard tap size in cap).
B. Cast iron body, 2-1/2 inches and larger, isolating type flanged ends where installed in copper lines, No 7 perforated monel strainer, flanged cap with bronze ball blow-off valve (size of blow-off valve shall be determined by standard tap size in cap).
   1. Special Note: Strainers 6 inches and larger shall have studs mounted in the body flange in lieu of bolts for removal of cap.
C. Baskets for strainers 6 inches and larger shall have stainless steel reinforcing bands at ends to prevent collapsing.
D. Suction diffusers shall be Paco or approved equal, cast iron body and cover, steel diffuser, and stainless steel strainer, 125 pound ASA (flat face) flange for a working pressure of 175 psi and temperature of 300°F.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer`s instructions to permit intended performance.
B. Support from building structure in accordance with manufacturer`s instructions.
C. Provide manual air vents at system high points and as indicated.
D. Provide manual air vents at entrance to all water coils, with a "cane" shaped discharge tube, positioned to permit draining to a portable receptacle.
E. For automatic air vents in ceiling spaces or other concealed locations, extend vent tubing to nearest drain.
F. Provide full supply line size strainers on all branches to chilled water coil connections Do not reduce to coil inlet piping size.
G. Provide valved drain and hose connection on strainer blow down connection.
H. Provide pump suction fitting on suction side of base mounted centrifugal pumps.
   1. Remove temporary strainers after cleaning systems.
   2. Clean all permanent strainers after circulating systems for a minimum of 48 hours at full capacity.
I. Support pump fittings with floor mounted pipe and flange supports.
J. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
K. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity Select equipment relief valve capacity to exceed rating of connected equipment.
L. Pipe relief valve outlet to nearest floor drain.
M. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 23 21 15

SECTION 23 22 23

STEAM AND STEAM CONDENSATE SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Steam traps.
B. Inverted bucket traps.
C. Float and thermostatic traps.
D. Thermostatic traps.
E. Flash tanks.
F. Condensate pumping units.
G. Steam pressure reducing valves.
H. Steam relief valves.
I. Steam safety valve discharge elbows.
J. Steam muffler attachments.
K. Steam pipe anchors.
L. Steam pipe guides.
M. Drip traps.
N. Sediment strainers.
O. Gauges and gauge connections.
P. Thermometer and thermometer wells.

1.3 RELATED REQUIREMENTS

A. Section 23 00 00 - UTSW Mechanical Design Requirements.
B. Section 23 05 15 - Mechanical Piping, Valves, and Fittings.
C. Section 23 05 13 - Motors.
D. Section 23 05 29 - Supports and Anchors.
E. Section 23 07 19 - Piping Insulation.
F. Section 23 07 16 - Equipment Insulation.
G. Section 23 21 15 - Hydronic Specialties.
H. Section 23 22 13 - Steam and Steam Condensate Piping.

1.4 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
B. ASTM A105/A105M - Forgings, Carbon Steel, for Piping Components.
C. ASTM A126 - Gray Iron Casings for Valves, Flanges, and Pipe Fittings.
D. ASTM A216/A216M - Steel Casings, Carbon, Suitable for Fusion Welding, for High Temperature Service.
E. ASTM A395/A395M - Ferric Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
F. ASME B31.9 - Building Services Piping.

1.5 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 - Building Services Piping.

1.6 QUALITY ASSURANCE

A. For each product specified, provide components by same manufacturer throughout.

1.7 SUBMITTALS

A. Submit shop drawings and product data under provisions of Division 01 and Section 23 00 00 - UTSW Mechanical Design Requirements for manufactured products and assemblies required for this project.
   1. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
B. Submit schedule indicating manufacturer, model number, size, location, rated capacity, and features for each specialty.
C. Submit manufacturer's installation instructions under provisions of Division 01 and Section 23 00 00 - UTSW Mechanical Design Requirements.
D. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section Division 01 and Section 23 00 00 - UTSW Mechanical Design Requirements.

1.9 ATTIC STOCK

A. Provide two service kits for each size and type of steam trap under provisions of Division 01 and Section 23 00 00 - UTSW Mechanical Design Requirements.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - STEAM TRAPS

A. Armstrong.
B. Spirax/Sarco.
C. ITT Hoffman.
D. Substitutions: Under provisions of Division 01 and Section 23 00 00 - UTSW Mechanical Design Requirements.

2.2 INVERTED BUCKET TRAPS

A. Cast iron or semi-steel body and bolted cover for 250 psig WSP; provide access to internal parts without disturbing piping; with top test plug and bottom drain plugs, brass or stainless steel bucket, stainless steel seats and plungers, and stainless steel lever mechanism with knife edge operating surfaces, integral inlet strainer of monel or stainless steel.

2.3 FLOAT AND THERMOSTATIC TRAPS

A. ASTM A126, cast iron or semi-steel body and bolted cover for 250 psig WSP; provide access to internal parts without disturbing piping; with bottom drain plug, stainless steel or bronze bellows type air vent, stainless steel or copper float stainless steel lever and valve assembly.

2.4 THERMOSTATIC TRAPS

A. Pressure balanced type with ASTM A216 WCB cast steel body and bolted or screwed cover, and integral ball joint union, for 300 psig WSP; monel or stainless steel bellows, stainless steel valve and seat, integral stainless steel strainer.
B. Freeze proof type with cast iron body for 300 psig WSP, bronze bellows, stainless steel valve and seat, external adjustment.
C. Bi-metallic type with ASTM A105 forged steel body and cover, for 300 psig WSP, bi-metal element with stainless steel components, integral Type 304 stainless steel strainer screen, 1/4 inch blow down valve.

2.5 FLASH TANKS

A. Closed type, welded steel construction, tested and stamped in accordance with Section 8D of ANSI/ASME Boilers and Pressure Vessels Code for 125 psig working pressure; cleaned, prime coated, and supplied with steel support legs.
B. Construct with nozzles and tappings for installation of accessories and piping connections.

2.6 CONDENSATE PUMPING UNITS

A. Condensate pumping units shall be Duplex Type manufactured by Sarco, Armstrong, Skidmore, Aurora, or approved equivalent.
   1. Unit shall be complete with 3/16 inch thick steel receiver galvanized inside and outside and shall have magnesium anode protection.

2. Each motor shall be provided with a fused safety switch and a magnetic starter providing overload and undervoltage protection.
3. Magnetic starters shall be provided with three pole overload protection.
4. The pump shall be bronze fitted throughout.
5. The bearings shall be such as to protect them from dust and corrosion.
6. Each duplex pump shall be mounted on a heavy steel mounting plate.
7. Each unit shall have fully automatic control by a float and float switch.
8. 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 A.
9. ll accessories and auxiliaries, such as pressure gauges, water gauge glasses, etc , shall be installed complete.
10. The electrical wiring required shall be so complete that no wiring beyond that required by the driving motor need be supplied in the field.
    a. Such units shall be tested at the factory and adjusted prior to shipment.
11. Alternator preferably shall be mechanical type.
    a. If electrical alternator is used, it shall be Allen Bradley.
12. Pumps shall be capable of pumping 212 degrees F condensate at the controlled water level.
    a. Each pump shall have stainless steel shafts.
13. Contractor shall furnish an extra set of Viton seals or provide the pump with Viton seals installed.
14. No turbine pumps will be permitted: only centrifugal type pumps shall be provided.

B. Capacities and electrical characteristics shall be as scheduled on Drawings.

C. Provide high level alarm switch complete with transformer, bell and one set of normally open contacts for connection to the Energy Management System.

D. Submit complete wiring diagram for this specific contract.

2.7 STEAM PRESSURE REDUCING VALVES

A. All pressure reducing valves shall be capable of maintaining the set pressure from zero to the maximum steam flow within reasonable limits when subjected to usual steam pressure fluctuations.
1. They shall be single seated valves with stainless steel trim, with renewable valve, lugs and seats.
2. Valve bodies shall be cast steel for high pressure service and cast iron for medium and low pressure service.
    a. These valves shall be self contained type with upstream and downstream pressure gauges and shall be installed as per manufacturer`s recommendations.
    b. Valve capacities are scheduled on the drawings.
    c. Each stage of pressure reduction shall consist of two PRVs sized 113 and 2/3 capacity.
    d. Discharge pressure shall be adjustable to any value between 10 psig and 75 percent of the supply pressure.

B. All pressure regulators 2-1/2 inches and larger shall have flanged connections and those 2 inches and smaller may have screwed connections.
1. Unions shall be installed on each side of any screwed pattern regulators installed.

C. Each reducing valve shall be preceded by a sediment strainer complete with a full-sized blow off valve with threaded end for hose connection.
1. These valves shall be Leslie, Spence, Spirax Sarco, Fisher, Mason Neilan, or approved equal, with suitable automatic controllers.

2.8 STEAM RELIEF VALVES

A. Relief valves 2 inches and smaller shall have brass bodies and arranged for screwed connections.
1. Such relief valves shall be Crane No 2501 or Spirax Sarec 6010 Brass Safety Valves for steam or approved equal Bushings shall not be used.

B. Relief valves 2-1/2 inch and larger shall in the case of all medium and low pressure steam piping systems be arranged for flanged inlet and screwed outlet connections.
1. Such relief valves shall be Consolidated Type 1511 or Spirax Sarco 252, ASME Standard Cast Iron Safety Valves, or approved equal.

C. The pressure at which each relief valve shall open is designated on the Drawings.
1. When such valves are ordered by the Contractor, he shall definitely specify the pressure at which each relief valve is to be set.

2. Each valve shall have a metal tag attached stamped with the valve identification plus the pressure setting.

2.9 STEAM SAFETY VALVE DISCHARGE ELBOWS

A. All vent lines from safety valves shall be provided with safety valve discharge elbows at the point at which such lines rise to an elevation higher than that of the safety valve.
   1. 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.
   2. These safety valve discharge elbows shall be Grinnell Company`s Safety Valve Drip Pan Elbows Figure No 1538F, Spirax Sarco No 299, or approved equivalent.
   3. No force shall be exerted on the safety valve by the discharge piping.

2.10 STEAM MUFFLER ATTACHMENTS

A. At the point at which vent lines from safety valve discharge elbows terminate, a muffler attachment of the proper size shall be installed.
   1. Muffler attachments shall be screwed pattern members Consolidated Type 1441, or approved equal.

2.11 STEAM PIPE ANCHORS

A. All steam fines shall be securely anchored at points designated on the Drawings and/or at such points as required to assure proper control of the expansion and contraction of such systems.
B. See Section 23 05 29 - Supports and Anchors for additional requirements.

2.12 STEAM PIPE GUIDES

A. All steam piping systems shall be properly guided as shown on the Drawings or as directed by Engineer.

2.13 DRIP TRAPS

A. High pressure drip trap assemblies shall be provided wherever called for on the Drawings and where required to keep such piping systems completely drained of condensate.
   1. Traps used in assemblies shall be 3/4 inch traps unless specifically shown to the contrary, i e , they shall have 3/4 inch inlet and outlet connections.
   2. They shall have semi-steel bodies and the internal operating mechanisms shall be made of heat treated chrome steel.
   3. The caps shall be bolted to the bodies by the use of allay steel heat treated machine bolts
   4. These No 213 Armstrong Traps, manufactured by Armstrong Machine Works, or approved equal, shall have a capacity for discharging at least 3,500 pounds of condensate per hour when operating at a pressure of 250 pounds per square inch.
   5. Where drip traps are installed in conjunction with 3 inches and larger steam lines, a drip pocket of the nature detailed on the Drawings shall be provided where a natural pocket does not exist
   6. The piping and valves in trap assemblies shall be arranged as detailed on the Drawings; extra strong pipes shall be used on both sides of the trap.
B. All drip traps used in medium pressure steam piping systems where automatic steam control valves are not employed shall be arranged as shown on the Drawings.
   1. They shall be 3/4 inch Armstrong No 811 Inverted Bucket Traps, or approved equal, with cast iron bodies, vacuum breakers and stainless steel trim.
   2. Each trap shall be provided with a valved test line and shall be preceded by a sediment strainer.
C. Condensate from coils, converters, hot water generators, low pressure drips and from all other devices where modulating steam valves are employed shall be of the float and thermostatic type.
   1. These traps shall be sized to handle 200 percent of the load with an inlet pressure drop of 0 5 psig and shall be equal to Armstrong "A" or "B" series, with vacuum breaker suitable for the system pressures.
   2. Installed traps with less than 12 inches of height between equipment outlet and trap inlet shall be sized for not less than 300 percent of the load.
   3. Each trap shall be provided with a 1/2 inches valve test line and shall be preceded by a sediment strainer
   4. Under no circumstances shall a float and thermostatic trap be installed in a manner to lift condensate up in a return line.
D. Shop Drawing submittal of traps shall contain an itemized list with a tabulation of the load, trap type, and trap size.

2.14 SEDIMENT STRAINERS

A. Each drip trap assembly, each control valve, for steam and each pressure reducing valve assembly regardless of its size shall be preceded by a sediment strainer.
   1. The arrangement of these sediment strainers shall be such that the screens may be removed for cleaning with ease through a gasketed plug.

B. Sediment strainers shall be placed in steam piping systems wherever shown on the Drawings and at such other points as may be required for the removal of foreign material from the piping systems.

C. Strainers in high pressure steam piping shall be cast steel sediment strainers and shall be suitable for working steam pressures as high as 300 pounds per square inch and temperatures not in excess of 750 degrees F.
   1. Strainers shall be the size designated on the Drawings.
   2. In the case of pipe sizes 2-1/2 inch and larger, Ranged pattern sediment strainers shall be used In the case of pipe smaller than 2-1/2 inch, screwed pattern shall be used.
      a. Such strainers shall be Yarway No 821 or 822 strainers manufactured by Yarnall Waring Company, or approved equal.
      b. The flanges of Ranged strainers shall be dimensioned, faced, dolled, and spot faced to conform to the 300 pound American Standard for Steel Pipe Flanges and Flanged Fittings (B16e-1939).

D. Strainers in low and medium pressure steam piping systems 2-1/2 inch and larger shall be flanged iron body strainers having bolted covers.
   1. These strainers shall be suitable for operating pressures as high as 125 psig.
   2. They shall be Crane Company No 989-1/2 Sediment Separators, or approved equal.

E. Sediment strainers in low and medium pressure steam piping systems 2 inches and smaller shall be arranged for screwed pipe connections.
   1. They shall be Crane No 988-1/2 Sediment Separators, or approved equal.

F. Full sized blow off valves shall be installed on all strainers in steam, condensate, chilled and hot water lines.

2.15 GAUGES AND GAUGE CONNECTIONS

A. See Section 23 05 19 - Meters and Gauges.

2.16 THERMOMETER AND THERMOMETER WELLS

A. See Section 23 05 19 - Meters and Gauges.

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 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 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 Refer to schedules on Drawings for relief valve settings.

N. Terminate relief valves to outdoors with muffler attachment 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 23

SECTION 23 31 00

DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Low Pressure Ducts.
B. Medium and High Pressure Ductwork.
C. Casings.
D. Kitchen Hood Ductwork.
E. Duct Cleaning.

1.3 RELATED REQUIREMENTS

A. Division 09 Section, Painting, priming or coating of metal ductwork exposed to view.
B. Section 23 00 00 - UTSW Mechanical Design Requirements
C. Section 23 05 29 - Supports and Anchors
D. Section 23 05 53 - Mechanical Identification
E. Section 23 07 13 - Ductwork Insulation
F. Section 23 33 00 - Ductwork Accessories
G. Section 23 36 00 - Air Terminal Devices
H. Section 23 37 00 - Air Inlets and Outlets
I. Section 23 05 93 - Testing, Adjusting, and Balancing

1.4 REFERENCE STANDARDS

A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals.
B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications.
C. ASTM A90 - Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
E. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
F. NFPA 45 - Standard on Fire Protection for Laboratories Using Chemicals.
G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
H. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
I. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
K. SMACNA (ROUND) - Round Industrial Duct Construction Standards.
L. Texas Government Code Chapter 2252.001-005 - Texas Government Code Chapter 2252.001-005.
M. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

1.5 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.
B. Low Pressure: 3 inch WG positive or negative static pressure and velocities less than 1,500 fpm.
C. Medium Pressure: 6 inch WG positive static pressure and velocities greater than 1,500 fpm.
D. High Pressure: 10 inch WG positive static pressure and velocities greater than 2,500 fpm.

1.6 SUBMITTALS

A. Product Data:
   1. Provide product data for all ductwork systems to be used on project. Product data submittals shall include the following as a minimum:

a. System name and type.
b. Duct system design pressure.
c. Hangers and supports, including materials, fabrication, methods for duct and building attachment.
d. Sealant type.

B. Shop Drawings shall be submitted on all items of sheet metal work specified herein.
1. Shop Drawings of ductwork at air units shall be submitted at a minimum scale of 3/8 inch equal to one foot.
2. Shop drawings of ductwork located at all other locations shall be prepared at a scale of not less than 1/4 inch equal to one foot.
3. Reproduction and submittal of the construction documents is not acceptable.
4. Shop drawings shall include the following:
a. Clearance dimensions between ducts and dimensions above finished floors for bottom and tops of ducts.
b. Call out of duct materials other than galvanized including but not limited to stainless steel, aluminum, or prefabricated fire rated ductwork.
c. Shop Drawings shall indicate location of all supply, return, exhaust and light fixtures from the approved reflected ceiling plans.
d. Shop drawings shall identify all duct sizes, reinforcement and spacing.
e. Penetrations through fire rated and other partitions.
f. Show major equipment with ductwork connections.
g. Show all dampers, turning vanes, access doors, fire dampers and all other ductwork accessories to be provided.
h. Submit shop drawings and product data under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements

C. Submit two samples of stainless steel welded duct joint to Engineer and Owner for approval. After approval, sample shall remain at job site for reference.

D. Welding Certificates. Provide for all welders including procedures and standards of acceptance.

E. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Store and protect products under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.

PART 2 - PRODUCTS

2.1 DUCTWORK GENERAL:

A. 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.
1. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA Duct Manuals where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein.
2. All exhaust ductwork including toilet room exhausts shall be constructed and leak tested as specified for medium pressure supply ducts at negative pressure.

B. All ductwork shown on the Drawings, specified or required for the heating, ventilating and air conditioning systems shall be constructed and erected in a first class workmanlike manner.
1. The work shall be guaranteed for a period of 1 year from and after the date of acceptance of the job against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation.
2. After the system is in operation, should these defects occur, they shall be corrected as directed by the Architect.

C. All duct sizes shown on the Drawings are air stream sizes. Allowance shall be made for internal lining where required, to provide the required cross sectional area.

D. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for any length of time.

E. Except for special ducts specified elsewhere herein, all sheet metal used on the project shall be constructed from prime galvanized steel sheets and/or coils up to 60 inches in width.
   1. Each sheet shall be stenciled with manufacturer's name and gauge.
   2. Coils of sheet steel shall be stenciled throughout on 10 foot centers with manufacturer's name and must be visible after duct is installed.
   3. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in SMACNA's "HVAC Duct Construction Standards."

F. Where ducts that are exposed to view (including equipment rooms), pass through walls, floors or ceilings, furnish and install sheet metal collars around the duct.

2.2 DUCTWORK LOW PRESSURE: (INCLUDES ALL EXHAUST DUCTWORK DOWNSTREAM OF FANS.)

A. The scope of low pressure ductwork is defined as all ductwork downstream of terminal units, and all exhaust ductwork downstream of fans.
   1. Construction of all low pressure duct shall be in accordance with Low Velocity Duct Construction Standards as published by Sheet Metal and Air Conditioning Contractors National Association (SMACNA) and shall be sealed and tested at 3 inch static with the same test procedures as medium pressure ductwork.

B. Spiral wound round duct shall be as manufactured by United McGill Sheet Metal Company or approved equal.

C. The metal gauges listed in the 1995 SMACNA HVAC Duct Construction Standards for Metal and Flexible Duct are the minimum which shall be used for this project.
   1. It shall be noted that the Contractor is responsible that the metal gauge selected is heavy enough to withstand the physical abuse of the installation.

D. Elbows:
   1. Elbows shall be radius type and have a centerline radius of 1-1/2 times the duct diameter or width.
   2. Elbows in round ducts may be smooth radius as described above or 5-piece 90 degree elbows and 3-piece 45 degree elbows.
   3. Joints in round ducts shall be slip type with a minimum of three sheet metal screws.
   4. Joints in sectional elbows shall be sealed as specified for duct sealing. 90˚ mitered elbows are not acceptable unless approved by the Architect/Engineer or Project Manager.

E. SEALANT:
   1. All ductwork (except welded exhaust duct) shall be sealed with either "MP" (Multi-Purpose), Hardcast "Iron-grip 601", Polymer Adhesive "Airseal #11", or "United Duct Seal" (United McGill Corp.) water base, latex or acrylic type sealant.
   2. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project.
   3. For exterior applications, "Uni-Thane " (United McGill Corp.) polyurethane based sealant shall be used.
   4. No other sealants may be used.
   5. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3 inch wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth.
   6. All sealants shall be UL rated at no more than flame spread of 5 and smoke developed of 0.
   7. At contractor’s option, Hardcast 1602 sealant tape may be used in lap joints and flat seams.

2.3 DUCTWORK MEDIUM PRESSURE: (INCLUDES ALL EXHAUST DUCTWORK UPSTREAM OF FANS).

A. The scope of medium pressure ductwork is defined as all ductwork downstream of all air handlers, up to and including terminal units, plus all return air ductwork.

B. Construction of all ducts shall be in accordance with High Velocity Construction Standards as published by SMACNA. All round and rectangular duct construction, duct fittings, dampers, etc., are covered in this manual and it is to be adhered to.
   1. Spiral wound round duct shall be as manufactured by United McGill Sheet Metal Company or approved equal.
   2. The metal gauges are listed herein for round duct and for rectangular duct.

C. All ductwork (except welded exhaust duct) shall be sealed with either "MP" (Multi-Purpose), Hardcast "Iron-grip 601", or "United Duct Seal" (United McGill Corp.) water base, latex or acrylic type sealant. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project.

D. For exterior applications, "Uni-Thane" (United McGill Corp.) polyurethane based sealant shall be used. No other sealants may be used.

E. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3 inch wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth.

F. At contractor's option Hardcast 1602 sealant tape may be used in lap joints and flat seams.

G. Testing of Medium Pressure Ductwork: (Includes from fan discharge through to the discharge of terminal units.)

1. All medium pressure ducts shall be pressure tested according to SMACNA Chapter 10 test procedures.
    a. Design pressure for testing ductwork shall be 6 inches of water.
    b. Total allowable leakage shall not exceed 1 percent of the total system design air flow rate.
    c. When partial sections of the duct system are tested, the summation of the leakage for all Sections shall not exceed the total allowable leakage.
2. The entire system of medium pressure ductwork shall be tested, including the VAV/Constant Volume Terminal Units (i.e. The ductwork shall be capped immediately prior to the Terminal Units, and tested as described above).
    a. After testing has proven that the ductwork is installed and performs as specified, the terminal units shall be connected to the ductwork and the connections sealed with extra care.
    b. The contractor shall inform the project inspector when the joints may be visually inspected for voids, splits, or improper sealing of the joints.
    c. If any leakage in the terminal unit connections/joints after the systems have been put into service, the leaks shall be repaired by:
        1) Complete removal of the sealing materials.
        2) Thorough cleaning of the joint surfaces.
        3) Installation of multiple layers of sealing materials.
3. At the option of the Owner, the Contractor may be allowed to eliminate the terminal units from testing by capping the supply ductwork prior to the terminal units, then inspecting the connection to the terminal units when complete. This option may only be exercised by the Resident Construction Manager, and then only if documented in writing prior to testing.

H. All exhaust ductwork, including toilet room exhausts, shall be constructed as for medium pressure ducts and shall be tested for leaks in the same manner as for medium pressure supply ducts.

I. Contractor may use DUCTMATE or Ward flanged Duct Joint system, reference SMCNA FIG. 1-4 "Transverse Joints" T-25a or T-25b on rectangular ductwork. Slip-on duct flanges are not acceptable. Contractor may at his option (where space permits) use rectangular ductwork with DUCTMATE or Ward system in lieu of oval ductwork.

J. Elbows:

1. Rectangular 90 degree elbows shall be constructed with single thickness turning vanes mounted on an integral rail.
2. Mitered 90 degree elbows are not allowed unless approved by the Engineer and Construction Manager.
3. Radius type rectangular elbows shall have a centerline radius of 1-1/2 times the duct diameter or width.
4. Elbows in round or oval ducts may be smooth long radius as described above or 5-piece 90 degree elbows and 3-piece 45 degree elbows.
5. Joints in round ducts shall be slip type with a minimum of three sheet metal screws. Joints in sectional elbows shall be sealed as specified for duct sealing.

2.4 VANES

A. Where rectangular elbows are shown, or are required for good air flow, contractor shall provide and install turning vanes.

B. Turning vanes shall be factory fabricated with integral support rail.

C. Radius elbows shall have a centerline radius of not less than one and one-half (1-1/2) times the duct width.

D. Submit Shop Drawings on factory fabricated and job fabricated turning vanes. Provide turning vanes in all rectangular radius elbows and offsets.

E. All turning vanes shall be anchored to the cheeks of the elbow in such a way that the cheeks will not breathe at the surfaces where the vanes touch the cheeks.

2.5 FLEXIBLE DUCTS

A. Low Pressure Insulated Flexible Duct may be used where shown on the drawings.

B. Duct shall be made with factory preinsulated duct supported by a corrosion resistant metal spiral, or a coated spring steel helix and solid inner liner mechanically interlocked or permanently bonded to the helix wire, covered with a minimum of 1-1/2 inch thick, 3/4 pound density fiberglass blanket sheathed in a vapor barrier of fiberglass reinforced aluminum foil and Mylar laminate.

1. The insulation shall have a minimum "K" factor of 0.29 at 60 degrees F. mean and a vapor barrier permeability rating of 0.05 per ASTM method E96-66, Procedure A.
2. The C factor shall be 0.24 to meet HUD requirements.

C. The duct shall be rated for a positive working pressure of 10 inches w.g. and a temperature of up to 250 degrees F.

D. The duct shall comply with NFPA 90A and be listed and labeled by Underwriters Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA, and other U. S. Government standards; flame spread, not over 25; smoke developed, not over 50.

E. Flexible ducts shall be not more than 5 feet in length, shall be installed as indicated in the diffuser connection detail, and shall be Flexmaster Type 1M or approved equal.

F. Connections:

1. The terminal ends of the duct core shall be secured by compression coupling or stainless steel worm gear type clamp equal to Ideal Series 56 Snaplock.
2. The fittings on Air Devices and on sheet metal duct shall be coated with the sealant specified for low pressure ductwork, then flexible duct core slipped over duct and coupling or clamp tightened, then connection sealed with more sealant.
3. Insulation of flexible duct shall be slipped over connection to point where insulation abuts mixing box or insulation on duct.
4. These insulation connections shall be sealed by imbedding fiberglass tape in the sealant specified for medium pressure ductwork and coating with more sealant to provide a vapor barrier. (This applies to all flex connections to diffusers, grilles, etc. when allowed on the drawings.)
5. Medium and High Pressure Insulated Flexible Duct:
   a. Shall be factory applied insulation of 1 inch minimum thickness, 3/4 pound density with a permeability rating of 0.30.
   b. The duct shall be composed of dead soft, spiral wound, triple locked corrugated aluminum core covered with Ratings shall be as described for Low Pressure Duct above.
6. Flexible ducts shall be not more than 2 feet in length, used for alignment or sound/vibration purposes only, and may only be installed in straight runs.
7. Flexible duct shall NOT be used for changes of direction of air flow,and shall be Flexmaster Type TL-M or approved equal. Installation, clamps and sealing shall be the same as specified for rigid duct.

2.6 LABORATORY EXHAUST DUCTWORK

A. Applies to stainless steel ductwork indicated in specification application table for Laboratory Exhaust Systems.

B. Provide exhaust ductwork of minimum gages:

DUCT SIZE	GAGE
28-inch diameter or less	18
30-inch to 60-inch diameter	16
61-inch diameter or greater	14
Greater than 60 x 42 (rectangular or oval)	Comply with SMACNA

C. ALL LAB EXHAUST DUCTWORK SHALL HAVE LONGITUDINAL BUTT (“SOLID”) WELD SEAMS WITH BUTT WELD JOINTS. Butt-weld all joints and fittings using Gas Tungsten Arc Welding (“TIG”). Welding

procedures shall meet the requirements of AWSD1.1. Welds on exposed ductwork inside the building shall be ground and polished. Duct sealant shall not be used to seal ductwork.

D. Provide required transitions from duct to equipment and make equipment connections as called out on drawings.

E. Fittings:

1. Refer to Round and Oval Ducts and Fittings General Requirements in this specification. Transverse and longitudinal seams shall be butt welded joints.
2. Refer to drawings for additional information.

F. Submit certification of welder's qualifications to perform the required welding operations and all project WPS for TIG welding sheet metal. All welder certifications shall be maximum 2 years prior to date of awarding contract.

2.7 DUST COLLECTOR SYSTEMS

A. Duct system shall be galvanized, constructed and supported in accordance with SMACNA Industrial Round Duct Construction for Class 2, 8 inch w.g. pressure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer also to requirements included in Part 2 of this specification.

B. Obtain manufacturer's inspection and acceptance of fabrication and installation of fiberglass ductwork prior to beginning of installation.

C. 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.

D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

E. Slope underground ducts to plenums or low pump out points at 1:500. Provide access doors for inspection.

F. Coat buried, metal ductwork without factory jacket with one coat and seams and joints with additional coat of asphalt base protective coating.

G. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

H. Connect terminal units to medium or high pressure ducts directly or with two feet maximum length of flexible duct. Do not use flexible duct to change direction. Allow for a minimum of 3 diameters of straight duct to the entrance of all terminal units.

I. Connect diffusers with 5 feet maximum length or troffer boots with 2 feet maximum length of flexible duct to low pressure ducts. Hold in place with strap or clamp, and seal as specified.

J. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout. Use stainless steel for ductwork exposed to view and stainless steel or galvanized steel for ducts where concealed.

K. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

3.2 LOW PRESSURE DUCT SUPPORTS

A. See Section 23 05 29 - Supports and Anchors

3.3 MEDIUM PRESSURE DUCT SUPPORTS:

A. See Section 23 05 29 - Supports and Anchors

3.4 DUCTWORK APPLICATION SCHEDULE

AIR SYSTEM	MATERIAL
MEDIUM PRESSURE SUPPLY	GALVANIZED STEEL
LOW PRESSURE SUPPLY	GALVANIZED STEEL
RETURN/RELIEF AIR	GALVANIZED STEEL

GENERAL EXHAUST AIR	GALVANIZED STEEL
LAB HOOD/BIOSAFETY CABINET EXHAUST/WASHER EQUIPMENT CONNECTION	316L STAINLESS STEEL TO MAIN DUCT CONNECTION – SLOPED BACK TO SOURCE

3.5 CLEANING OF SYSTEMS

A. Before turning the installation over to the Owner, all ducts should be cleaned and blown free of all dust and dirt that has collected in the ducts.

END OF SECTION 23 31 00

SECTION 23 33 00

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Manual and Automatic Volume Control Dampers.
B. Backdraft Dampers.
C. Air Turning Devices.
D. Flexible Duct Connections.
E. Duct Access Doors.
F. Duct Test Openings.

1.3 RELATED REQUIREMENTS

A. Section 01 91 00 - General Commissioning Requirements.
B. Section 23 00 00 - UTSW Mechanical Design Requirements.
C. Section 23 05 29 - Supports and Anchors.
D. Section 23 05 53 - Mechanical Identification.
E. Section 23 31 00 - Ductwork.
F. Section 23 36 00 - Air Terminal Devices.

1.4 REFERENCE STANDARDS

A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks.
B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
C. Bluetooth CS - Bluetooth Core Specification.
D. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications.
E. IEEE 802.15.4 - IEEE Standard for Low-Rate Wireless Networks.
F. LonMark Interoperability Guide - LonMark Application-Layer Interoperability Guide and LonMark Layer 1-6 Interoperability Guide; Version 3.4.
G. Modbus (PS) - The Modbus Organization Communications Protocol..
H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
I. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.
J. NFPA 92 - Standard for Smoke Control Systems.
K. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
L. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives.
M. Texas Government Code Chapter 2252.001-005 - Texas Government Code Chapter 2252.001-005.
N. UL 33 - Safety Heat Responsive Links for Fire-Protection Service.
O. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
P. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
Q. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
R. UL 263 - Standard for Fire Tests of Building Construction and Materials.
S. UL 555C - Standard for Safety Ceiling Dampers.
T. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

1.5 SUBMITTALS

A. Product Data: Provide published literature for volume control dampers, duct access doors, duct test holes, and hardware used including dimensions, weights, capacities, ratings, gauges, and finishes of materials, and electrical characteristics and connection requirements.

B. Shop Drawings: Submit under the provisions of 23 00 00 - UTSW Mechanical Design Requirements. Submit assemblies for shop fabricated assemblies indicated including model numbers, locations, and qualities for components including volume control dampers.

C. Submit manufacturer's installation instructions under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements for fire dampers and combination fire and smoke dampers.

D. Mockups: Provide mockups for all types of fire and smoke dampers in locations as directed by Owner's Project Manager and OSBC.

E. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

PART 2 - PRODUCTS

2.1 DAMPERS

A. Furnish and install manual volume dampers where shown on the drawings and wherever necessary for complete control of the air flow, including all supply, return and exhaust branches, "division" in main supply, return, and exhaust ducts, each individual air supply outlet and fresh air ducts.

1. Where access to dampers through a fixed suspended ceiling is necessary, the Contractor shall be responsible for the proper location of the access doors.

B. Locations: Dampers shall be carefully fitted, and shall be controlled by locking quadrants equal.

1. Exposed uninsulated ductwork: Provide equal to Ventlok No. 555.
2. Exposed externally insulated ductwork: Provide equal to Ventlok No. 644.
3. Concealed ductwork above lay-in accessible ceilings: Provide Ventlok No. 555 or No. 644 locking quadrant for splitter dampers.
4. Concealed ductwork not above lay-in accessible ceilings: Provide equal to Ventlok No. 677 (2 5/8 inch diameter) chromium plated dover plate.
5. When No. 555 or No. 644 regulators are used, furnish and install end bearings for damper rods on the ends opposite the quadrant.
6. When No. 677 regulators are used, furnish and install end bearings for the damper rods on both ends.

C. Dampers larger than three (3) square feet in area shall be controlled by means of rods hinged near the leading edge of the damper with provisions for firmly anchoring the rod and with end bearings supporting the axle.

D. Manual volume dampers shall be equal to Ruskin model CD60, Greenheck model VCD-33, or approved equal.

1. Blades shall not exceed 48 inches in length or 12 inches in width and shall be of the opposed interlocking type.
2. The blades shall be of not less than No. 16-gauge galvanized steel supported on 1/2 inch diameter rust proofed axles.
3. Axle bearings shall be the self-lubricating ferrule type.

E. Install all automatic control dampers, furnished by the Temperature Control Manufacturer, in strict accordance with the manufacturer's recommendations and requirements of these Specifications.

F. All adjustable dampers installed in externally insulated ductwork shall be installed with Ventlok No. 639, or equivalent elevated dial operators.

1. Insulation shall extend under the elevated dial.

2. All adjustable dampers installed in internally insulated ductwork shall be installed with Ventlok No. 635 or equivalent dial operators.
3. All damper shaft penetrations in the ductwork shall be installed with Ventlok #609 end bearings.

2.2 FLEXIBLE CONNECTIONS

A. Provide Ventglas fabric connection where flexible connections for ducts connect to fans, including roof exhausters.
1. Fabric connection shall be fire resistant, waterproof, mildew resistant, and air tight, and shall weigh approximately 30 ounces per square yard.
2. Provide a minimum of 1/2 inch slack in the connections, and a minimum of 2 1/2 inches distance between the edges of the ducts except that there shall also be a minimum of 1 inch of slack for each inch of static pressure on the fan system.
3. This does not apply to Air Handling Units with internal isolation.

2.3 DUCT ACCESS DOORS

1. Provide low, medium, and high-pressure duct access doors with gaskets/seals appropriate for designed pressures of each installation. Provide product greater than or equal to Ductmate Duct Access Door sandwich style with double thumbscrew latch.
2. Double-skin doors with one-inch of insulation in the door required where ducts are insulated.
3. Doors shall be 18 inches by 16 inches or 18 inches in diameter minimum, dependant on duct sizing, and provide Ventlok No. 260 latches on rectangular doors.
4. Doors sized smaller than 18 inches by 16 inches shall use Ventlok No. 100 or 140 latches.
5. Doors for zone heating coils shall be minimum 10 inches by 12 inches or 12 inches in diameter Ventlok doors. Provide stamped, insulated doors, complete with latch and two (2) hinges.
6. Doors required to be round shall be Flexmaster USA "Inspector Series" spin-in type or approved equal.
7. Doors for personnel access to ductwork shall be nominal 24 inches in diameter.

B. Where these access doors are above a suspended ceiling, this Contractor shall be responsible for the proper location of the ceiling access doors.

2.4 SCREENS

A. Furnish and install screens on all duct, fan, etc., openings furnished by this Contractor that lead to, or are, outdoors.
B. Screens shall be No. 16 gauge, 1/2 inch mesh in removable galvanized steel frame.
C. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no ductwork is connected.

2.5 DUCT TAPS (CONICAL FITTINGS)

A. Conical fittings shall be used for duct taps and shall include quadrant dampers on all lines to air devices (diffusers and grilles), even though a volume damper is specified for the air device. A damper is not required for medium pressure duct taps. Spin in fittings shall be sealed at the duct tap with a gasket, or compression fit, or sealed with sealant specified for medium pressure ductwork. The location of spin in fittings in the ducts shall be determined after dual or single duct terminal units are hung or the location of the light fixtures is known to minimize flexible duct lengths and sharp bends.
B. The conical fitting shall be made of at least 26-gauge galvanized sheet metal. The construction to be a two- piece fitting with a minimum overall length of 6 inches and shall be factory sealed for high pressure requirements. Average loss coefficient for sizes 6, 8, and 10 shall be less than 0.055.
C. Each fitting shall be provided with a minimum 24-gauge damper plate with locking quadrant operator and sealed end bearings. Damper blade shall be securely attached to shaft to prevent damper from rotating around shaft.
D. Provide flange and gasket with adhesive peel-back paper for ease of application. The fitting shall be further secured by sheet metal screws spaced evenly at no more than 4 inches on-center with a minimum of four screws per fitting.
E. The conical bell-mouth fitting shall be one of the following:
1. Flexmaster U.S.A., Inc. Series 3000G.
2. Buckley Air Products, Inc., 'AIR-TITE'.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Use splitter dampers only where indicated.

C. Provide balancing dampers on medium or high pressure systems where indicated.

D. Provide backdraft dampers on exhaust fans or exhaust ducts where indicated.

E. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment. Cover connections to medium and high pressure fans with leaded vinyl sheet, held in place with metal straps.

F. Provide duct test holes where indicated and where required for testing and balancing purposes.

END OF SECTION 23 33 00

SECTION 23 36 00

AIR TERMINAL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Variable volume terminal units.
B. Integral sound attenuator.
C. Integral damper motor operators.
D. Integral controls.

1.3 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.
B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018
C. AHRI 880 (I-P) - Performance Radiant of Air Terminals; 2011 with Addendum 1.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Submit shop drawings under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.
   2. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.
B. Product Data:
   1. Submit product data under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.
   2. Submit product data indicating configuration, general assembly, and materials used in fabrication Include catalog performance ratings that indicate air flow, static pressure, and NC designation.
   3. Include schedules listing discharge and radiated sound power level for each of second through seventh octave bands at inlet static pressures of one inch w g.
   4. Submit manufacturer`s installation instructions under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.
C. Samples:
   1. A sample 8 inch size production run unit shall be submitted for examination and approval by the Engineer, UTSW FM, and the Owners Testing and Balancing (TAB) Consultant.
      a. This submittal box shall be submitted, in addition to the required written submittal, well in advance of any requirement for installation of boxes, but absolutely no later than 60 days after the date of the start of construction stipulated in the Work Order letter from the Owner to the General Contractor.
      b. A minimum of three weeks shall be allowed by the Contractor for file testing of the box from the time of submittal to the time of determination of project worthiness.
      c. This period shall restart if the sample box is rejected and another box is resubmitted.
      d. If rejected for any reason, the Contractor shall expedite the corrections documented, and shall resubmit a sample box as soon as possible.
      e. Any delay in the submittal of the box for approval shall not be grounds for a claim of delay on the part of the Contractor.
      f. If approved, the unit shall remain in the possession of the Owner at the job site for comparison with units as shipped to project.
      g. The unit shall be installed in the project, at an accessible, marked location.
      h. The unit manufacturer shall test and certify that each box used on this project has been tested as specified.

D. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Division 1 and Section 23 00 00 - UTSW Mechanical Design Requirements.

B. Include manufacturer`s descriptive literature, operating instructions, maintenance and repair data, and parts lists

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years documented experience

1.7 WARRANTY

A. Provide one-year manufacturer`s warranty under provisions of Division 01 and Section 22 00 10 - Basic Plumbing Requirements.

PART 2 -- PRODUCTS

2.1 VARIABLE OR CONSTANT VOLUME TERMINAL UNITS

A. The Contractor shall furnish and install pressure independent dual and/or single duct variable air volume control assemblies with integral attenuator (single duct units) and attenuator-mixers (dual duct units), of the sizes, capacities and configurations shown on the Drawings.

1. Casing Construction:
   a. The units shall be constructed of a minimum of 22 gauge galvanized steel and internally lined with a minimum of 1 inch thick, three pound per cubic toot density insulation.
   b. The insulation shall be foil faced with the edges and seams sealed or "captured", encapsulating all fibers of the insulation.
   c. The insulation shall be neatly installed with no rough edges to interrupt the smooth flow of air through the box.
   d. The casing shall be insulated throughout its interior.
   e. The external insulation shall be as specified in other sections of this specification for duct insulation with full vapor barrier, and shall be field installed unless coil and plenum section is furnished as an integral part of the box.
   f. All interior features of the boxes (such as mixing baffles, damper housings, etc) shall be secured within the casing to avoid excessive movement or rattling with air movement or externally generated vibration.
   g. All external features of the terminal units shall be designed not to extend beyond the ends of the unit (For example, the actuator mounting brackets, etc., shall not extend beyond the plane of the inlet "bulkhead").
      1) The only exception shall be flow sensors installed in the inlet duct connections.
      2) Note that if a separate flow station is installed within a frame within the casing, then it shall be so installed not to allow air flow to bypass the flow measurement station.
2. The terminal units shall be constructed with inlet and discharge ductwork connections.
   a. The inlet ductwork connections shall extend a minimum of 4 inches from the unit casing including an allowance for the installation of air flow station(s) or probe(s).
   b. The discharge connection shall include 1 inch extension with slip and drive connections for use by the contractor to secure the discharge ductwork or appurtenances to the unit and shall be reinforced to provide a rigid assembly.
3. Casing Leakage:
   a. Assembled Units shall be so constructed and sealed to limit air leakage to the following listed quantities at 6 inch static pressure
   b. Leakage curves or tables will be required as part of the submittal data The following is the maximum allowable casing leakage including all components:

Diameter(inches)	Maximum Allowed CFM (Area x 2000 fpm)	Maximum AllowableCFM Casing Leakage
4, 5, 6,	393	8.0
7 - 8	698	14.0
9 - 10	1091	22.0

11 - 12	1571	30.0
12 - 14	2138	40.0

4. Access Plenum and Door:
   a. An access panel shall be provided immediately downstream of the dampers for inspection and service of the dampers.
   b. The access plenum shall contain a minimum of a 12 inch diameter or 12 inch by 12 inch (or full width of unit if less than 12 inches) access door as manufactured by Ventlok.
   c. Door frame may be bolted, screwed or flanged and sealed to the casing.
   d. Door shall be gasketed and shall be double all construction or insulated similar to main casing
   e. Door shall be held in place with latches or other captive retainer devices.
   f. If the damper assembly is easily removed from the rear of the box, the access size can be reduced to 8 inch round or 8 inches by 8 inches for inspection only.
5. Damper Construction:
   a. The damper blades shall be an equivalent of 18 gauge galvanized steel or equal aluminum and shall be securely riveted or bolted through the damper shafts to assure no slippage of the blades.
   b. The damper shafts shall operate in rust-proof self-lubricating bearings.
   c. Damper shafts penetrating the unit casings shall be sealed against leakage, and bearings shall be installed for protection against wear in the casing penetration.
   d. Damper shafts shall be formed of, or cut from solid stock; no hollow shafts will be allowed.
   e. The dampers shall seat against gasketed stops or the dampers shall have gasketed edges.
   f. The dampers shall be so constructed to prevent "oil canning" of the damper blade.
   g. The units shall be tested for leakage in both inlets with 6 inches static pressure imposed on one inlet at a time.
   h. The maximum percent leakage from all tests shall be reported.
   i. Leakage curves as a function of pressure shall be supplied as part of the submittal data.
   j. The damper actuator linkage, if used, shall be constructed of material of sufficient strength to avoid buckling under extreme loads.
   k. Linkages shall not allow play greater than 5 degrees of damper movement.
   l. The controls for the dampers shall cause the dampers to fail in the position of last control (freeze in place), or fail to the open position.
6. Damper Leakage:
   a. The following is the maximum damper leakage allowable for the various size diameter inlets at 6 inches w g differential pressure.
      1) The damper leakage shall not exceed the values listed in the table below at 6 inches S P, following ARI 880 Testing Procedures.

Diameter (inches)	Maximum Allowed CFM (Area x 2000 fpm)	Maximum Allowable CFM Damper Leakage
4, 5, 6,	393	6.0
7 - 8	698	10.5
9 - 10	1091	16.5
11 - 12	1571	20.0
12 - 14	2138	30.0

7. Unit Pressure Drop:
   a. Single duct unit pressure drop shall be limited to 0.15 inches water gauge under the same conditions above.
8. Certification:
   a. The unit manufacturer shall certify that each unit used on this project will perform as specified.
   b. Each unit shall bear a tag or decal listing the following specified information:
      1) Test Pressure.
      2) Leakage CFM (damper).
      3) Leakage CFM (casing).
      4) Date of Mfg.
      5) Room or area served.
      6) Unit size - 6 inches, 8 inches, etc.

7) Calibrated CFM, i e 800 CFM.

9. Flow Measurement:
   a. Air flow thru the unit shall be accomplished by the use of brass "T's" and a metal multi-port sensing device with a minimum of four radially distributed pick-up points connected to a center averaging chamber with adequate internal passages to prevent restrictions that can result in control "hunting".
10. Sound: (Note that the maximum sound levels listed in this paragraph refer to raw sound levels, with no credits taken for the construction).
    a. Discharge Sound:
       1) Maximum discharge Sound Power Levels at 2000 fpm primary air inlet velocity with 1.5 inch w g inlet static pressure shall not exceed that listed in the following table.
       2) No credit for lined discharge duct, branching, flow division, end reflection, room absorption or any other effects shall be allowed.

Octave Band	Center Frequency (Hz)	Sound Power Level (dB re 10^{12} Watts)
2	125	76
3	250	66
4	500	63
5	1000	58
6	2000	60
7	4000	55

    b. Radiated Sound:
       1) Maximum discharge Sound Power Levels at 2000 fpm primary air inlet velocity with 1.5 inch w g inlet static pressure shall not exceed that listed in the following table.
       2) No credit for ceiling plenum, ceiling tiles, room absorption, or any other effects shall be allowed.

Octave Band	Center Frequency (Hz)	Sound Power Level (dB re 1012 Watts)
2	125	
3	250	
4	500	
5	1000	
6	2000	47
7	4000	

    c. All sound power levels shall be obtained from testing in accordance with ARI-ADC Standard 880 and shall be certified at ARI-880 certification points.
11. Testing Prior to Installation:
    a. Shipment Testing:
       1) A minimum of ten percent of each size of the terminal units (but no less than one unit of each size used) may be tested for conformance to this specification, at the Owner`s discretion.
       2) The Contractor shall allow sufficient time during construction and space for the Owners TAB Consultant to perform all testing as may be required.
    b. Unit Non-Performance:
       1) If the results of the Shipment Testing show that any of the units do not perform as specified, then an additional 10 percent of each size (but no less than one unit of a size, unless 100 percent of the size has been tested) of the units shall be tested.
          (a) If this testing, in the Owner`s opinion, shows that 10 percent or more of the units tested do not perform as specified, then 100 percent of all sizes of the units shall be tested for conformance with these specifications.
          (b) The results of that testing shall be reviewed carefully between the Contractor, manufacturer, the Owner`s construction administrator(s), and the Owner`s design engineer(s).
          (c) A method of repair or replacing the units will be negotiated.
          (d) The Owner, however, shall maintain the right of final approval of any proposed solution.

2) Should for any reason the testing described above under "Submittal" and "Shipment Testing" prove that any of the units do not perform as specified, the Contractor shall be responsible for all subsequent labor, travel, travel expenses, and incidental expenses, penalties, or other costs attendant to any additional testing as described under "Unit
   (a) Non-Performance", or as required to prove that the units perform as specified.
   (b) This shall Include, but not be limited to, the labor, travel and reasonable incidental expenses of not only the Contractor and Owner`s TAB Consultant, but also those incurred by the Owner as may be specifically required for this purpose.
   (c) The expenses to be reimbursed to the Owner shall be labor at a rate of $300 per day or any portion of a day, plus travel and travel expenses at actual cost, plus reasonable incidental expenses at actual cost.

12. Manufacturer:
    a. All Terminal Units shall be as manufactured by Titus (model DESV or DMDV), Metal*Aire (TH-500), Nailor Industries (model 3000-UT or 3200-UT) or Price Industries (models SDV-UT or DDS-UT).
    b. Note that the model and series numbers listed may differ slightly from catalogue information.
    c. No other manufacturers or models are acceptable.
    d. Even though specific manufacturers may be named, the material supplied by any approved manufacturer shall meet all of the provisions of this specification without exception.
13. Hot water Coils:
    a. Hot water coils installed in conjunction with single duct terminal units shall be factory installed, one or two row with a maximum of 10 aluminum fins per inch.
    b. Air side pressure drop shall be limited to 0.2 inch wg at box rated flow.
    c. Full fin collars shall be provided for accurate fin spacing and maximum fin-to-tube contact.
    d. Tubes shall be 1/2 inch diameter seamless copper with a minimum wall thickness of 0.016 inch, tested at 400 psig air pressure under water with a minimum rated burst pressure of 1500 psig.
    e. Male sweat-type water connections shall be provided.
    f. Side and end plates shall be a minimum of 18 gauge galvanized sheet metal construction.
    g. All coils shall be constructed and tested in accordance with UL and/or ARI Standards.
14. General Performance:
    a. Devices using mechanical CFM limiters will not be accepted, nor shall it be necessary to change control components to make airflow rate changes.
    b. DDC flow stations shall be furnished, mounted and adjusted by the terminal unit assembly manufacturer to assure their proper placement within the units It shall be noted that the terminal unit manufacturer shall be responsible for the workmanship and materials of the entire assembly of unit controls.
    c. The terminal unit manufacturer shall be responsible only for the construction of the terminal unit and the installation of internal control components installed at the manufacturers factory, and shall not be responsible for the installation of controls not installed at the terminal unit manufacturer`s factory, nor shall the manufacturer be responsible for the performance of the DDC controls.
    d. The terminal unit manufacturer will furnish and install the control power disconnect and control voltage transformer.
    e. The performance of DDC controls, especially in connection with terminal units, shall be the responsibility of the DDC controls manufacturer.
15. Control Performance:
    a. Assemblies shall be able to be reset to any airflow between zero and the maximum cfm shown on Drawings.
    b. To allow for maximum flexibility and future changes, it shall be necessary to make only simple screwdriver or keyboard adjustments to arrange each unit for any maximum air flow within the ranges for each inlet size as scheduled on the Drawings.
    c. The control devices shall be designed to maintain the desired flow regardless of inlet flow deflection.
    d. All terminal units shall be installed with a minimum of four diameters of straight duct directly prior to the entry into each terminal unit connection.

16. Control Sequences:
    a. The control sequence arrangements shall be as described on the Drawings, whether the controls used on this project are pneumatic or DDC, and the terminal units shall be shipped from the manufacturer with all necessary control devices to accomplish each sequence, except as may be prohibited by the controls manufacturer.
    b. The desired sequence shall be adjustable according to space usage or a change in space conditions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to requirements included in Part 2 of this specification.
B. Install in accordance with manufacturer`s instructions.
C. Provide ceiling access doors or locate units above easily removable ceiling components. Refer to Section 08 31 13 - Access Doors and Frames.
D. Support units individually from structure Do not support from adjacent ductwork.
E. Connect to ductwork in accordance with Section 23 31 00 - Ductwork.
F. Install heating coils in accordance with Section 23 82 16 - Air Coils.

3.2 TERMINAL UNIT SCHEDULE

A. Refer to Drawings for schedule.

END OF SECTION 23 36 00

SECTION 23 36 10
AIR VALVES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Air Valves

1.2 RELATED REQUIREMENTS

A. Section 23 00 00 - UTSW Mechanical Design Requirements

B. Section 23 21 13 - Hydronic Piping

C. Section 23 05 23 - General Duty Valves for HVAC Piping

D. Section 23 05 53 - Mechanical Identification

E. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

F. Section 23 07 13 - Ductwork Insulation

G. Section 23 31 00 - Ductwork

1.3 REFERENCE STANDARDS

A. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

B. Air Movement and Control Association, AMCA Standard 210.

C. ASHRAE Standard 70-2006, Method of Testing the Performance of Air Outlets and Air Inlets.

D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

E. SMACNA HVAC Duct Construction Standards.

1.4 SUBMITTALS

A. Submit product data and all required information in accordance with the provisions of Division 01.

B. Submit product, performance data, and control diagrams for review.

C. Submit test reports as specified herein.

D. Submit certificates as specified herein.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum eight years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 WARRANTY

A. See Division 01 for additional warranty requirements.

B. Provide five year manufacturer warranty for air valves and integral controls.

1.7 GUARANTEE

A. Manufacturer guarantees resultant noise levels to be within NC rating published by manufacturer.

PART 2 - PRODUCTS

2.1 AIR VALVES (SUPPLY, RETURN, EXHAUST, FUME HOOD EXHAUST)

A. Acceptable Manufacturer: Accutrol, Siemens, Price Industries (Antec Controls), or Phoenix Controls.

B. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use.

C. The system provided shall be by one manufacturer, complete in all respects, including required controller, accessories, hardware, software and peripheral devices necessary to execute the sequence of operations.

D. The airflow control device shall be pressure independent over its specified differential static pressure operating range. An integral pressure independent assembly shall respond and maintain specific airflow within one second of a change in duct static pressure irrespective of the magnitude of pressure and/or flow change or quantity of airflow controllers.

E. The airflow control device shall include factory-mounted digital controls to control flow without the need for an airflow measuring device in the airstream, and a factory-mounted high speed actuator. The valve shall provide electronic flow feedback.

F. The airflow control device shall be linear type and maintain accuracy within ±5% of signal over an airflow turndown range of no less than 8 to 1.

G. A maximum of two duct diameters entering the valve shall be provided to ensure accuracy and/or pressure independence.

H. Air pressure drop is not to exceed 0.3” wg on any single valve, not including heating coil if applicable.

I. Valve body material for fume hood air valves or other corrosive service shall be Type 304 stainless steel; 20 gauge for body and 16 gauge for blades.

J. Valve body material for non-corrosive service such as for supply, return, and general exhaust shall be aluminum.

K. Furnish labor, materials, tools, equipment, controls, and services for air valve system. The control system shall vary the amount of supply and return/exhaust air into the room to operate the space at the lowest possible airflow rates necessary to maintain temperature control, achieve minimum ventilation rates, and maintain room pressurization in relation to adjacent spaces (positive or negative as indicated on the drawings).

L. For lab areas, the system provided shall be based on variable fume hood exhaust volume with sash position reset control of fume hoods (as applicable), on / off status of fume hoods, synchronization of supply and exhaust airflow, and control of lab room temperature via reheat coil(s) and airflow reset.

M. Any changes required in the ductwork, air handling equipment or other mechanical systems, which would be required for the application of proposed equipment other than the specified basis of design shall be the responsibility of the laboratory airflow control system supplier. All changes shall be subject to prior approval by the Architect/Engineer.

N. The laboratory airflow control systems shall digitally interface to the building automation system (BAS). The laboratory airflow control contractor shall be responsible to provide an interface device between the air valve airflow controls and the BAS via BACnet protocol.

O. Coordinate work of this section with control drawings and sequences as indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all units as indicated and in accordance with manufacturer's recommendations and instructions.

B. Check connections to insure they are tight with all leakage of 1% or less.

C. Provide insulation in accordance with Section Section 23 07 13 - Ductwork Insulation.

3.2 CLEANING, TESTING, START-UP, DEMONSTRATION

A. Clean units in accordance with Section 23 00 00 - UTSW Mechanical Design Requirements, including flushing of connected piping and cleaning of water control valves.

B. Start-up units, check for proper operation as a system with air handling unit, fans, and connected ductwork.

C. Test units in accordance with Section .

D. Prepare units for Test and Balance as required by Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC, correct any deficiencies found and retest.

E. Demonstrate operation of units as a complete system to maintenance personnel and instruct them in the operation, adjustment and repair of the system.

F. Air valve airflow control system shall be commissioned by provider and tested as required by commissioning agent under Division 01.

G. The air valve airflow control contractor shall demonstrate to the Engineer the ability of the controls to maintain setpoints in all modes of operation.

END OF SECTION 23 36 10

SECTION 23 37 00

AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. Diffusers.
B. Diffuser Boots.
C. Registers/Grilles.

1.3 RELATED REQUIREMENTS

A. Section 09 91 23 - Interior Painting
B. Section 23 00 00 - UTSW Mechanical Design Requirements
C. Section 23 05 29 - Supports and Anchors
D. Section 23 05 53 - Mechanical Identification
E. Section 23 31 00 - Ductwork
F. Section 23 33 00 - Ductwork Accessories

1.4 REFERENCE STANDARDS

A. AHRI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
B. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
D. Texas Government Code Chapter 2252.001-005 - Texas Government Code Chapter 2252.001-005.

1.5 QUALITY ASSURANCE

A. Test and rate performance of air outlets and inlets in accordance with AHRI 885.

1.6 REGULATORY REQUIREMENTS

A. Conform to NFPA 90A.

1.7 SUBMITTALS

A. Submit product data under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements for items required for this project.
B. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.
C. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.
D. Submit manufacturer's installation instructions under provisions of Section 23 00 00 - UTSW Mechanical Design Requirements.
E. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

PART 2 - PRODUCTS

2.1 AIR SUPPLIES AND RETURNS

A. Grilles, registers and ceiling outlets shall be as scheduled on the Drawings and shall be provided with sponge rubber or soft felt gaskets.
    1. If a manufacturer other than the one scheduled is used, the sizes shown on the Drawings shall be checked for performance, noise level, face velocity, throw, pressure drop, etc., before the submittal is made.
    2. Selections shall meet the manufacturer's own published data for the above performance criteria.
    3. The throw shall be such that the velocity at the end of the throw in the five foot occupancy zone will be not more than 50 FPM nor less than 25 FPM.

4. Noise levels shall not exceed those published in the ASHRAE Guide for the type of space being served (NC level). Grilles, registers and ceiling outlets shall be Titus, Metalaire, Price, or approved equal.

B. Locations of outlets on Drawings are approximate and shall be coordinated with other trades to make symmetrical patterns and shall be governed by the established pattern of the lighting fixtures or architectural reflected ceiling plan.
   1. Where called for on the schedules, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual damper.
   2. These shall be the standard product of the manufacturer, subject to review by the Architect, and equal to brand scheduled.

2.2 SQUARE CEILING DIFFUSERS

A. Provide square ceiling diffusers of architectural square panel type with sizes and mounting types shown on plans and schedules.

B. Provide frame type appropriate for ceiling type. For lay in ceilings, diffuser shall fit in inverted T-bar frame. For plaster ceilings, diffuser shall fit in plaster frame and ceiling frame.

C. The face panel of the diffuser shall be smooth, flat, and free of visible fasteners. The face panel shall project no more than 1/4 inch below the outside border of the diffuser back pan.

D. The diffuser face panel shall have an aerodynamically shaped, rolled edge to ensure a tight, horizontal discharge pattern across ceiling.

E. Fabricate of steel with baked enamel finish.

2.3 SUPPLY REGISTERS/GRILLES

A. Provide grilles with streamlined and individually adjustable curved blades to discharge air along face of grille, with one-way or two-way deflection as scheduled.

B. Frames shall have 1-1/4 inch wide border on all sides. Screw holes on frames shall be countersunk so that screw heads sit flush with frame face.

C. Fabricate of aluminum extrusions with factory acrylic paint finish.

D. Provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

2.4 EXHAUST AND RETURN REGISTERS/GRILLES

A. Grilles shall have fixed deflection blades and shall be of the sizes and mounting types scheduled.

B. Frames shall have 1-1/4 inch wide border on all sides. Screw holes on frames shall be countersunk so that screw heads sit flush with frame face.

C. Fabricate of aluminum extrusions with factory acrylic paint finish.

D. Provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

E. In gymnasiums, blades shall be front pivoted, welded in place or securely fastened to be immobile.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install items in accordance with manufacturers' instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Refer to Section 09 91 23 - Interior Painting.

C. Install diffusers to ductwork with air tight connection.

D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register assembly.

E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 91 23 - Interior Painting.

END OF SECTION 23 37 00

SECTION 23 82 19

FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provisions established within the Conditions of the Contract and Division 01 General Requirements, the remaining Sections of the Specifications, and the Contract Drawings are collectively applicable to this Section.

1.2 SECTION INCLUDES

A. The extent of fan coil unit work is shown on drawings and in schedules, (but not by way of limitation).

B. Fan coil unit is defined to include, but not limited to, the following components and accessories:

1. Water coil.
2. Water control assembly.
3. Vibration isolation.
4. Return air grille.
5. Return air plenum.
6. Duct connections.
7. Fan speed switch.
8. Thermostat.
9. Filter.
10. Fan motor.

1.3 REFERENCE STANDARDS

A. Texas Government Code Chapter 2252.001-005; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

A. Submit shop drawings and product data indicating unit dimensions, unit weight, required clearances, construction details, field connection details, capacities, ratings, fan performance, electrical characteristics and material gauges and finishes.

B. Provide fan curves with operating point clearly plotted.

C. In addition to A and B, if equipment is other than manufacturer specified, submit complete drawing showing that unit will fit space requirements with proper clearances for access and maintenance.

D. Provide certification of adherence and compliance with Texas Government Code Chapter 2252.001-005 Contracts with Governmental Entity requirements.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver products and materials to site in factory-fabricated protective containers with factory-installed shipping skids and lifting lugs.

B. Store products in clean, dry space and protect from weather and construction traffic Handle as required to avoid damage to components, enclosures, and finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Magic Aire.

B. Airtherm Mfg Co.

C. McQuay Corp.

D. Trane Co.

2.2 MATERIALS

A. Provide manufacturer's certification of fan coil unit capacity compliance with ARI Standard 441.

B. Except as otherwise indicated, provide fan coil unit manufacturer`s standard materials and components as indicated by his published product information, designed and constructed as recommended by the manufacturer, and as required for a complete installation.

C. Coils:

1. Except as otherwise indicated, provide manufacturer`s standard coil of the indicated type and rated for the indicated capacity.
2. Copper tube coils, mechanically expanded into aluminum plate fins; rated at 250 psig and leak tested at 350 psig min air pressure.
    a. Air Vents: Provide manual type.
3. Size coils for the indicated room sensible cooling load Btuh room total cooling load Btuh, entering air temperature wet-bulb and dry-bulb, water temperature change external static pressure in wg , and maximum coil-water pressure drop.
4. Size coils for the indicated steam flow rate, room heating load Btuh, entering air temperature and entering water temperature.

D. Water-flow control shall be factory-connected valve assemblies of the indicated operation.

E. Fans:
1. Balanced statically and dynamically, and of the indicated capacity; designed and assembled to be easily removed for servicing.
2. Construct fans of 22-gage minimum galvanized steel.
3. Provide centrifugal, forward-curved type impeller.

F. Motors:
1. Provide motors, of the indicated capacity, with automatic-reset thermal overload protection of one of the following types:
    a. Split-capacitor motor.
2. Motors shall be installed for easy removal.

G. Cabinets: Fabricate of formed 18-gage (min) cold-rolled steel Include access panels with positive-locking, quarter-turn fasteners
1. Form cabinets to receive the indicated cabinet accessories

H. Cabinet Accessories: Manufacturer`s standard of the following types:
1. Discharge duct collars; integral with unit and extending 1 inch minimum.
2. Return air duct collar; integral with unit and extending 2 inches minimum.

I. Cabinet Insulation:
1. Where not otherwise indicated, line cabinets with 1/2 inch coated glass fiber insulation
2. Comply with NFPA No 90A, and arrange to minimize both heat and sound transmissions, and to prevent sweating.

J. Drain Pans:
1. Provide galvanized steel drain pan designed to project under length and width of coil including heaters and return bends. Insulate pan and pitch for positive drainage with fan coil unit level.
2. Provide overflow secondary drain connection; 1/2 inch pipe/tube size where not otherwise indicated.
3. Design drain pans to extend under connecting piping and valves where fan coil units are indicated for ceiling suspension or overhead installation.
4. Insulation: Manufacturer`s standard insulation material.
5. Filters: Manufacturer`s standard; one of the following types:
    a. Filter location must be accessible for filter changes. May be located in return grilles, if applicable.
    b. Type: Throw-away filters of glass fiber; 2 inches thick.

K. Vibration Isolation: Provide devices of the type and size recommended by the manufacturer, except as otherwise indicated.

L. Factory Finish:
1. Manufacturer`s standard factory finish including metal surface cleaning before coating.
2. Provide baked alkyd enamel metal finish paint coat of the indicated color on fan coil units, applied on exposed ferrous metal surfaces.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Except as otherwise indicated, install fan coil units, including components and controls required for operation, in accordance with manufacturer`s instructions.

B. Locate each unit accurately in the position indicated in relation to other work Position unit with sufficient clearance for normal service and maintenance, including clearance for cabinet removal.

C. Install units on vibration isolation mounts in accordance with manufacturer`s instructions, and as indicated.

D. Level fan coil units to the tolerance recommended by the manufacturer.

E. Install valves, including balancing valves to comply with these specifications.

END OF SECTION 23 82 19