

Dewberry Project Number
50086982

Project Manual

for

UTMB REBECCA SEALY
LEVEL 3&4 RESTROOM RENOVATION

VOLUME 1 OF 2
FOR
EAST & WEST

UTMB PROJECT NO. 59915

RFP #17-039

Galveston, Texas

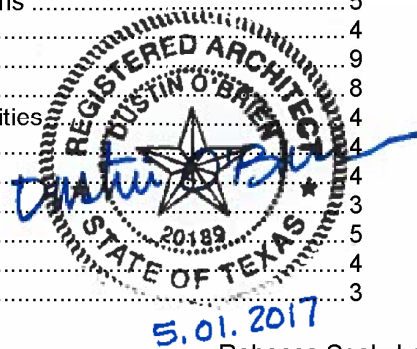
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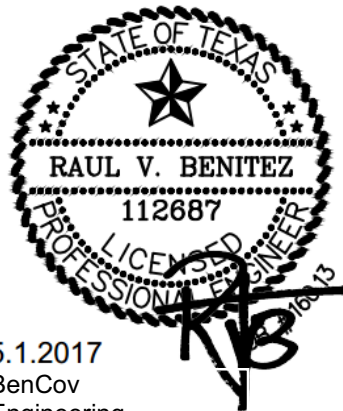


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Rebecca Sealy Level 3 & 4
 East & West Restroom Renovations
 UTMB Project #59915

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5.1.2017
BenCov
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Dewberry
Project No.: 50086982

Rebecca Sealy Level 3 & 4
East & West Restroom Renovations
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SECTION 23 00 00 – BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This section covers the requirements of the project that apply to Fire Protection, Plumbing and HVAC work. Refer to Divisions 21, 22 and additional Division 23 sections for additional requirements for HVAC, Plumbing and Fire Protection work.
- B. Provide all plant, labor, equipment, appliances and materials, and perform all operations in connection with the installation of the Mechanical Work in accordance with the Specifications and applicable Drawings.
- C. Execute all work hereinafter specified or indicated on accompanying Drawings. Provide all equipment necessary and usually furnished in connection with such work and systems whether or not mentioned specifically herein or on the Drawings.

1.3 SUBMITTALS

- A. Submit the material and equipment list as directed in Division 01 and include, but not limit the submittals to, the following:
 - 1. Plumbing and Fire Protection: Plumbing Fixtures and Brass, Sump Pumps, Tank and Sump Alarm, Pressure Booster Pumps, Motors, Valves, Wall Hydrants, Hose Bibbs, Gas Cocks, Gauges and Instruments, Pipe and Fittings, Insulation-Covering, Adhesives, Anchors, Hangers, Drains, Cleanouts, Fire Hose Cabinets, Equipment, etc., Fire Protection Sprinkler System, Domestic Hot Water Heater and Storage Tank, All Laboratory and Other Special Equipment, etc.
 - 2. Air Conditioning and Ventilating: Pipe and Fittings, Pipe Anchors and Hangers, Valves, Safety Valves and Regulating Valves, Strainers, Flow Measuring Devices, Anchors, Hangers, all scheduled equipment, Pumps, Gauges and Instruments, Insulation - Covering, and Liner, Adhesives, Equipment Foundations, Composite Wiring Diagrams, Motors, Motor Controls, Fans (ventilating), Automatic Control Systems, Air Filters, Registers and Grilles, Dampers (Regular, Smoke and Fire), Sound Insulation for ducts, etc., Luminaire Diffusers, Flexible Duct, Sound Attenuation Devices, Mixing Boxes, High Velocity Duct, etc.
- B. Submit copies of the manufacturer's specifications, recommendations, installations instructions, and maintenance data for each type of material required. Include a letter of certification or a certified test laboratory report indicating that each material complies with the requirements and is recommended for the applications shown.

1.4 SHOP DRAWINGS

- A. Refer to Division 01 for submittal of shop drawings and product data after Material and Equipment list is reviewed.

- B. Prepare fabrication drawings of duct at a scale of not less than 1/4" to 1'. Draw fabrication drawings for duct in Mechanical Rooms at a minimum 1/4" - 1'-0" scale. Submit one sepia and six blue-line prints of each fabrication drawing for review.
- C. Submit other fabrication drawings whenever (1) equipment proposed varies in physical size and arrangement from that indicated on the Drawings, causing rearrangement of equipment space, (2) tight spaces require extreme coordination between duct, piping, conduit, and other equipment, (3) called for elsewhere in these Specifications; and (4) additional drawings are specifically requested by the owner's representative. Include all costs for fabrication drawings in the bid.
- D. The Mechanical Trades will provide complete wiring diagrams indicating power wiring and interlock wiring. Diagrams are to be submitted for review. Base diagrams on accepted equipment and include complete full phase and interlock control Drawings, not a series of manufacturer's individual diagrams. After these diagrams have been reviewed, submit copies to the Electrical Trades.

1.5 CLOSEOUT SUBMITTALS

- A. Refer to Division 01 for Record Documents, Operating and Maintenance Manuals, and other similar submittals.

1.6 STANDARDS AND CODES

- A. Conformance to Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriter's 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, submit proof that the items furnished under this Section of the Specifications conform to such requirements. The label of the Underwriter's Laboratories, Inc., applied to the item will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements.

1.7 SPECIAL CONDITIONS

- A. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction may be required for work indicated or specified in this Section or work specified in other sections, provide material and equipment usually furnished with such systems or required to complete the installation, whether mentioned or not.
- B. Be responsible for fitting material and apparatus into the building and carefully lay out work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation.
- C. The Mechanical and associated Drawings are necessarily diagrammatic in character and cannot show every connection in detail or every pipe or conduit in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. Carefully investigate structural and finish conditions and coordinate the separate trades in order to avoid interference between the various phases of work. Layout work so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Install work to avoid crippling of structural members; install inserts to accommodate pipe hangers before concrete is poured, and provide proper openings through floor, walls, beams, etc., as hereinafter specified or as otherwise indicated or required. Install all work parallel or perpendicular to the lines of the building unless otherwise noted.
- D. When the mechanical Drawings do not give exact details as to the elevation of pipe, conduit and ducts, physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Piping, conduit and duct systems are generally intended to be installed true and square to the building construction, located as high as

possible against the structure in a neat and workmanlike manner and located above finished ceilings. Drawings do not show all required offsets, control lines, pilot lines and other location details. Conceal work in all finished areas. Piping specified to be insulated must be supported in a manner that will allow the insulation to be installed without gaps. Offset insulated piping in concealed areas with fittings, as necessary, to permit installation of insulation. Bending piping or installing pipes in a strain to insulate will not be permitted.

1.8 OBSTRUCTIONS

- A. The drawings indicate certain information pertaining to surface and sub-surface obstructions which has been taken from UTMB's and utility company drawings. This information is not guaranteed as to accuracy of location or complete information.
- B. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided, verify locations given.
- C. Should obstruction be encountered, whether shown or not, re-route existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown on the drawings.
- D. Where obstructions encountered are beyond the scope of work shown or specified in this project, refer the matter to the Owner's representative and a cost differential proposal will be agreed upon before the added work is undertaken as stipulated in the uniform general conditions.

1.9 VIBRATION

- A. All mechanical, plumbing and fire protection systems must operate without excessive noise and vibration. Provide all isolators, pads, dampers and other apparatus as required for quiet, vibration free operation of all systems.

1.10 CONNECTION TO EXISTING SERVICES

- A. Do not make connection to existing services or utilities without the Owner's Representative's knowledge and permission. All such connections must be planned and scheduled to minimize the length of service interruption required. Make request for shutdown to Owner's Representative as far as possible in advance, and provide a detailed written schedule of activities during shutdown and a list of materials required for connection and renewal of service. All such service interruptions must be made at UTMB's convenience, not the Contractor's; and no increase in contract amount will be allowed for reasons of premium time or inefficiency of operations which may result.
- B. Outages of services as required by the new installation will be permitted but only at a time approved by the owner's representative. Allow the Owner's Representative as much time as possible in order to schedule required outages. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner's Representative. Include all costs of outages, including overtime charges in the contract amount. Do not turn off or on any equipment for a building nor shut any valves without permission from Owner's Representative.

1.11 ELECTRICAL CHARACTERISTICS

- A. The electrical design and Drawings are based on the equipment scheduled and indicated on the Drawings. Should any mechanical equipment be provided requiring changes to the electrical design, make the required electrical changes at no additional cost to UTMB.

PART 2 - PRODUCTS

2.1 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

- A. Manufacturers' Instructions: Follow the manufacturers' published instructions for preparing, assembling, installing, erecting, and cleaning manufactured materials and equipment, unless otherwise indicated. Promptly notify the Owner's Representative in writing of any conflict between the requirements of the Contract Documents and the manufacturers' directions and obtain the Owner's Representative instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturers' directions or such instructions from the Owner's Representative, bear all costs arising in connection with the deficiencies.
- B. Minimum capacities are specified or noted.
- C. Nameplates: Each major component of equipment must have the manufacturer's name, address and catalog number on a plate securely attached to the item of equipment. All data on nameplates is to be legible at the time of Final Inspection.
- D. Protection from Moving Parts: Belts, pulleys, chains, gears, couplings, projecting set screws, keys, and other rotating parts located so that any person can come in close proximity thereto, are to be fully enclosed or properly guarded.

2.2 EQUIPMENT IDENTIFICATION AND LABELING

- A. Mechanical: Identify items of mechanical equipment by the attachment of engraved nameplates. Engraving to be condensed gothic, at least 1/2" high, appropriately spaced. Include the name of the item, its mark number, area, space, or equipment served, and other pertinent information. Equipment to be labeled will include but not be limited to the following:
 - 1. Air conditioning units.
 - 2. Pumps.
 - 3. Air conditioning control panels and switches.
 - 4. Constant volume boxes.
 - 5. Vacuum pumps.
 - 6. Exhaust fans.
 - 7. Compressors.
 - 8. Miscellaneous - similar and/or related items.

2.3 WALL, FLOOR AND CEILING PLATES

- A. Except as otherwise noted, provide C.P. brass floor and ceiling plates around pipes, conduits, ducts, etc., passing exposed through walls, floors, or ceilings, in any spaces except underfloor and attic spaces. Size plates to fit snugly against the outside of the pipe or against the insulation on lines which are insulated and positively secure to such pipe or insulation. Plates will not be required for piping where pipe sleeves extend 3/4" above finished floor. All equipment rooms are classified as finished areas. Round and rectangular ducts are to have plates made to fit accurately at all floor, wall and ceiling penetrations.

2.4 FIRE SAFING OF PENETRATIONS

- A. Refer to Section 07 84 00 – Firestopping.

2.5 ACCESS DOORS

- A. General: Provide wall or ceiling access doors as specified in Division 08 for unrestricted access to all concealed items of mechanical equipment.

- B. Doors: Provide access doors for access to valves, clean-outs, trap primers, shock arrestors, etc.

PART 3 - EXECUTION

3.1 VERIFICATION OF DIMENSIONS

- A. Be responsible for the coordination and proper relation of all work with the building structure and to the work of all trades. Visit the premises and become thoroughly familiar with all details of the work and working conditions, verify all dimensions in the field and advise the Owner's Representative of any discrepancy before performing any work. Make adjustments to the work required in order to facilitate a coordinated installation at no additional cost to UTMB.

3.2 PRECEDENCE OF MATERIALS

- A. These Specifications and the accompanying Drawings are intended to cover systems which will not interfere with the structural design of the building, will fit within available spaces, and which will ensure complete and satisfactory operating systems. Be responsible for the proper fitting of materials and equipment into the building.
- B. Harmonize and coordinate work of all other trades so that it may be installed in the most direct and workmanlike manner. Address interferences by giving precedence to pipe lines which require a stated grade for proper operation. Where space requirements conflict, the following order or precedence will, in general, be observed.
 1. Building Lines
 2. Structural Members
 3. Soil and Drain Piping
 4. Fuel Oil Gravity Return Piping
 5. Supply and Return Duct
 6. Exhaust Duct
 7. Vent Piping
 8. Refrigerant Piping
 9. Steam Piping
 10. Condensate Piping
 11. Electrical Bus Duct
 12. Circulating Chilled Water Piping
 13. Fuel Oil Supply Piping
 14. Domestic Hot and Cold Water Piping
 15. Medical Gas Piping
 16. Natural Gas Piping
 17. Fire Sprinkler Piping
 18. Electrical Conduit

3.3 PROTECTION

- A. 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. 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 if recommended by the manufacturer. Failure 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. Cover all finished floors, step treads and finished surfaces to prevent any damage by workmen or their tools and equipment during the construction of the building.

- C. Protect equipment and materials from rust both before and after installation. Any equipment 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. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number; otherwise, surface of ferrous metal is to be given a rust-inhibiting coating. The treatment must withstand 200 hours in salt-spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen is to show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8" on either side of the scratch mark. Where rust-inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified except that coal tar or asphalt type coating will not be acceptable unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, for items fabricated of steel sheet of 12 gauge and lighter, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to ASTM A 780. All steel heavier than 12 gauge specified to be galvanized must be hot dip galvanized after fabrication.

3.4 INSTALLATION ARRANGEMENT AND COORDINATION

- A. Location of Outlets in Rooms: Reference all plumbing, acoustical tile, modular lighting outlets, diffusers, grilles, registers and other devices to coordinated, established data points and locate to present symmetrical arrangements with these points and to facilitate the proper arrangements of acoustical tile panels and other similar panels with respect to the mechanical and electrical outlets and devices. Reference those mechanical and electrical outlets to such features as wall and ceiling furring, balanced border widths, masonry joints, etc. Outlets in acoustical tile must occur symmetrically in tile joints or in the centers of whole tiles. The exact location of each outlet and arrangements to be followed must be acceptable to the Owner's Representative.
- B. The Drawings show diagrammatically the location of the various outlets and apparatus. Exact locations of these outlets and apparatus is to be determined by reference to the general Drawings and to all detail drawings, equipment Drawings, rough-in Drawings, etc., by measurements at the building, and in cooperation with the other trades. The Owner's Representative reserves the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.

3.5 SERVICE ACCESS

- A. All oiling devices and all parts of equipment requiring adjustment must be easily accessible. Locate and install equipment to permit convenient and safe maintenance and future replacement. Do not locate piping, conduit, valve stems, etc., that will block service space. The trade furnishing the equipment is responsible for notifying the Contractor, who must notify the Owner's Representative, prior to ordering same in the event that equipment specified and/or approved is not compatible with this requirement.
- B. Install all equipment in a manner to permit access to all surfaces. Install all valves, motors, drives, filters, and other accessory items in a position to allow removal for service without disassembly of another part.

3.6 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 is to be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, protect such apparatus from damage as hereinafter specified.
- B. Storage at Site: Do not receive material or equipment at the job site until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage.

3.7 DEMOLITION AND RELOCATION

- A. Modify, remove, and/or relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. Conduct all removals and/or dismantling in a manner as to produce maximum salvage. Salvage materials will remain the property of UTMB. Deliver salvaged materials and equipment to such destination as directed by the Owner's Representative unless they are not wanted, then remove such items from the UTMB campus and properly dispose of them. Repair and restore to good operative condition materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations. The Contractor may, at his discretion, and upon the approval of the Owner's Representative, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.
- B. Remove all items which are to be relocated in reverse order to original assembly or placement and protect until relocated. Clean, repair and provide all new materials, fittings and appurtenances required to complete the relocations and to restore them to good operative order. Perform all relocations by workmen 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, call the attention of the Owner's Representative to such items and receive further instructions before removal. Be responsible for items damaged in repositioning operations and repair or replace as approved by the Owner's Representative, at no additional cost to UTMB.
- D. Remove service lines and wiring to items to be removed, salvaged, or relocated to points indicated on the Drawings, specified, or acceptable to the Owner's Representative. Remove service lines and wiring not scheduled for reuse to the points at which reuse is to be continued or service is to remain. Seal, cap, or otherwise tie-off or disconnect such services in a safe manner acceptable to the Owner's Representative. All disconnections or connections into the existing facilities must be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Do not interrupt services to existing areas or facilities which must remain in operation during the construction period without prior specific approval of the Owner's Representative.
- E. Remodeling and demolition work in the middle of an existing facility involves identification and location of many pieces of existing piping and equipment. Locations of much of this is shown on project plans from information available. Cognizance of these variables must be considered in the bid to accomplish the intent of the plans and specifications.
- F. Plans are intended only as a guide to aid the Contractor in determining the scope of his work in the removal of existing mechanical work.
- G. Plans do not necessarily show all demolition nor all demolition that may be required by other trades in related areas.
- H. Where the project involves connection to existing piping or duct, or relocation of piping, duct, etc., repair the insulation at the point of connection. Provide pipe identification markers on the existing piping within four feet of the connection, as well as on the run of new piping.
- I. If unnoted piping is discovered, trace line to determine what it is, whether it is active and what it serves. Relocate as required. If a problem arises on what to do with the piping, bring it to the attention of the Owner's Representative.

3.8 INSTALLATION METHODS

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

- B. Where to Expose: In mechanical rooms, janitor's closets tight against pan soffits in exposed precast concrete "Tee" Structures, or storage spaces, but only where necessary, piping may be run exposed. Route all piping in the neatest, most inconspicuous manner, and parallel or perpendicular to the building lines whether concealed or exposed.
- C. Support: All piping shall be adequately and properly supported from the building structure as specified in this Division.
- D. Maintaining Clearance: For new construction, where limited space is available above the ceilings, below concrete beams or other deep projections, sleeve pipe and conduit through the projection where it crosses, rather than hang below them, in a manner to provide maximum above-floor clearance. Approval shall be obtained from the Structural Engineer for each penetration.
- E. Cut all pipe, conduits, etc.; accurately to measurements established at the building and work into place without springing or forcing. Install all ducts, pipes and conduits run exposed in machinery and equipment rooms parallel to the building lines, except that piping must be sloped to obtain the proper pitch. Install piping and ducts run in furred ceilings, etc., similarly, except as otherwise shown. Conduits in furred ceilings and other concealed spaces may be run at angles to the construction but must be neatly grouped and racked indicating good workmanship. All conduit and pipe openings must be kept closed until the systems are closed with final connections.
- F. Special Notes: Do not install pipe joints nearer than 12" to a wall, ceiling or floor penetration unless pipe joint is welded.
- G. Study all construction documents and carefully lay out all work in advance of fabrication and erection in order to meet the requirements of the extremely limited spaces. Where conflicts occur, meet with all involved trades and resolve the conflict prior to erection of any work in the area involved.
- H. Consider all piping not directly buried in the ground as "interior piping".

3.9 INSPECTIONS

- A. Prior to the installation of any ceiling material, gypsum, plaster, or acoustical board, notify the Owner's Representative and the Architect so that arrangements can be made for an inspection of the above-ceiling area about to be "sealed" off. Give as much advance notice as possible, up to 10 working days, but no less than 5 working days.
- B. All above-ceiling areas will be subject to a formal inspection before ceiling panels are installed, or installation is otherwise concealed from view. All mechanical and electrical work at and above the ceiling, including items supported by the ceiling grid, such as air inlets or outlets and lighting fixtures, is to be complete and installed in accordance with contract requirements, including power to lighting fixtures, fans, and other powered items. Provide adequate lighting to permit thorough inspection of all above-ceiling items. The inspection will include representatives of the following: General Contractor and each Subcontractor having work above the ceiling and the Owner's Representative. Coordinate areas to be included and time of inspection with all parties.
- C. 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, the fire protection system and any other special above ceiling systems such as pneumatic tube, vacuum cleaning, and cable tray systems. The ceiling supports (tee bar or lath) must be in place so that access panel and light fixture locations are identifiable and so that clearances and access provisions may be evaluated.
- D. No ceiling materials may be installed until the resulting punch list from this inspection is worked off and the Owner's Representative has given approval.
- E. For Project Closeout Inspections, refer to Division 01 sections.

3.10 EXCAVATION, TRENCHING AND BACKFILLING

- A. Refer to Division 02 sections for requirements.
- B. Install all exterior lines with a minimum cover of 24", unless otherwise indicated. Generally, provide more cover if grade will permit.

3.11 FOUNDATIONS

- A. Provide concrete foundations for the support of equipment such as floor-mounted panels, water heaters, pumps, fans, etc., not less than 6" high and extended 4" on all sides beyond the limits of the mounted equipment unless otherwise noted. Pour in forms built of new-dressed lumber. Chamfer all corners of the foundations neatly by means of sheet metal or triangular wood strips nailed to the form. Place foundation bolts in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt is to be set in a sleeve of size to provide 1/2" clearance around bolt. Allow 1" below the equipment bases for alignment and grouting. After grouting, remove the forms and hand rub the surface of the foundations with carborundum. Provide foundations for equipment located on the exterior of the building as indicated. Construct foundations in accordance with Division 03 sections.

3.12 CONNECTION OF EQUIPMENT SUPPLIED BY OTHERS

- A. 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 rough-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, make all final connections and provide all required pipe, fittings, valves, traps, etc.
- C. Provide all air gap fittings required. In each water line serving an item of equipment or piece of machinery, provide a shut-off valve. On each drain not provided with a trap, provide a suitable trap.
- D. All pipe fittings, valves, traps, etc., exposed in finished areas and connected to chrome-plated lines provided by others is to be chrome-plated to match.
- E. Provide all sheet metal duct, transition pieces, etc., required for a complete installation of vent hoods, fume hoods, etc., provided by others.

END OF SECTION 23 00 00

SECTION 23 05 53 – MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe Markers.

1.3 RELATED SECTIONS

- A. Division 09 - Painting: Identification painting.

1.4 REFERENCES

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.5 SUBMITTALS

- A. Submit under provisions of Division 01.
- B. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Samples: Submit two of each type of label, tag, etc., of the approximate size specified or implied in the specification.
- F. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01.
- B. Record actual locations of tagged valves.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers: Brady, Brimar or Seton. Other acceptable manufacturers offering equivalent products will be acceptable.
- B. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner's Representative.

2.2 TAGS

- A. Manufacturers: Brady, Brimar or Seton. Other acceptable manufacturers offering equivalent products will be acceptable.
- B. Description: Brass metal with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C. Chart: Typewritten letter size list in anodized aluminum frame.

2.3 PIPE MARKERS

- A. Manufacturers: Brady, Brimar or Seton. Other acceptable manufacturers offering equivalent products will be acceptable.
- B. Color: Conform to ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

2.4 CEILING TACKS

- A. Manufacturers: Brady, Brimar or Seton. Other acceptable manufacturers offering equivalent products will be acceptable.
- B. Description: Steel with 3/4 inch diameter color coded head.
- C. Color code as follows:
 - 1. Yellow - HVAC equipment.
 - 2. Red - Fire dampers/smoke dampers.
 - 3. Green - Plumbing valves.
 - 4. Blue - Heating/cooling valves.

- 2.5 General: Make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, valves, piping, etc., by marking them. All items of equipment such as fans, pumps, etc., are to be clearly marked using engraved nameplates as specified. Use equipment identification numbers that appear on the design documents and/or equipment identification numbers furnished by the Owner's Representative.

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

Pumps	Exhaust Fans
Fan and Coil Units	Hot Water Generators
Condensing Units	Storage Tanks
Converters	Compressors
Air Conditioning Control	Miscellaneous - similar and/or related items
Panels and Switches	Fume Hood Exhaust Fans

- 2.7 Piping: Pipe markers and arrow markers also are to be provided on, but not limited to, the piping of the following systems:

Primary Chilled Water Supply and Return	Steam Condensate and Condensate Return
Refrigerant Piping	Secondary Chilled Water Supply and Return
Instrument Air	Deionized Water (or Reverse Osmosis Water)
Condenser Water Supply and Return	Secondary Chilled Water Return
Atmospheric Relief	Compressed Air
Fuel Oil	Fire Standpipe
Steam (All pressures)	Domestic Cold Water Supply
Heating Hot Water Supply and Return	Acid Waste and Vent
Sanitary Soil, Waste and Vent	Natural Gas
Grease Waste	Oxygen
Laboratory Air	Nitrous Oxide
Medical Air	Carbon Dioxide
Medical Vacuum	Inert Gas
Laboratory Vacuum	Distilled Water
Evacuation Vacuum	Roof Drain

Nitrogen	Overflow Drain
Domestic Hot Water Supply and Return	Fire Sprinkler
Equipment Coolant	Equipment Drain

2.8 Electrical: Nameplates to be 3 ply laminated plastic, a minimum of 3/32" thick, such that letters will be white on black background. Letters to be similar to Roman Gothic of a size that is legible and appropriate to the application. Attachment of nameplates to be by screws. Rivets or adhesives are not acceptable.

- A. Electrical equipment to be identified includes: All switchgear, distribution panels, transformers, motor control centers, panelboards, disconnect switches, starters, contactors and time switches.
- B. Nameplates on distribution panels, motor control centers and panelboards to give voltage characteristics.

Example:

PANEL LA
120/208V, 3 PH, 4 W
SERVED FROM "MSBA".

- C. Individual circuit breakers in distribution panels, individual units in motor control centers, disconnecting means, and motor starters, are to include nameplates showing the load served.
- D. Branch circuit panelboards to have neatly typed circuit directories behind clean plastic. Identify circuits by room numbers. Use room numbers finally selected by the Owner's Representative; not necessarily those given on contract Drawings. If a circuit serves more than one room, list each room. Spares and spaces are to be indicated with erasable pencil; not typed.

2.9 Prepare and install, in a suitable glazed frame, typewritten valve charts giving the number, location, function and area or rooms served for each line valve installed under this Contract. Each valve to be numbered on these charts in accordance with the system of which it is a part of and its location. For example, valves in different systems would be designated as follows:

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

- A. Provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above. These tags are to be affixed to all valves. These tags to be brass discs, minimum 19 gauge thickness and 1-1/2" in diameter. Attach each tag to its valve with brass beaded chain and locking link.
- B. Valves at water headers and steam PRV stations, valves associated with condensate, gas, water meters, and other valves are also to be tagged.

2.11 Identify all pipe runs throughout the building, including those above lift out ceilings, under floor, exposed and those exposed to view when access doors or access panels are opened, by means pipe markers. In addition to the pipe markers indicating service, include arrow markers to indicate direction of flow. For medical gases, natural gas, compressed air and steam, include normal system operating pressure information. The following specific instructions shall apply to the application of these markers:

- A. Provide a pipe marker at each valve to indicate proper identification of pipe contents. Where several valves exist on one header, it is necessary to mark only the header.
- B. Provide an arrow marker with each pipe marker pointing away from the pipe marker to indicate direction of flow.
- C. Provide a double ended arrow marker when flow can be in either or both directions.
- D. Provide a pipe marker and an arrow marker at every point of pipe entry or exit where line goes through a wall or service column.
- E. Provide pipe markers and arrow markers at intervals not exceeding 50 feet.
- F. Locate markers on the two lower quarters of the pipe where view is unobstructed.
- G. Use snap-on type identification for all piping systems, 3/4" thru 6". For piping systems larger than 6", use strap on markers.
- H. Pipe Markers must conform to ANSI A 13.1-1981 "Scheme for the Identification of Piping Systems". Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.
- I. Locate markers so as to be visible from floor. Letter size to be adequate to provide legibility from floor level.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces.
- B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners.
- B. Install tags with corrosion resistant chain and locking link.
- C. Apply stencil painting in accordance with Division 09.
- D. Install plastic pipe markers in accordance with manufacturer's instructions. Tape each end of snap-on pipe markers completed around pipe or insulation.
- E. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.
- F. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates.
- G. Identify control panels and major control components outside panels with plastic nameplates.
- H. Identify thermostats relating to terminal boxes or valves with nameplates.

- I. Identify valves in main and branch piping with tags.
- J. Identify air terminal units and radiator valves with tags.
- K. Tag automatic controls, instruments, and relays. Key to control schematic.
- L. Provide ceiling tacks to locate valves, dampers or other concealed equipment above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
- M. Identify ductwork with stenciled painting. Include air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure and at each obstruction.

END OF SECTION 23 05 53

SECTION 23 05 90 - SYSTEM PREPARATION FOR TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Perform all work required to prepare the building HVAC systems for testing, adjusting and balancing indicated by the Contract Documents as follows:
 - 1. Responsibilities of project contractor.
 - 2. Preparation for balancing of air systems.
 - 3. Preparation for balancing of hydronic and steam systems.
 - 4. Final total air balance.
- B. The scope of the TAB work as defined in Section 23 05 93 is indicated in order that the Contractor will be advised of the coordination, adjustment, and system modification which will be required under the project work in order to complete the Owner's requirements for final TAB. The Contractor in his original bid shall allow for the costs required to cover all work which may be required in the TAB phases as defined herein and as may be necessary for the completion of the TAB work as defined by the TAB firm.

1.3 RELATED SECTIONS

- A. Division 01 - Starting of Systems.
- B. Section 23 00 00 - Basic Mechanical Requirements.
- C. Section 23 05 48 - Vibration Isolation.
- D. Section 23 21 16 - Hydronic Specialties.
- E. Section 23 22 16 - Steam and Steam Condensate Specialties.
- F. Section 23 21 23 - HVAC Pumps.
- G. Section 23 82 16 - Air Coils.
- H. Section 23 73 00 - Air Handling Units.
- I. Section 23 34 16 - Centrifugal Fans.
- J. Section 23 31 00 - Ductwork.
- K. Section 23 33 00 - Ductwork Accessories.
- L. Section 23 36 00 - Air Terminal Units (VAV).

- M. Section 23 36 16 - Air Terminal Units (FPVAV).
- N. Section 23 37 00 - Air Outlets and Inlets.
- O. Section 23 09 43 - Pneumatic Controls.
- P. Section 23 09 23 - Direct Digital Control Systems.
- Q. Section 23 09 93 - Sequence of Operation.
- R. Section 23 05 93 - System Testing, Adjusting & Balancing (TAB).

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. However, the preparation for and corrections necessary for the Testing, Adjusting and Balancing of these systems, as described herein, are the responsibility of the Contractor.
- B. As a part of this project Construction Contract, the Contractor shall make any changes or replacements to the sheaves, belts, dampers, valves, etc. required for correct balance as advised by the TAB firm, at no additional cost to the Owner.
- C. The Contractor shall provide and coordinate the services of qualified, responsible Subcontractors, suppliers and personnel as required to correct, repair, and/or replace any and all deficient items or conditions found during the course of this project, including the testing, adjusting and balancing period.
- D. In order that all systems may be properly tested, balanced, and adjusted as required herein by these Specifications, the Contractor shall operate said systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB. This length of time shall be subject to the approval of the Construction Inspector.
- E. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The contractor shall allow adequate time for the testing and balancing activities of the owner provided services, during the construction period, and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.
- F. The Drawings and Specifications indicate valves, dampers and miscellaneous adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to install these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by the TAB firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor or the Construction Inspector shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.

1.5 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 his contracted work within the construction schedule. The contractor shall complete his work by systems or floors whichever is the most efficient for scheduling. After awarding of the contract and the contractor has developed a construction schedule, a TAB coordination meeting shall be held at the RCM's office with the TAB agency, the general contractor and his primary subcontractors (i.e.

mechanical, electrical, building automation etc.) to develop a testing schedule for the project. The contractor shall submit copies of the proposed schedule two (2) weeks prior to this meeting and TAB Agency.

The following are minimum time requirements:

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

3. Promptly correct deficiencies of materials and workmanship identified as delaying completion of TAB work.
 4. Be responsible for any added costs to the Owner resulting from his failure to have the building and air conditioning systems ready for TAB when scheduled, or from his failure to correct deficiencies promptly.
- B. Complete operational readiness of the building requires that construction status of the building shall permit the closing of doors, windows, ceilings installed, etc., to obtain simulated or projected operating conditions.
- C. Complete operational readiness of the air conditioning systems also requires that the following be accomplished:
1. 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. Dampers serving requirements of minimum and maximum outside, return and relief air shall provide tight closure and full opening, smooth and free operation.
 - c. All supply, return, exhaust and transfer grilles, registers, diffusers and terminal devices installed.
 - d. 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.
 - e. 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.
 - f. 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. Check and verify pump alignment and rotation.
 - b. Open all valves to their full open position, close bypass stop valves. Set mixing valves to full-flow through systems components. After the system is flushed and checked for proper operation, remove and clean all strainers. The Contractor shall repeat the operation until circulating water is clean.
 - c. Record each pump motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating.
 - d. Verify that the electrical heater elements are of the proper size and rating.
 - e. In preparation of TAB all water circulating systems shall be full and free of air, expansion tanks shall be set for proper water level, and all air vents shall be installed at high points of systems and operating freely. Systems shall be cleaned and flushed. Chemicals shall be added to closed systems to treat piping and inhibit corrosion.
 - f. Check and set operating parameters of the heat exchangers and control devices to the design requirements.

- 3. Automatic Controls:
 - a. The Contractor shall schedule a meeting with the Engineer, Control Contractor, TAB firm 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. The Automatic Temperature Contractor and/or Energy Management System Contractor shall provide technical support (technicians and necessary computers) to the TAB agency 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.

D. Notification of System Readiness:

- 1. After completion of the work in Paragraph 1.5 A through C above, the Contractor shall notify the Owner in writing, certifying that the work has been accomplished and that the building and the air conditioning systems are in operational readiness for testing, adjusting, and balancing. He shall include a copy of the tabulated data of Paragraph 1.5C.4 above.
- 2. The Owner will, in turn, notify the TAB firm of the readiness for balancing and forward copies of the Contractor's certification and the tabulated voltages and currents.
- 3. Should the TAB firm be notified as described above, and the TAB work commenced and the systems are found NOT to be in readiness or a dispute occurs as to the readiness of the systems, the Contractor shall request an inspection be made by duly appointed representative of the Owner, Architect, TAB firm and the Contractor. This inspection will establish to the satisfaction of the represented parties whether or not the systems meet the basic requirements for TAB services. Should the inspection reveal the TAB services notification to have been premature, all cost of the inspection and wasted work accomplished by the TAB firm shall be reimbursed to the appropriated parties by the Project Contractor.

1.6 RESPONSIBILITIES OF THE TAB FIRM

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

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 23 05 90

SECTION 23 05 93 – SYSTEM TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Testing, adjusting and balancing (TAB) of the air conditioning systems and related ancillary equipment will be performed by an impartial technically qualified TAB firm as part of General Contractors scope of work.
- B. The firm shall be capable of performing the services specified at the location of the facility described within the time specified, of preparing and submitting the detailed report of the actual field work performed, and following up the basic work as may be required.

1.3 QUALIFICATIONS

- A. The Firm shall be one which is organized to provide professional services of this specified type in the State of Texas and as a minimum shall have one (1) professional engineer licensed in the State of Texas, with current registration, to perform such professional services. This engineer shall be personally responsible for developing the job site data as required in the test procedures outlined in these Specifications.
- B. The Firm shall have operated a minimum of five (5) years under it's current Firm name, and shall be in good standing with the State of Texas, Franchise Tax Board. The firm shall submit their full incorporated name, Charter Number and Taxpayer's I.D. Number for proper verification of the firm's status.
- C. The Firm shall be capable of providing a performance bond, by a bonding company licensed to do business in the State of Texas, if determined by the Owner that such a bond is required. The amount of the bond which may be required shall be equal to the cost of the proposal submitted, or in the case of more than one proposal, the sum of all such proposals and any awarded work in progress.
- D. The Firm shall maintain current insurance coverages in the minimum amounts shown below. If the Firm normally carries such insurance coverages (minimum or higher) incident to it's operation, additional insurance for the specific proposal or proposals is not required. The minimum insurance coverages required are:
 - 1 Worker's Compensation as required by law.
 - 2. General Liability for not less than \$1,000,000 aggregate refer to Division 01, General Conditions.
 - 3. Fire Damage, and Extended Coverage, Vandalism and Malicious Mischief, in the full amount of Contract. The above policies shall be carried with companies satisfactory to the Owner. Certificates of each of the above policies, together with a written statement by the issuing company, stating that said policy will not be canceled without ten (10) days prior written notice to the Board of Regents of the University of Texas system, shall be delivered to the Owner before any work is started.

- E. All personnel used on the job site shall be either professional engineers or engineering technicians, who shall have been permanent, full time employees of the firm for a minimum of six (6) months prior to the start of work for this specific project.
- F. The TAB firm shall submit biographical data on the individual proposed to directly supervise the TAB work, as well as other personnel scheduled to perform the technical work under the contract. It shall also submit a background record of at least five years of specialized experience in the field of air hydronic system balancing, and shall possess properly calibrated instrumentation. The supervisory personnel for the TAB firm shall be registered engineers in the mechanical field and all of the employees used in the TAB firm shall be permanent, full-time employees of the firm.
- G. The scope of the TAB work as defined herein is indicated in order that the Mechanical Contractor will be advised of the coordination, adjustment and system modification which will be required under the project work in order to complete the Owner's requirements for final TAB. The General Contractor shall engage one of the certified TAB firms from the approved list below:

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

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

Precision Air of Texas - (281) 449-0961

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

1.4 REFERENCES

- A. National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, Fifth Edition 1989.
- B. ASHRAE - 1991 HVAC Applications Chapter 34: Testing, Adjusting and Balancing.
- C. ANSI/ASHRAE Standard 111-1988 - Practices for Measurement, Testing, Adjusting and Balancing of Buildings, Heating, Ventilation, Air Conditioning and Refrigeration Systems.

1.5 DOCUMENTS

- A. The TAB firm shall, as a requirement of the TAB contract, arrange with the Architect to compile one set of mechanical specifications, all pertinent change orders, and the following:
 - 1. One complete set of Drawings less the structural sheets.
 - 2. One set of mechanical floor plans of the conditioned spaces. These Drawings shall be ozalid type (blue or black on light background) reproductions to facilitate marking.
- B. Approved submittal data on equipment installed, and related changes as required to accomplish the test procedures outlined in Paragraphs 1.6 through 1.10 of this Specification will be available through the Construction Inspector.

1.6 RESPONSIBILITIES OF THE TAB FIRM

- A. The TAB personnel shall check, adjust, and balance the components of the air conditioning system which will result in optimal noise, temperature, and airflow conditions in the conditioned spaces of the building while the equipment of the system is operating economically. This is intended to be accomplished after the system components are installed and operating as provided for in the contract documents. It is the responsibility of the Mechanical Contractor to place the equipment into service. Variable air volume systems shall be balanced in accordance with AABC 1989 Standard, Fifth Edition.

- B. Liaison and Early Inspection:
1. The TAB firm personnel on the job shall act as liaison between the Owner, Architect and Contractor. The following reviews (observations) and tests shall be performed by the TAB Agency:
 - a. During construction, review all HVAC submittals such as control diagrams, air handling devices, etc., that pertain to commissioning work and balance ability.
 - b. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the Construction Inspector shall be advised in writing so that the condition can be corrected by the Mechanical Contractor. The written document need not be formal, but must be understandable and legible. Data from malfunctioning equipment shall not be recorded in the final TAB report. The TAB firm shall not instruct or direct the Contractor in any of the work, but will make such reports as are necessary to the Owner.

1.7 FINAL AIR BALANCE

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

1.8 FINAL CHILLED AND HEATING HOT WATER BALANCE

- A. General: When systems are completed and ready for operation, the TAB Consultant will perform a final water balance for each chilled and hot water system. The general scope of balancing by the TAB Consultant will include, but not be limited to, the following:
1. Adjusted System Tests: Adjust balancing valves at each coil and heat exchanger for design flow, $\pm 5\%$. Adjust balancing valves at pumps to obtain design water flow. Record pressure rise across pumps and GPM flow from pump curve. Permanently mark the balanced position for each valve (Note: If discharge valves on the pumps are used for balancing record the head being restricted by the valves).
 2. Temperature Readings: Read and record entering and leaving water temperature at each water coil, converter and heat exchanger. Adjust as necessary to secure design and conditions. Provide final readings at all thermometer well locations.
 3. Pressure Readings: Water pressure shall be recorded at all gauge connections. Pressure readings at coils and pumps shall be related to coil and pump curves in terms of GPM flow through flow measuring status, if provided and installed, at each air handler. The flow of water through all water coils shall be adjusted by manipulating valves until the rated pressure drops across each coil is obtained and total water flow is verified by flow measuring status. For coils equipped with 3 way valves, the rated pressure drop shall first be adjusted through the coils. The bypass valve shall then be adjusted on each coil until an equal pressure drop between supply and return connections is the same as with the flow through the coil.
 4. Ampere Readings: Reading and record full load amperes for each pump motor.

1.9 TESTING OF TEMPERATURE CONTROL SYSTEMS

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

1.10 STAIRWELL PRESSURIZATION SYSTEMS

- A. With all doors closed, measure the door pull to determine that the opening force required is below 30 #/ft.
- B. With all doors closed, measure the pressure differential across each door to verify the pressure differentials at each floor.
- C. Measure the air flow in the stairwell with the maximum number of doors fully open by pitot tube traverse, if traverse locations are available. If traverse locations are not available, measure air flow at each outlet.
- D. Verify with smoke that the smoke detector in the stair pressurization fan inlet shuts the fan down.

1.11 REPORTS

- A. The activities described in this section shall culminate in a report to be provided in quadruplicate (4) individually bound to the RCM. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operations personnel.
- B. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the reports must have been made onsite by the permanently employed technicians or engineers of the firm.
- C. At the option of the Construction Inspector, all data sheets tabulated each day by TAB personnel shall be submitted for initial by the Construction Inspector. Those work sheets so initialed, or copies thereof, shall be presented as a supplement to the final TAB report.
- D. Submit reports on forms approved by the Owner & Engineer which will include the following information as a minimum:
 - 1. Title Page:
 - a. Company Name.
 - b. Company Address.
 - c. Company telephone number.
 - d. Project name.
 - e. Project location.
 - f. Project Manager.
 - g. Project Engineer.
 - h. Project Contractor.
 - i. Project Identification Number.
 - 2. Instrument List:
 - a. Instrument.
 - b. Manufacturer.
 - c. Model.
 - d. Serial Number.
 - e. Range.
 - f. Calibration date.
 - g. What test instrument was used for.
 - 3. Fan Data (Supply and Exhaust):
 - a. Location.
 - b. Manufacturer.
 - c. Model.
 - d. Air flow, specified and actual.
 - e. Total static pressure (total external), specified and actual.

- f. Inlet pressure.
- g. Discharge pressure.
- h. Fan RPM.
4. Return Air/Outside Air Data (If fans are used, same data as for 3 above):
 - a. Identification/location.
 - b. Design return air flow.
 - c. Actual return air flow.
 - d. Design outside air flow.
 - e. Return air temperature.
 - f. Outside air temperature.
 - g. Required mixed air temperature.
 - h. Actual mixed air temperature.
5. Electric Motors:
 - a. Manufacturer.
 - b. HP/BHP.
 - c. Phase, voltage, amperage, nameplate, actual.
 - d. RPM.
 - e. Service factor.
 - f. Starter size, heater elements, rating.
6. V-Belt Drive:
 - a. Identification/location.
 - b. Required driven RPM.
 - c. Driven sheave, diameter and RPM.
 - d. Belt, size and quantity.
 - e. Motor sheave, diameter and RPM.
 - f. Center-to-center distance, maximum, minimum and actual.
7. Duct Traverse:
 - a) System zone/branch.
 - b) Duct size.
 - c) Area.
 - d) Design velocity.
 - e) Design air flow.
 - f) Test velocity.
 - g) Test air flow.
 - h) Duct static pressure.
 - i) Air temperature.
 - j) Air correction factor.
8. Air Monitoring Station Data:
 - a. Identification/location.
 - b. System.
 - c. Size.
 - d. Area.
 - e. Design velocity.
 - f. Design air flow.
 - g. Test velocity.
 - h. Test air flow.
9. Air Distribution Test Sheet:
 - a. Air terminal number.
 - b. Room number/location.
 - c. Terminal type.
 - d. Terminal size.
 - e. Area factor.
 - f. Design velocity.
 - g. Design air flow.
 - h. Test (final) velocity.
 - i. Test (final) air flow.

10. Pump Data:
 - a. Identification/number.
 - b. Manufacturer.
 - c. Size/model.
 - d. Impeller.
 - e. Service.
 - f. Design flow rate, pressure drop, BHP.
 - g. Actual flow rate, pressure drop, BHP.
 - h. Discharge pressure
 - i. Suction pressure.
 - j. Total operating head pressure.
 - k. Shut off, discharge and suction pressure.
 - l. Shut off, total head pressure.
 - m. Pressure differential settings.
11. Cooling Coil Data:
 - a. Identification/number.
 - b. Location.
 - c. Service.
 - d. Manufacturer.
 - e. Entering air DB temperature, design and actual.
 - f. Entering air WB temperature, design and actual.
 - g. Leaving air DB temperature, design and actual.
 - h. Leaving air WB temperature, design and actual.
 - i. Water pressure flow, design and actual.
 - j. Water pressure drop, design and actual.
 - k. Entering water temperature, design and actual.
 - l. Leaving water temperature, design and actual.
 - m. Air pressure drop, design and actual.
12. Heating Coil Data:
 - a. Identification/number.
 - b. Location.
 - c. Service.
 - d. Manufacturer.
 - e. Air flow, design and actual.
 - f. Water flow, design and actual.
 - g. Water pressure drop, design and actual.
 - h. Entering water or steam temperature, design and actual.
 - i. Leaving water temperature, design and actual.
 - j. Entering air temperature, design and actual.
 - k. Leaving air temperature, design and actual.
 - l. Air pressure drop, design and actual.
13. Sound Level Report:
 - a. Location (Location established by the design engineer).
 - b. NC curve for eight (8) bands - equipment off.
 - c. NC curve for eight (8) bands - equipment on.
14. Vibration Test on equipment having 10 HP motors or above:
 - a. Location of points:
 - 1) Fan bearing, drive end.
 - 2) Fan bearing, opposite end.
 - 3) Motor bearing, center (if applicable).
 - 4) Motor bearing, drive end.
 - 5) Motor bearing, opposite end.
 - 6) Casing (bottom or top).
 - 7) Casing (side).
 - 8) Duct after flexible connection (discharge).
 - 9) Duct after flexible connection (suction).

- b. Test readings:
 - 1) Horizontal, velocity and displacement.
 - 2) Vertical, velocity and displacement.
 - 3) Axial, velocity and displacement.
 - c. Normally acceptable readings, velocity and acceleration.
 - d. Unusual conditions at time of test.
 - e. Vibration source (if non-complying).
15. Control verification indicating date performed and any abnormalities identified.
- a. Point Location/Description.
 - b. EMS Readout (Setpoint and Actual).
 - c. Actual Readout.
 - d. Interlocks.
 - e. Safeties:
 - 1) VSD Normal Operation.
 - 2) VSD Bypass Operation.
 - f. Alarms.
 - g. Sequences of Operation.

END OF SECTION 23 05 93

SECTION 23 07 13 – DUCTWORK INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Ductwork insulation.
- B. Insulation jackets.

1.3 REFERENCES

- A. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM C518 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- C. ASTM C553 - Mineral Fiber Blanket and Felt Insulation.
- D. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
- E. ASTM E84 - Surface Burning Characteristics of Building Materials.
- F. ASTM E96 - Water Vapor Transmission of Materials.
- G. NFPA 255 - Surface Burning Characteristics of Building Materials.
- H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- I. UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Section 23 00 00.
- 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. Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

1.5 QUALITY ASSURANCE

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

1.6 QUALIFICATIONS

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 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 ACCEPTABLE MANUFACTURERS

- A. Owens Corning.
- B. Manville.
- C. Knauf.
- D. Certainteed.

2.2 INSULATION A

- 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" on center on bottom of duct and where required elsewhere to hold insulation securely against the duct as noted in the published recommendations of the Insulation Manufacturer.
- C. After insulation is in place, all joints and seams shall be sealed with Foster 30-35 white vapor barrier emulsion applied over a 3" 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" and over in height, the Contractor shall apply a strip of fiberglass board 1" thick by 6" wide, sealing same to the other insulation with mastic.
- E. Vapor sealing of joints and seams is not required on hot duct application where concealed.

2.3 INSULATION B

- 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 his option may substitute Insulation A where Insulation B is called for.

2.4 INSULATION C

- 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 wrapped tightly on the ductwork with all circumferential joints butted and longitudinal joints overlapped a minimum of 2". Adhere insulation to metal with 4" strips of insulation bonding adhesive at 8" on center. On circumferential and longitudinal joints, the 2" flange of the facing shall be secured using 9/16" flare door staples applied 6" on center and taped with 4" wide fiberglass tape embedded in Foster 30-35 white vapor barrier Emulsion and covered with Foster 30-35 white vapor barrier Emulsion until the tape is completely covered. All pin penetrations or punctures in facing shall also be taped. Vapor sealing of joints is not required on hot duct application where concealed.

2.5 INSULATION D (GLASS FIBER DUCT LINER, FLEXIBLE)

- A. Insulation: ASTM C1071, Type 1; flexible, noncombustible blanket.
 - 1. 'K' Value: ASTM C518, 0.24 at 75 degrees F.
 - 2. Maximum Service Temperature: 250 degrees F.
 - 3. Density: 1.5 lb/cu ft.
 - 4. Maximum Velocity on Coated Air Side: 4,000 ft/min.
 - 5. Thickness: 1".
 - 6. Coated with black pigmented fire-resistant coating on the side toward the air stream.
 - 7. Comply with NFPA 90A/90B.
- B. Adhesive:
 - 1. Manufacturers:
 - a. Kingco.
 - b. Foster (H. B. Fuller Co.).
 - c. 3M.
 - 2. Waterproof fire-retardant type, nonflammable.
- C. Liner Fasteners: Galvanized steel, welded with integral head.

2.6 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.

2.7 Low pressure supply duct taps to ceiling diffusers shall be externally insulated including top of ceiling diffuser with 2" Insulation C.

2.8 Flexible round ducts are specified in Section 23 31 00 as factory insulated.

2.9 All kitchen hood exhaust ductwork connected to both inlet and discharge sides of Fans shall be insulated. Insulation shall be 1" insulation A or B.

2.10 JACKETS

- A. Canvas Jacket: UL listed.
 - 1. Fabric: 6 oz/sq yd, plain weave cotton treated with dilute fire retardant lagging adhesive.
 - 2. Lagging Adhesive:
 - a. Compatible with insulation.
- B. Aluminum Jacket: ASTM B209.
 - 1. Thickness: 0.016 inch sheet.
 - 2. Finish: Smooth.
 - 3. Joining; Longitudinal slip joints and 2 inch laps.
 - 4. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

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. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated ductwork conveying air above ambient temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. For exterior applications, provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
- E. External Duct Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Secure insulation without vapor barrier with staples, tape, or wires.
 - 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
 - 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- F. Return Air Plenum Liner Application:
 - 1. Adhere insulation with adhesive for 100 percent coverage.
 - 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.
 - 3. Seal and smooth joints.
 - 4. Seal liner surface penetrations with adhesive.

5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.
- 3.3 All piping, equipment, ductwork, all plenums including metal and masonry construction, fans, etc., shall be insulated as indicated on the Drawings, as specified herein, and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.
- 3.4 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.
- 3.5 All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application, and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.
- 3.6 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 three inches (3"). Where insulation terminates, it shall be neatly beveled and finished. No insulation shall be applied until the pipe, duct, etc., have been pressure tested and found tight. 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.
- 3.7 Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.
- 3.8 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.
- 3.9 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.
- 3.10 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.
- 3.11 The handling and installation of all insulation materials shall be performed in strict accordance with the manufacturers recommendations.
- 3.12 TOLERANCE
- A. Substituted insulation materials shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.13 DUCT INSULATION SCHEDULE:

<u>Duct Type</u>	<u>Insulation Type</u>
Cold Supply Round	1 1/2" Insulation A
Hot Supply Round	1" Insulation A
Cold Supply Flat Oval	1 1/2" Insulation A
Hot Supply Flat Oval	1" Insulation A
Cold/Hot/or Combination Rectangular	1 1/2" Insulation B
Hot and Cold Combination Supply Round	2" Insulation C
Outside Air	1" Insulation B
Return Air Plenum and Sound Baffles	1" Insulation D

END OF SECTION 23 07 13

SECTION 23 31 00 – DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Low pressure ducts.
- B. Medium and high pressure ductwork.
- C. Casings.
- D. Kitchen hood ductwork.
- E. Duct cleaning.

1.3 RELATED WORK

- A. Division 09 - Painting: Weld priming, weather resistant, paint or coating.
- B. Section 23 00 00 - Basic Mechanical Requirements.
- C. Section 23 05 29 - Sleeves, Flashings, Supports and Anchors.
- D. Section 23 05 48 - Vibration Isolation.
- E. Section 23 07 13 - Ductwork Insulation.
- F. Section 23 33 00 - Ductwork Accessories.
- G. Section 23 36 00 - Air Terminal Units.
- H. Section 23 37 00 - Air inlets and Outlets.
- I. Section 23 05 90 - System Preparation for Testing, Adjusting and Balancing.
- J. Section 23 05 93 - System Testing, Adjusting and Balancing.

1.4 REFERENCES

- A. ASHRAE - Handbook of Fundamentals; Duct Design.
- B. ASHRAE - Handbook of Equipment; Duct Construction.
- C. ASTM A 90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.

- D. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- E. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
- F. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.
- G. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.
- H. ASTM C 14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
- I. ASTM C 443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- J. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- K. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
- L. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooling Equipment.
- M. SMACNA - Low Pressure Duct Construction Standards.
- N. SMACNA - High Pressure Duct Construction Standards.
- O. UL 181 - Factory-Made Air Ducts and Connectors.

1.5 REFERENCES

- A. Fundamentals Handbook, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
- B. Equipment Handbook, ASHRAE.
- C. HVAC Duct Construction Standards, Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
- D. HVAC Duct System Design, SMACNA.
- E. Round Industrial Duct Construction Standards, SMACNA.
- F. Engineering Design Manual for Air Handling Systems, United McGill Corporation (UMC).
- G. Assembly and Installation of Spiral Duct and Fittings, UMC.
- H. Engineering Report No. 132 (Spacing of Duct Hangers), UMC.

1.6 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.
- B. Low Pressure: 2 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.

1.7 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards.

1.8 SUBMITTALS

- A. Shop Drawings shall be submitted on all items of sheet metal work specified herein. Shop Drawings of ductwork at air units shall be submitted at a minimum scale of 3/8" equal to one foot.
- B. Shop Drawings shall be submitted on all other ductwork per Division 01. Shop Drawings shall indicate location of all supply, return, exhaust and light fixtures from the approved reflected ceiling plans. These shop drawings shall be submitted at a minimum scale of 1/4" equal to one foot.
- C. Submit shop drawings and product data under provisions of Division 01.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Division 01.
- B. Store and protect products under provisions of Division 01.

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. 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. 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. The work shall be guaranteed for a period of one (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. 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" in width. Each sheet shall be stenciled with manufacturer's name and gauge. Coils of sheet steel shall be stenciled throughout on ten foot (10') centers with manufacturer's name and must be visible after duct is installed. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in latest edition of SMACNA's "HVAC Duct Construction Standards."

- F. Where ducts, 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. 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" 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 latest edition of SMACNA HVAC Duct Construction Standards for Metal and Flexible Duct per Division 01 are the minimum which shall be used for this project. 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 shall be radius type and have a centerline radius of 1-1/2 times the duct diameter or width. Elbows in round ducts may be smooth radius as described above or 5-piece 90 degree elbows and 3-piece 45 degree elbows. 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.
- E. SEALANT: 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. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project. For exterior applications, "Uni-Weather" (United McGill Corp.) neoprene based sealant shall be used. No other sealants may be used. 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" wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth. All sealants shall be UL rated at no more than flame spread of 5 and smoke developed of 0. 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. 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.
- B. 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. For exterior applications, "Uni-Weather" (United McGill Corp.) solvent based sealant shall be used. No other sealants may be used. 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" wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth. At contractor's option Hardcast 1602 sealant tape may be used in lap joints and flat seams.

- C. Oval ducts shall be spiral flat oval or welded flat oval equal to those of United McGill Sheet Metal Company with gauges and reinforcing as recommended by the manufacturer for medium pressure or the ducts may be Shop fabricated of completely welded construction of the following gauge:
- | | |
|----------------------|--------------|
| Major Axis 12 to 20 | No. 24 gauge |
| Major Axis 20 to 30 | No. 22 gauge |
| Major Axis 30 to 46 | No. 20 gauge |
| Major Axis 46 to 50 | No. 18 gauge |
| Major Axis 50 and Up | No. 16 gauge |
- D. Oval fittings shall be equal to those of United McGill Sheet Metal Company with requirements, sealing, etc., similar to that specified for round medium pressure work.
- E. Oval duct reinforcing methods shall be submitted as Shop Drawings for approval. Reinforcing galvanized angles shall be of sizes specified for same size rectangular ducts. Galvanized angles shall be used where standing seams are specified for rectangular ducts. Attaching methods shall be shown on Shop Drawings and submitted for approval.
- F. 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. Design pressure for testing ductwork shall be six inches (6") of water. Total allowable leakage shall not exceed 1% of the total system design air flow rate. 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). 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. The contractor shall inform the project inspector when the joints may be visually inspected for voids, splits, or improper sealing of the joints. 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, and 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.
- G. 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.
- H. Contractor may at his option use DUCTMATE or Ward coupling system on rectangular ductwork. Contractor may at his option (where space permits) use rectangular ductwork with DUCTMATE or Ward system in lieu of oval ductwork. No other flange-type duct joining systems may be used.
- I. Rectangular 90 degree elbows shall be constructed with single thickness turning vanes. Radius type rectangular elbows shall have a centerline radius of 1-1/2 times the duct diameter or width. Contractor shall have the option to substitute short radius vanned elbows, but shall request the substitution at the time of submittal of Shop Drawings, and shall request the substitution as required in Division 01. 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. 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 MIXED AND R. A. (LOW PRESSURE) CASING PLENUMS

- A. All low pressure casings and plenums shall be following gauges and construction:

<u>Casing Height</u>	<u>Galv.</u>	<u>Alum.</u>	<u>Angles</u>	<u>Standing Seams</u>
Up to 4'	20 ga.	.051	1 x 1 x 1/8"	1"
4' to 6'	18 ga.	.051	1 x 1 x 1/8"	1"
6' to 8'	18 ga.	.064	1-1/2 x 1-1/2 x 3/16"	1-1/2"
8' to 10'	18 ga.	.064	1-1/2 x 1-1/2 x 3/16"	1-1/2"
Over 10'	16 ga.	.064	2 x 2 x 3/16"	1-1/2"

- B. All low pressure casings shall be fabricated by the Mechanical Contractor enclosing the filter and automatic dampers as shown on the Drawings. The casing shall be fabricated of galvanized sheet metal erected with 3 foot center maximum standing seams reinforced with 1/4 inch bars. The casing shall be stiffened on three foot centers maximum with angle irons tack welded in place.
- C. All openings to the casing shall be properly sealed to prevent any air leakage. Access doors shall be installed as shown and shall be air tight, double skin insulated construction with frames welded in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners equal to Ventlok #310 latches and #370 hinges that can be operated from both the inside and the outside.
- D. Casings shall be anchored by the use of angle irons sealed and bolted to the curb and floor of the apparatus casing. Submit Shop Drawings for approval. The casing shall be tested and provided tight at a pressure of three inches water column.
- E. The casing shall have 1" thick duct liner applied as specified under paragraph "Duct Liner" in this section.

2.5 MEDIUM PRESSURE BUILT-UP UNIT CASINGS

- A. All medium pressure unit casings shall be fabricated by the Mechanical Contractor and shall enclose the filters and automatic dampers. Casings shall be constructed of cellular, standing seam panels with 3" deep reinforced "hat" sections as manufactured by metal deck manufacturers and as shown and described in SMACNA High Velocity Duct Standards Manual. Shop Drawings shall be submitted for approval showing casing construction details and equipment layout and mounting. Shop fabricated cellular sections are acceptable under the foregoing conditions if evidence is provided to show ability of cellular section to withstand the static pressures of the system.
- B. All openings to the casing shall be properly sealed to prevent any air leakage. Access doors shall be installed for easy access to equipment and shall be air tight, double skin insulated construction with frames welded in place. Doors shall be rubber gasketed with #390 Ventlok gasketing and equipped with fasteners equal to Vent-lok #310 latches that can be operated from both the inside and the outside. Hinges shall be equal to Ventlok #370.
- C. Casing shall be anchored by the use of galvanized angle irons sealed and bolted to the curb and floor of the apparatus casing as shown on the SMACNA Drawings.
- D. A fan discharge diffuser plate shall be located on the fan discharge and shall be constructed of 10 gauge steel perforated plate installed in 6" channel iron frames (8.2#) rigidly supported to withstand the high velocity discharge of the fan. Perforations shall be 3/8" (.375") staggered on 11/16" centers (27% open area). One section shall be hinged to provide an access door between the discharge side of the fan and the entering side of the coils. After fabrication of diffuser plate, coat it with rust resistant paint. After installation, touch-up diffuser plate and paint channel iron frames with rust resistant paint.
- E. Casing shall have sufficient access openings to allow access for maintenance of all parts of the apparatus. Access door size shall be as large as feasible for the duty required.

2.6 ELBOWS

- A. Where rectangular elbows are shown, or are required for good air flow, contractor shall provide and install turning vanes. Job fabricated turning vanes, if used, shall be fabricated of the same gauge and type of material as the duct in which they are installed. Vanes must be fabricated for same angle as duct offset. Radius elbows shall have a centerline radius of not less than one and one-half (1-1/2) times the duct width. Submit Shop Drawings on factory fabricated and job fabricated turning vanes. Provide turning vanes in all rectangular radius elbows and offsets.
- B. 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. In most cases, this will necessitate the installation of an angle iron support on the outside of the cheek parallel to the line of the turning vanes.
- C. Where turning vanes are to be provided and installed as required above, in ducts of over 12" thickness (vanes are over 12" long), contractor shall provide and install Tuttle and Bailey double thickness vanes or approved equal. The installation of the turning vanes shall be as described for single thickness vanes.

2.7 FLEXIBLE DUCTS

- A. Low Pressure Insulated Flexible Duct may be used where shown on the drawings. Duct shall be made with factory preinsulated duct composed of dead soft, spiral wound, triple locked corrugated aluminum core covered with a minimum of 1-1/2" thick, 3/4 lb. density fiberglass blanket sheathed in a vapor barrier of fiberglass reinforced aluminum foil and mylar laminate. 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. The C factor shall be 0.24 to meet HUD requirements. The duct shall be rated for a positive working pressure of 10" w.g. and a temperature of up to 250 degrees F. The duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriter's Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA and other U. S. Government standards; flame spread, not over 15; smoke developed, not over 10. Flexible duct insulation must conform to International Energy Conservation Code, IECC requirements. Flexible ducts shall be not more than 24" in length, shall be installed in straight runs only, and shall be Flexmaster Type TL-M or approved equal.
 - 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. The fittings on air mixing 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. Insulation of flexible duct shall be slipped over connection to point where insulation abuts mixing box or insulation on duct. 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.)
- B. Medium and High Pressure Insulated Flexible Duct shall be the same construction as the Low Pressure Duct, factory applied insulation of 1" minimum thickness, 3/4 lb. density with a permeability rating of 0.30. The duct shall be 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. Ratings shall be as described for Low Pressure Duct above. Flexible ducts shall be not more than 2'-0" in length, used for alignment or sound/vibration purposes only, and only be installed in straight runs. Flexible duct shall NOT be used for changes of direction of air flow. Installation, clamps and sealing shall be the same as specified for rigid duct.

- 2.8 DUCT LINER: NOTE: ALL DUCTWORK SHALL BE EXTERNALLY INSULATED UNLESS OTHERWISE INDICATED ON THE PROJECT DRAWINGS. (See Section 23 07 13, for the applicable insulation specification.)

- A. Where indicated on the Drawings, ducts shall have lining equal to Fiberglass Aeroflex No. 150 duct liner. Duct liner shall be one inch (1") thick unless otherwise indicated. The liner shall be applied to the inside of the duct with heavy density side to the air stream and shall be secured in the duct with fireproof 3M #37 or St. Clair R41B adhesive, completely coating the clean sheet metal. All joints in the insulation shall be "buttered" and firmly butted tightly to the adjoining liner using fireproof adhesive. Where a cut is made for duct taps, etc., the raw edge shall be accurately and evenly cut and shall be thoroughly coated with fireproof adhesive. On ducts over twenty-four (24") in width or depth, the liner shall be further secured with mechanical fasteners. The fasteners shall be A. J. Gerrard Company pronged straps, or approved equal, secured to the ducts by fireproof adhesive. The clips shall be eighteen inch (18") maximum spacing and shall be pointed up with fireproof adhesive. Liner shall be accurately cut and ends thoroughly coated with fireproof adhesive so that when the duct section is installed, the liner shall make a firmly butted and tightly sealed joint. Where ducts are lined exterior insulation will not be needed unless otherwise noted, except that the two insulations shall not lap less than twenty-four inches (24"). Dimensions given on the Drawings are sheet metal sizes. Refer to Section 23 00 00 for Flame-Spread Properties.
- B. Duct liner in medium pressure ducts shall be the same except a perforated metal liner shall be used over duct liner for securement in lieu of fasteners.

2.9 FACTORY LINED ACOUSTICAL DUCTS: (NOTE: Must appear on the Drawings.)

- A. Where indicated on the Drawings, furnish and install double wall internally insulated duct and fittings.
- B. Duct shall consist of outer metal pressure shell, 1" thick glass fiber insulation and internal perforated metal liner.
- C. Duct and fittings shall be equal to Acousti-K 27 as manufactured by United McGill Sheet Metal Company.

2.10 FUME HOOD EXHAUST DUCTWORK

- A. Duct and stack material shall be Type 316L Stainless Steel, welded construction in accordance with SMACNA standards for negative pressure up to -6" wg. Duct sealant shall not be used to seal this ductwork. All ductwork shall be installed within the constraints of the design indicated in the drawings. In all cases, the ductwork shall be installed so that all liquids shall drain back to the hood.
- B. Metal gauges shall be as specified in 1985 SMACNA Standards for Low Pressure Ductwork but not less than 16 gauge. Fittings shall be in accordance with SMACNA construction standards.
- C. The stack shall drain back to the fan, which shall include a drain from the bottom of the scroll back to the exhaust ductwork. All piping to and from the ductwork and stack shall be threaded Type 316 Stainless Steel.

2.11 ALUMINUM DUCTWORK

- A. Provide aluminum ductwork only where indicated on the drawings. Duct gauge shall be as specified on drawings.
- B. Duct joints shall be all soldered construction, one standard gauge heavier than for the same size galvanized steel ducts.

2.12 DUST COLLECTOR SYSTEMS

- A. Duct system shall be galvanized, constructed and supported in accordance with SMACNA Industrial Round Duct Construction for Class 2, 8" w.g. pressure.

2.13 KITCHEN HOOD EXHAUST

- A. All duct material shall be Type 316L stainless steel, welded construction, in accordance with SMACNA standards for negative pressure up to -6" W.G. Ductwork shall be installed so that all liquids drain back to the hood.
- B. Provide drain and trap at all low points and pipe to floor drain connected to kitchen grease drain system. All piping shall be threaded Type 316 stainless steel.
- C. Provide access doors at all changes in direction.
- D. Provide fire protection enclosure/wrap per NFPA and local building code. Fire protection wrap shall be 3M "Firemaster", UL listed for kitchen exhaust ductwork, or approved equal.

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 4 diameters of straight duct to the entrance of all terminal units.
- I. Connect diffusers or troffer boots to low pressure ducts with 6 feet maximum length of flexible duct. 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.

- 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.

3.3 MEDIUM PRESSURE DUCT SUPPORTS

- A. See Section 23 05 29.

3.4 DUCTWORK APPLICATION SCHEDULE

AIR SYSTEM

MATERIAL

Low Pressure Supply (Heating Systems)	Galvanized Steel, Aluminum
Low Pressure Supply (Systems with Cooling Coils)	Galvanized Steel, Aluminum
Buried Supply or Return Reinforced Plastic	Galvanized Steel, Concrete
Medium and High Pressure Supply	Galvanized Steel
Return and Relief	Galvanized Steel, Aluminum
General Exhaust	Galvanized Steel, Aluminum
Kitchen Hood Exhaust	Stainless Steel
Dishwasher Exhaust	Stainless Steel
Fume Hood Exhaust	Stainless Steel
Outside Air Intake	Galvanized Steel
Combustion Air	Galvanized Steel
Evaporative Condenser Intake and Exhaust	Galvanized Steel
Emergency Generator Ventilation	Galvanized Steel

3.5 CLEANING OF SYSTEMS

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

1.2 WORK INCLUDED

- A. Volume control dampers.
- B. Fire dampers.
- C. Combination fire and smoke dampers.
- D. Backdraft dampers.
- E. Air turning devices.
- F. Flexible duct connections.
- G. Duct access doors.
- H. Duct test holes.

1.3 RELATED WORK

- A. Section 23 05 48 - Vibration Isolation.
- B. Section 23 31 00 - Ductwork.
- C. Section 23 36 00 - Air Terminal Units: Medium and high pressure damper assemblies.

1.4 REFERENCES

- A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- B. SMACNA - Low Pressure Duct Construction Standards.
- C. UL 33 - Heat Responsive Links for Fire-Protection Service.
- D. UL 555 - Fire Dampers and Ceiling Dampers.

1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 1.
- B. Provide shop drawings for shop fabricated assemblies indicated, including volume control dampers duct access doors duct test holes. Provide product data for hardware used.

- C. Provide air quantity, size, free area of all fire/fire smoke dampers, pressure drop and proposed velocity through each damper.
- D. Provide manufacturer's data of all fire/fire smoke dampers and its accessories or options.
- E. Submit manufacturer's installation instructions under provisions of Division 01 for fire dampers and combination fire and smoke dampers.
- F. Submittal(s) for fire and combination fire/smoke dampers shall include the following:
 - 1. Assign identification numbers for each damper with corresponding number noted on the drawings.
 - 2. Provide air quantity, size, free area of damper, pressure drop and proposed velocity through each damper.
 - 3. Provide manufacturer's data of damper and its accessories or options.
- G. One sample 18" x 12" damper shall be furnished for the purpose of illustrating damper operation to the owner's operating and maintenance personnel.

PART 2 - PRODUCTS

2.1 VOLUME CONTROL/BALANCING DAMPERS

- A. Furnish and install 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. 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. Outside air dampers shall be 316L stainless steel. Refer to Section 23 09 43, Pneumatic Controls or 23 09 23, Direct Digital Control Systems.
- C. Splitter dampers shall be fabricated of steel not lighter than 16 gauge. The leading edge of the damper shall be hemmed. Each splitter shall be a minimum of 12" long or 1-1/2 times the width of the smaller of the two branches it controls, whichever is greater. Dampers shall be carefully fitted, and shall be controlled by locking quadrants equal to Ventlok No. 555 on exposed uninsulated ductwork, No. 644 on exposed externally insulated ductwork and No. 677 (2-5/8" diameter) chromium plated cover plate for concealed ductwork not above lay-in accessible ceilings. Furnish and install end bearings for the damper rods on the end opposite the quadrant when No. 555 or No. 644 regulators are used, and on both ends when No. 677 regulators are used.
- D. On concealed ductwork above lay-in accessible ceilings use Ventlok No. 555 or No. 644 locking quadrant for splitter dampers.
- E. 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.
- F. Volume dampers shall be equal to those of American Foundry. Blades shall not exceed 48 inches (48") in length or twelve inches (12") in width and shall be of the opposed interlocking type. The blades shall be of not less than No. 16 gauge galvanized steel supported on one-half inch (1/2") diameter rust-proofed axles. Axle bearings shall be the self-lubricating ferrule type.
- G. Install all dampers furnished by the Temperature Control Manufacturer's in strict accordance with the manufacturer's recommendations and requirements of these Specifications.

- H. All adjustable dampers installed in externally insulated ductwork shall be installed with Ventlok No. 639, or equal, elevated dial operators. Insulation shall extend under the elevated dial. All adjustable dampers installed in internally insulated ductwork shall be installed with Ventlok No. 635, or equal, dial operators. All damper shaft penetrations in the ductwork shall be installed with Ventlok #609 end bearings.

2.2 FIRE, SMOKE, AND FIRE/SMOKE DAMPERS

A. Fire Dampers:

1. Furnish and install where shown on the drawings or required by the Specifications, fire dampers meeting the following requirements.
2. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety Standard 555. All dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural drawings) protection rating, 165 or 212 degree F fusible link, and shall bear a U.L. label in accordance with Underwriters' Laboratories labeling procedures. Fire dampers shall be constructed such that the damper frame material and the curtain material shall be galvanized.
3. Fire dampers shall be curtain blade or multi-blade type and the damper shall be so constructed that the blades are either out of the air stream or installed in an oversized sleeve to provide a 100 percent free area of the duct in which the damper is housed.
4. The damper manufacturer's literature submitted for approval prior to the installation shall include performance data developed from testing in accordance with AMCA 500 Standards and shall show the pressure drops for all sizes of dampers required at anticipated air flow rates. Maximum pressure drop through fire damper shall not exceed 0.05 inch water gauge.
5. Fire dampers shall be equipped for vertical or horizontal installation as required by the locations shown in the drawings. Fire dampers shall be installed in wall and floor openings utilizing steel sleeves, angles and other material and practices required to provide an installation equivalent to that utilized by the manufacturer when the respective dampers were tested by Underwriters Laboratories. Mounting angles shall be a minimum of 1 1/2 inch by 1 1/2 inch by 14 gauge and bolted, tack welded or screwed to the sleeve at maximum spacings of 12 inches and with a minimum of two connections at all sides. Mounting angles shall overlap at least equal to the gauge of the duct defined by the appropriate SMACNA Duct Construction Standard, latest edition, and as described in NFPA 90A. The entire assembly, following installation, shall be capable of withstanding 6" water gauge static pressure.
6. The damper installation shall be in accordance with the damper manufacturer's instructions.
7. All fire dampers shall comply with the specification as written above and shall be Ruskin, Greenheck, Prefco or approved equal.
8. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape so as to allow for expansion and contraction of the sleeve and damper assembly.
9. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design air flow at the point of installation. The minimum closure pressure rating shall be 8" wg for air flow in either direction.

B. Combination Fire/Smoke Dampers:

1. Furnish and install where shown on the Drawings, or as required by the Specifications, combination fire/smoke dampers meeting the following requirements.
2. Each combination fire/smoke damper shall be 1 1/2 hour fire rated under UL Standard 555, 4th Edition, and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. The damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be no higher than Leakage Class I (4 cfm per square foot at one inch water gauge pressure and 8 cfm per square foot at 4 inches water gauge pressure). The maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10 inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.)

3. The damper frame shall be a minimum of 20 gauge galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in an extruded hole in the frame or an extruded frame raceway. The dampers may be either parallel or opposed blade type. The blades shall be constructed with a minimum of 14 gauge equivalent thickness. The blade edge seal material shall be able to withstand 450 degrees F. The jamb seals shall be flexible stainless steel compression type or lap seal type.
4. In addition to the leakage ratings specified herein, the combination fire/smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 250 degrees F. Electric operators shall be installed by the damper manufacturer at the time of damper fabrication. The damper and operator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and operators. The manufacturer shall provide a factory assembled sleeve. The sleeve shall be a minimum of either 20 gauge for dampers where neither width nor height exceeds 48 inches or 16 gauge where either dimension equals or exceeds 48 inches.
5. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures of at least 4 inches water gauge in the closed position, and 2500 fpm air velocity in the open position.
6. Each combination fire/smoke damper shall be equipped with a UL Classified Firestat/releasing device. The firestat/releasing device shall electrically and mechanically lock the damper in a closed position when the duct temperatures exceed 165 degrees F and still allow the appropriate authority to operate the damper as may be required for smoke control functions. The damper must be operable while the temperature is above 250 degrees F. The actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. The Firestat/releasing device and position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm systems, and remote indicating/control stations.
7. The damper releasing device shall be mounted within the airstream. The device shall be activated and the damper shall close and lock when subjected to duct temperatures in excess of approximately 285 degrees F.
8. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated in the plans, and shall be furnished and installed by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this specification. All required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system shall be furnished by the Contractor.
9. Each damper shall be furnished in a square or rectangular configuration. The Contractor shall furnish and install sleeves manufactured by the approved damper manufacturer for each damper. The sleeves shall be constructed with square or rectangular to square, rectangular, round, or oval adapters as required. Dampers shall be installed in the sleeves in accordance with manufacturers U.L. installation instructions. The entire assembly, following installation, shall be capable of withstanding 6" W.G. static pressure.
10. All combination fire/smoke dampers shall comply with the specification as written above and shall be Ruskin, Greenheck, Prefco or approved equal.
11. The contractor shall completely seal the assembly to the building components using Hardcast 1602 sealant tape so as to allow for expansion and contraction of the sleeve and damper assembly.
12. Dampers shall be UL labeled for use in dynamic systems. Closure reading shall be 110% of the maximum design air flow at the point of installation. The minimum closure pressure rating shall be 8" wg for air flow in either direction.

- C. Smoke Dampers:
1. Furnish and install, where shown on the drawings or required in the specifications, smoke dampers meeting the following requirements.
 2. Smoke dampers shall bear classifications, leakage ratings and UL listings for use in smoke control systems as required for combination fire/smoke combination fire/smoke dampers. Maximum air pressure drop shall be as for combination fire/smoke dampers.
 3. Damper frame and damper construction shall be as required for combination fire/smoke dampers.
 4. Dampers shall be qualified to an elevated temperature, and operators and sleeves shall be as required for combination fire/smoke damper.
 5. Dampers shall have demonstrated capacities to open against pressure and velocity as required for combination fire/smoke dampers.
 6. Motors, relays, switches and other connections shall be as required for combination fire/smoke dampers.
 7. Damper and sleeve configuration shall be as required for combination fire/smoke dampers.
 8. Dampers shall be dynamic type with closure characteristics as required for combination fire/smoke dampers.
 9. Dampers shall be Ruskin, Greenheck, Prefco or approved equal.

2.3 BACKDRAFT DAMPERS

- A. All backdraft dampers shall be Greenheck "HB-110" or approved equal.
- B. Gravity Backdraft Dampers, shall be provided at all exhaust fans or exhaust ducts where indicated on drawings.
- C. Frame shall be formed aluminum channel for non-corrosive air and stainless steel when used in corrosive air systems.
- D. Axles shall be stainless steel with stainless steel clevis arms, tiebars, and pivot pins and nylon pivot bearings. Provide adjustment device to permit setting for varying differential static pressure.
- E. Blades shall be a maximum 6" width, with flexible vinyl seal edges, linked together in rattle-free manner with 90 degree stop.

2.4 AIR TURNING DEVICES/EXTRACTORS

- A. All air turning devices/extractors shall be of the same material as duct installed in and fabricated per SMACNA standards.
- B. Multi-blade device with radius double wall blades attached to pivoting from and bracket with push-pull operator strap.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions.
- B. Provide volume control/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 volume control/balancing dampers on medium and high pressure systems where indicated. Refer to Section 23 36 00 - Air Terminal Units.

- D. Provide fire dampers, and combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and code requires a damper to be installed to preserve a component's rating. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges. Provide smoke dampers at locations indicated, and where required by NFPA.
- E. Demonstrate re-setting of fire dampers to Owner's representative.
- F. Provide backdraft dampers on exhaust fans or exhaust ducts where indicated.
- G. Installation:
 - 1. The air quantity and free area through each fire, smoke, and combination fire and smoke damper has been noted on the drawing adjacent to the duct size or wall opening size where such damper is required.
 - 2. Access doors as specified elsewhere shall be provided to make all parts of the damper accessible. Doors shall open not less than 90 degrees following installation and shall be insulated type where installed in insulated ducts.
 - 3. Contractor shall install each damper square and true to the building. The installation shall not place pressure on the damper frame, but shall enclose the damper as required by UL555.
 - 4. After each fire damper and combination fire, smoke, and smoke damper has been installed and sealed in their prescribed openings and prior to the installation of the ceilings, the Contractor shall, as directed by the Construction Inspector, activate part or all the dampers as required to verify "first-time" closure. Activation of the damper shall be accomplished by manually operating the resettable link, disconnecting the linkage at the fusible link of the fire damper, and manually operating the fire/smoke damper through the pneumatic or electronic controls as appropriate. Failure of the damper to close properly and smoothly on the first attempt will be cause to replace the entire damper assembly.

3.2 FLEXIBLE CONNECTIONS

- A. Where ducts connect to fans, including roof exhausters, flexible connections shall be made using "Ventglas" fabric that is fire-resistant, waterproof, mildew resistant and practically air tight, and shall weigh approximately thirty ounces (30 oz.) per square yard. There shall be a minimum of one-half inch (1/2") slack in the connections, and a minimum of two and one-half inches (2-1/2") distance between the edges of the ducts except that there shall also be a minimum of one inch (1") of slack for each inch of static pressure on the fan system.

3.3 ACCESS DOORS

- A. Furnish and install in the ductwork, hinged rectangular or round "spin-in" access doors to provide access to all fire dampers mixed air plenums, upstream of steam reheat coils, automatic dampers, etc. Where the ducts are insulated, the access doors shall be double skin doors with one inch (1") of insulation in the door. Where the size of the duct permits, the doors shall be eighteen inches (18") by sixteen inches (16"), or eighteen inches in diameter, and shall be provided with Ventlok No. 260 latches (latches are not required in round doors). Latches for rectangular doors smaller than 18" x 16" shall be Ventlok No. 100 or 140. Doors for zone heating coils shall be Ventlok, stamped, insulated access doors, minimum 10" x 12", complete with latch and two (2) hinges, or twelve inches (12") in diameter. Round access doors shall be "Inspector Series" spin-in type door as manufactured by Flexmaster USA, or approved equal. Doors for personnel access to ductwork shall be nominal twenty-four inches (24") 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.
- C. Where these access doors penetrate a fire rated surface, access doors with a matching fire rating shall be provided and installed to preserve the fire rating.

3.4 DUCT SOUND ABSORBERS

A. General:

1. The Contractor shall furnish and install prefabricated silencers in the air handling system of the size and performance shown on the duct silencer schedule.
2. The duct silencers supplier or his qualified representative shall be responsible for providing such supervision as may be required to assure correct and complete installation of the duct silencers.
3. The duct silencers shall be as supplied by Industrial Acoustics, Koppers, Rink Corporation or approved equal.

B. General Design Features:

1. The outer casings of all rectangular silencers shall be of not less than 22 gauge galvanized steel construction and external seams shall be locked form and filled with mastic or continuously welded and shall be air tight up to 8" pressure differential. Interior partitions shall be of not less than 24 gauge galvanized perforated steel.
2. The acoustical filler materials shall consist of inorganic mineral or glass fiber of a density required to obtain the specified acoustic performance and packed under not less than 5% compression to eliminate voids due to vibration and settling. Materials shall be inert, vermin and moisture proof, and impart no odor into the air. The incombustible acoustical filler material shall exhibit not more than the following fire hazard classification values when tested in accordance with the Standard ASTM E-84, or UL 723 test methods:

<u>Flame Spread</u>	<u>Smoke Developed</u>
25	50

C. Acoustic and Aerodynamic Performance:

1. Acoustical testing shall be determined by the "duct to a reverberation room", as recommended by SIW 42 Subcommittee of the American National Standards Institute. Tests shall be run with air flowing through the silencer at not less than three (3) different flow rates and also at zero (0) flow. All ratings shall be based on test data from a nationally known qualified independent laboratory. Test methods shall eliminate effects due to end reflection vibration flaring transmission and standing waves in the reverberant room. Air flow and pressure loss data taken in accordance with the AMCA procedures shall be obtained from the same silencer used for acoustical performance test.
2. Static pressure loss of silencers shall not exceed those listed in the silencer schedule at the indicated air flow.

3.5 SCREENS

- A. Furnish and install screens on all duct, fan, etc., openings furnished by this Contractor which lead to, or are, outdoors. Screens shall be No. 16 gauge, one-half inch (1/2") mesh in removable 316 stainless steel frame. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no ductwork is connected.

3.6 TEST OPENINGS

- A. Furnish and install in the return air duct and in the discharge duct of each fan unit Ventlok No. 699 instrument test holes. The test holes shall be installed in locations as required to measure pressure drops across each item in the system, e.g., O.A. louvers, filters, fans, coils, intermediate points in duct runs, etc.

3.7 LOW PRESSURE TAPS (Conical Bell Mouth Fittings)

- A. Conical fittings may 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. (This does not apply to medium pressure duct.) 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 so as 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 to be provided with 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 bellmouth fitting shall be Series 3000G as manufactured by Flexmaster U.S.A., Inc., or Buckley Air Products, Inc., 'AIR-TITE'.

END OF SECTION 23 33 00

SECTION 23 36 00 – AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Constant volume terminal units.
- B. Variable volume terminal units.
- C. Dual duct terminal units.
- D. Single duct terminal units.
- E. Variable volume regulators.
- F. Integral sound attenuator.
- G. Integral heating coils.
- H. Integral damper motor operators.
- I. Integral controls.

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Section 23 09 23 - Direct Digital Control Systems: Thermostats and control components.
- B. Section 23 05 90 - Testing, Adjusting and Balancing.
- C. Section 26 05 19 - Cable, Wire and Connectors, 600 Volt.
- D. Section 26 76 26 - Wiring Devices and Floor Boxes.

1.4 RELATED SECTIONS

- A. Section 23 00 00 - Basic Mechanical Requirements.
- B. Section 23 05 13 - Motors.
- C. Section 23 21 13 - Hydronic Piping: Connections to heating coils.
- D. Section 23 21 16 - Hydronic Specialties: Connections to heating coils.
- E. Section 23 31 00 - Ductwork.

- F. Section 23 33 00 - Ductwork Accessories.
- G. Section 23 37 00 - Air Outlets and Inlets.
- H. Section 23 09 23 - Direct Digital Control Systems.
- I. Section 23 05 90 - System Preparation for Testing, Adjusting and Balancing.
- J. Section 23 05 93 - System Testing, Adjusting and Balancing.
- K. Division 26 - Cable, Wire and Connectors, 600 Volt.
- L. Division 26 - Wiring Devices and Floor Boxes.

1.5 REFERENCES

- A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- B. UL 181 - Factory-Made Air Ducts and Connectors.
- C. ADC 1062 - Air Distribution and Control Device Test Code.
- D. ARI 880 - Standard for Air Terminals.

1.6 SUBMITTALS

- A. Submit shop drawings under provisions of Division 01.
- B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.
- C. Submit product data under provisions of Division 01.
- D. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and NC designation.
- E. Include schedules listing discharge and radiated sound power level for each of second through seventh octave bands at inlet static pressures of one inch wg.
- F. Submit manufacturer's installation instructions under provisions of Division 01.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 01.
- B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

1.8 QUALIFICATIONS

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

1.9 WARRANTY

- A. Provide one year manufacturer's warranty under provisions of Division 01.

PART 2 - PRODUCTS

2.1 VARIABLE OR CONSTANT VOLUME TERMINAL UNITS

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.

A. Casing Construction:

1. The units shall be constructed of a minimum of 22 gauge galvanized steel and internally lined with a minimum of R5, three pound per cubic foot density insulation. The insulation shall be foil faced with the edges and seams sealed or "captured", encapsulating all fibers of the insulation. The insulation shall be neatly installed with no rough edges to interrupt the smooth flow of air through the box. Closed cell polymer insulation by IMCOA may be used instead of the fiberglass described above. The casing shall be insulated throughout its interior, up to or at least to within 2" of the heating coil connection. Insulation for the heating coil shall enclose the coil casing and tube bends and shall overlap the box internal lining by at least 3". 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.
2. 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. 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.") The only exception shall be flow sensors installed in the inlet duct connections. 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.
3. The terminal units shall be constructed with inlet and discharge ductwork connections. 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). The discharge connection shall include 1" 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.

- B. Casing Leakage: Assembled Units shall be so constructed and sealed to limit air leakage to the following listed quantities at 6" static pressure. If sealing is required to obtain the leakage performance, seal as for medium pressure ductwork Hardcast 1602 tape may be used to seal lap joints and flat seams only. Leakage curves or tables will be required as part of the submittal data. The following is the maximum allowable casing leakage including all components:

<u>Diameter</u>	<u>Maximum Allowed CFM (Area x 2000 fpm)</u>	<u>Maximum Allowable CFM Casing Leakage</u>
4"-5"-6"	393	8.0
7"-8"	698	14.0
9"-10"	1091	22.0
11"-12"	1571	30.0
13"-14"	2138	40.0

- C. Access Plenum And Door: Single duct units provided with hot water coils also shall be provided with an access section or plenum between the single duct terminal and the coil for coil inspection. The construction of the plenum shall be equal to the quality of materials and workmanship to that of the terminal unit. The access plenum may also be used as a transition, and shall be constructed with a

transition angle not to exceed 15 degrees. 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") access door as manufactured by Ventlok, Flexmaster Inspector, Ward or equal. Door frame may be bolted, screwed or flanged and sealed to the casing. Door shall be gasketed and shall be double all construction or insulated similar to main casing. Door shall be held in place with latches or other captive retainer devices. On both single duct and double duct boxes, an additional access panel shall be provided immediately downstream of the dampers for inspection and service of the dampers. If the damper assembly is easily removed from the rear of the box, the access size can be reduced to 8" round or 8" x 8" for inspection only.

- D. **Damper Construction:** 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. The damper shafts shall operate in rust-proof self-lubricating bearings. Damper shafts penetrating the unit casings shall be sealed against leakage, and bearings shall be installed for protection against wear in the casing penetration. Damper shafts shall be formed of, or cut from solid stock; no hollow shafts will be allowed. The dampers shall seat against gasketed stops or the dampers shall have gasketed edges. Gaskets shall be mechanically fastened to the blades. If the fastening method is not full contact clamping type, then the addition of adhesive to the gasket shall be required. The dampers shall be so constructed to prevent "oil canning" of the damper blade. The units shall be tested for leakage in both inlets with 6" static pressure imposed on one inlet at a time. The maximum percent leakage from all tests shall be reported. Leakage curves as a function of pressure shall be supplied as part of the submittal data. The damper actuator linkage, if used, shall be constructed of material of sufficient strength to avoid buckling under extreme loads. Also, linkages shall not allow play greater than 5 degrees of damper movement. 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.
- E. **Damper Leakage:** The following is the maximum damper leakage allowable for the various size diameter inlets at 6" w.g. differential pressure. The damper leakage shall not exceed the values listed in the table below at 6" S.P., following ARI 880 Testing Procedures.

<u>Diameter</u>	<u>Maximum Allowed CFM (Area x 2000 fpm)</u>	<u>Maximum Allowable CFM Damper Leakage</u>
4"-5"-6"	393	6.0
7"-8"	698	10.5
9"-10"	1091	16.5
11"-12"	1571	20.0
13"-14"	2138	30.0

- F. **Unit Pressure Drop:** For dual duct units with an integral attenuator-mixer, but with no other accessories, the static pressure across the assembly with an equivalent 2000 fpm inlet velocity through one inlet shall not exceed 0.50 inches water gauge, with the total flow through either inlet. Single duct unit pressure drop shall be limited to 0.15 inches water gauge under the same conditions above.
- G. **Certification:** The Unit Manufacturer shall certify that each unit used on this project will perform as specified. 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", 8", etc
 7. Calibrated CFM, ie 800 CFM

- H. **Mixing:** Dual duct terminal units as specified herein shall provide mixing within the units, and not rely upon the discharge ductwork to provide for the completion of the mixing process. The horizontal average temperature of the air as it leaves the terminal unit shall not vary more than 1°F for each 20°F. of temperature difference between the two inlet air supplies. (For example, if the cold supply air is 55°F. and the hot supply air is 95°F., the difference is 40 degrees. The allowable temperature variation of the discharge air is, thus, 2°F.) The temperature of the discharge air shall be measured using a pattern of four vertical, evenly spaced columns, and three horizontal, evenly spaced rows. The rows and columns shall be spaced so that the resulting 12 points shall be at the centers of equal areas. The plane of the points shall be perpendicular to the direction of air flow, within 4 inches of the discharge of the terminal unit, within the discharge ductwork. The three readings in each column shall be averaged to determine compliance with the 1° criteria.
- I. **Flow Measurement:** Air flow thru the unit shall be accomplished by the use of a 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'. On all systems, sensors shall be mounted as required by the temperature controls supplier.
- J. **Sound:** (Note that the maximum sound levels listed in this paragraph refer to raw sound levels, with no credits taken for the construction.)

DISCHARGE SOUND

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. 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

RADIATED SOUND

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. No credit for ceiling plenum, ceiling tiles, room absorption, or any other effects shall be allowed.

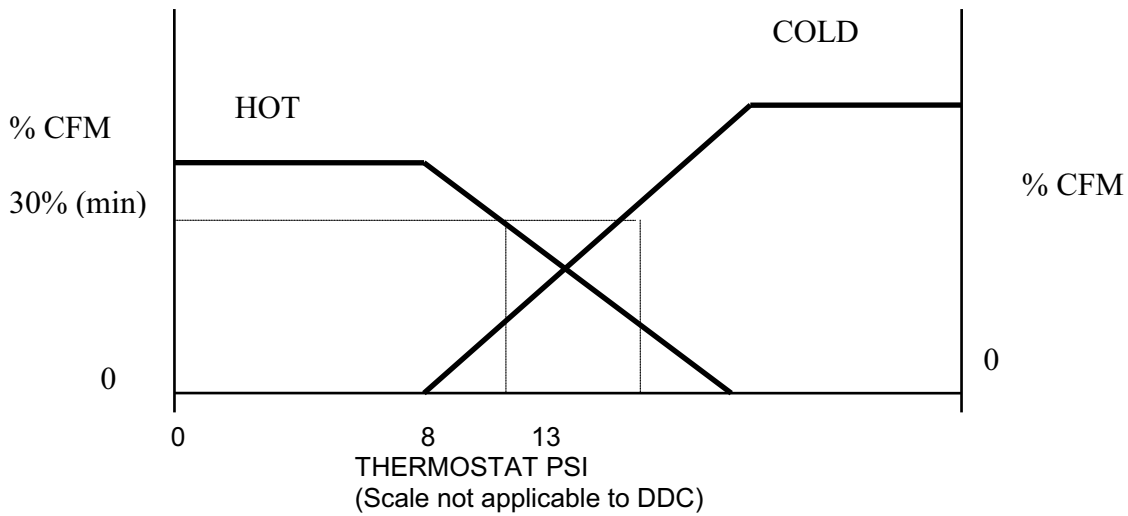
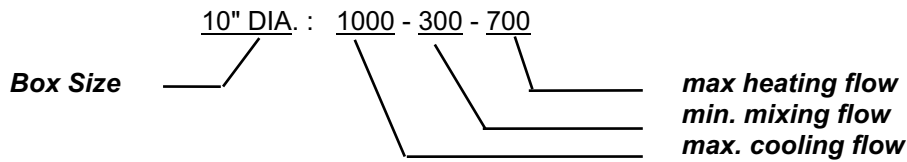
Octave Band	Center Frequency (Hz)	Sound Power Level (dB re 10 ⁻¹² Watts)
2	125	72
3	250	67
4	500	64
5	1000	54
6	2000	47
7	4000	45

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.

- K. MANUFACTURER: All Terminal Units shall be as manufactured by Titus (Model MDV-3100-UT or MDC-3100-UT), Metal*Aire (Series 400DDUT), or Naylor Industries 3000-UT or 3200-UT. *Note that the model and series numbers listed may differ slightly from catalogue information.* No other manufacturers or models are acceptable. Even though specific manufacturers may be named herein, the material supplied by any approved manufacturer shall meet all of the provisions of this specification without exception.
- L. General Performance: Devices using mechanical CFM limiters will not be accepted, nor shall it be necessary to change control components to make airflow rate changes. If used, pneumatic actuator motors, pneumatic controllers, and pneumatic or 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 and controls if pneumatic controls are specified and supplied with the unit. If DDC controls of another manufacturer (NOT the terminal unit manufacturer) are provided for this project, 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 manufacturers factory, nor shall the manufacturer be responsible for the performance of the DDC controls. The performance of DDC controls, especially in connection with terminal units, shall be the responsibility of the DDC controls manufacturer.
- M. Hot Water Coils: 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. Air side pressure drop shall be limited to 0.2" wg at box rated cold air flow. Full fin collars shall be provided for accurate fin spacing and maximum fin-to-tube contact. Tubes shall be 1/2 inch diameter seamless copper with a minimum wall thickness of 0.016 inch, tested at 300 psig air pressure under water with a minimum rated burst pressure of 1500 psig. Male sweat-type water connections shall be provided. Side and end plates shall be a minimum of 18 gauge galvanized sheet metal construction. All coils shall be constructed and tested in accordance with UL and/or ARI Standards. The tube ends shall be protected with tube end caps of sheet metal similar to the casing material, and shall be insulated within the caps.
- N. Control Performance: Assemblies shall be able to be reset to any airflow between zero and the maximum cfm shown on Drawings. 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. The control devices shall be designed to maintain the desired flow regardless of inlet flow deflection. 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 and of the same size as the box connection.
- O. Control Sequences: The control sequence arrangements shall be as described below, 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. The desired sequence shall be adjustable according to space usage or a change in space conditions.

Dual Duct Units - VAV

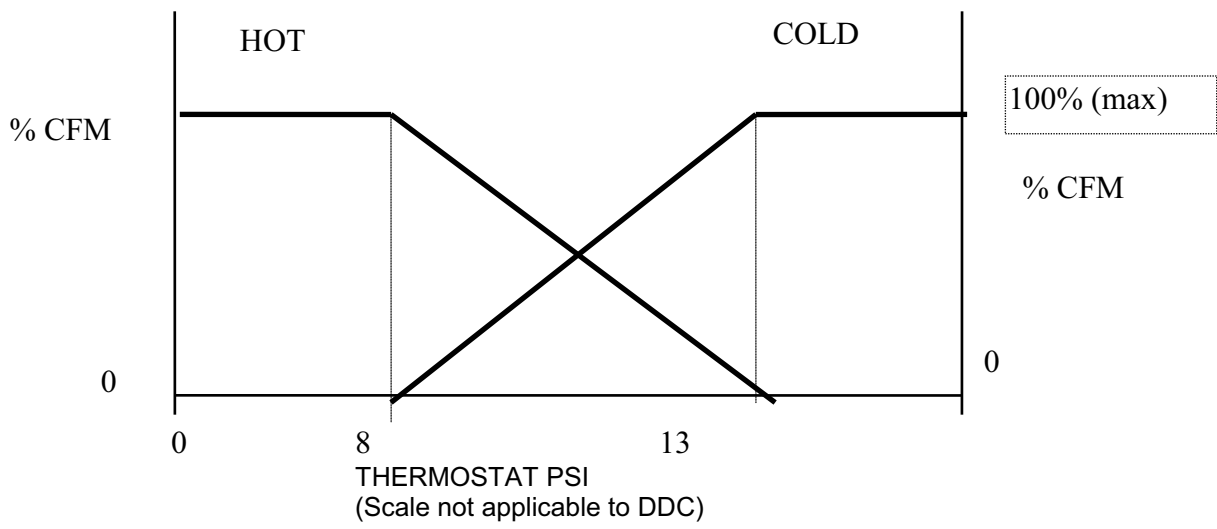
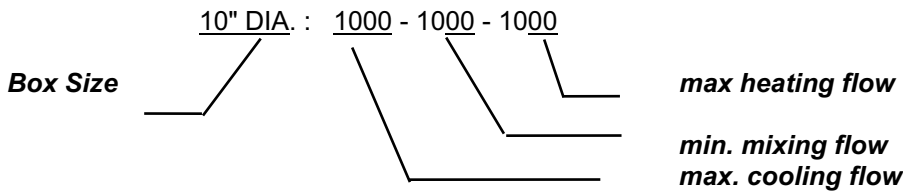
Note: Inlets are same diameter.



Separate maximum CFM values for hot and cold ducts with zero minimum flow values for both hot and cold ducts, with adjustable mixing of hot and cold air flow to allow for adjustable minimum total air flow from the terminal unit. Note that the minimum air flow is shown as 30 percent of the nominal air flow for the individual terminal unit. (Nominal air flow is defined as the flow to the unit at an average velocity of 2000 fpm through one inlet.)

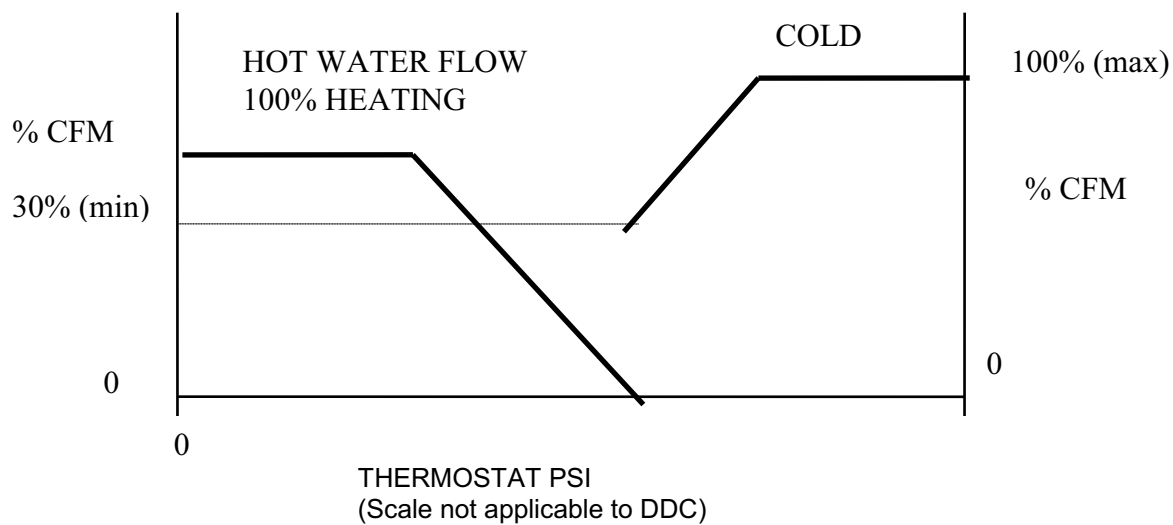
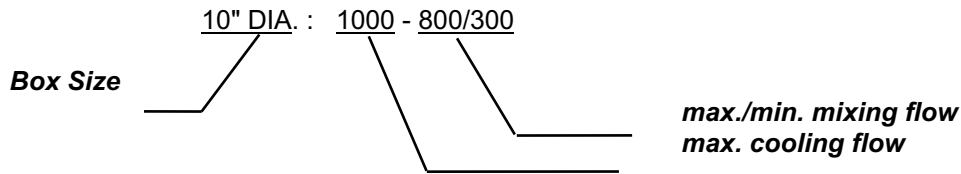
Constant Volume

Note: Inlets are same diameter.



Constant volume operation with full mixing of hot and cold air flow between demands for full heating and full cooling, with adjustable total air flow. The terminal control assembly shall not allow excessive hot air flow to be delivered to the space if the pressure in the cold duct becomes less than design during the mixing or full cooling demand. Therefore, depending on the type of controls, the maximum hot air supplied may necessarily be slightly less than the maximum cold air supplied.

Single Duct Units - VAV



Increasing CFM value for cold air supply occurs only when the hot water valve is fully closed. The hot water valve stays in the closed position (normally closed valve) until the cold supply air reaches its minimum. The hot water flow then increases until reaching its maximum scheduled flow. Note that the minimum air flow is shown as 30 percent of the nominal air flow for the individual terminal unit.

P. Pneumatic Control Systems:

1. Required field pneumatic control air connections by the temperature control Contractor shall consist of one (1) 20 psig main air connection at the double duct assembly and one (1) thermostat signal line at the double duct assembly. All interconnecting tubing between the heating and cooling sides of the assembly is to be installed by the box manufacturer. A calibration chart and piping diagram shall be submitted for approval. A copy of the approved color coded piping diagram shall be attached to the side of the unit near the cold duct valve.
2. Pneumatic actuators and controllers shall be selected to operate with a 20 psi main air supply. Only brass pneumatic tubing connectors shall be used. Actuators, flow sensors and controllers shall be prepped such that there is one point of connection of main and of branch air lines by temperature control Contractor. Separate external total pressure and static pressure taps shall be provided for connection to a differential pressure gauge for field determination of air flow

quantity. To provide for maximum airflow from unit inlet ducts at each unit in the event of control air failure, the units are to be arranged so that all inlet dampers fail to the open position (normally open).

3. The actuators shall be pneumatic piston-type with rolling diaphragm and all metal body. Plastic bodied actuators may be used only if specifically approved during the submittal process, and if the plastic bodied actuator is enclosed in a protective metal cover. Note that actuators that combine metal and plastic in the actuator body and/or end cap are not acceptable. Each operator shall be fully proportional-type to operate under normal operating conditions to guarantee closure to the position set on the linkage by the terminal unit assembly manufacturer. The following manufacturers of pneumatic actuators are acceptable: Kreuter (Model No. 36313), Johnson, and Powers. In all cases, 5 to 10 psi spring ranges are required, and in all cases the pneumatic actuator with damper linkages shall develop 40 in-lbs. of force at the damper shaft, at 10 psi pneumatic pressure. The actuator shall operate smoothly throughout its sequence of operation.
4. The volume controller shall constantly monitor thermostat input, air flow quantity, and system static and total pressure in a manner such that input data is processed and analyzed and the damper actuator is energized to obtain the required system conditions. The results of the damper movement shall be sent as signals through a feedback loop to the controller for evaluation and correction. Minor variations in load and system conditions are to be sensed immediately and acted upon, so that hunting and over-controlling are minimized. The pneumatic consumption for the operation of each pneumatic controller shall not exceed 0.025 scfm at 20 psi (with normally open dampers).
5. In the event of malfunction of the volume controller, it shall be possible to service the device from the outside of the assembly. Assemblies with a control arrangement necessitating disassembly of the ductwork from the terminal unit to gain access to integral working parts of the volume controller will be unacceptable.
6. It is required that total versatility in sequence of operation shall be available with the variable volume terminal units. All necessary sequencers, switching and reversing relays, etc., shall be provided with the terminal units as shipped from the manufacturer to allow any of the herein described operational modes with only simple screwdriver adjustments for selection of the desired mode. The reset span of the pneumatic volume controller shall be 5 psi for all maximum and minimum air flow rate settings, and the "start" point of the reset span shall be field adjustable but factory set.

Q. DDC Systems:

1. Electronic motors and controllers shall be installed by the terminal unit manufacturer unless specifically prohibited by the by the controls manufacturer. In such an event, the controls manufacturer shall be responsible for the installation of the controls. The controls manufacturer shall be responsible for the operational performance of the entire system. The terminal unit manufacturer shall remain responsible only for the performance of the mechanical components of the unit.
2. DDC Controls Protocol/Description:

PART 3 - EXECUTION

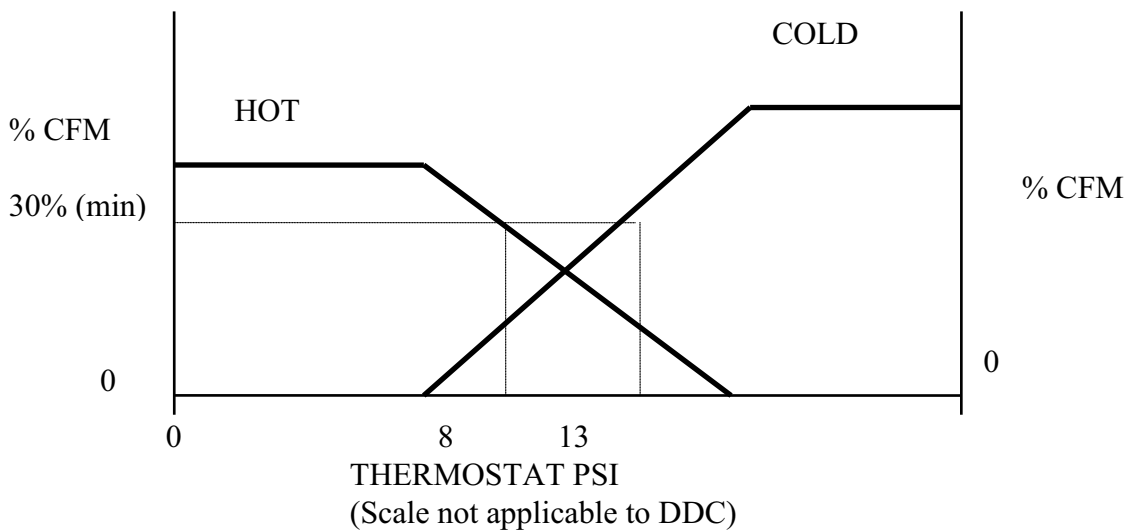
3.1 INSTALLATION

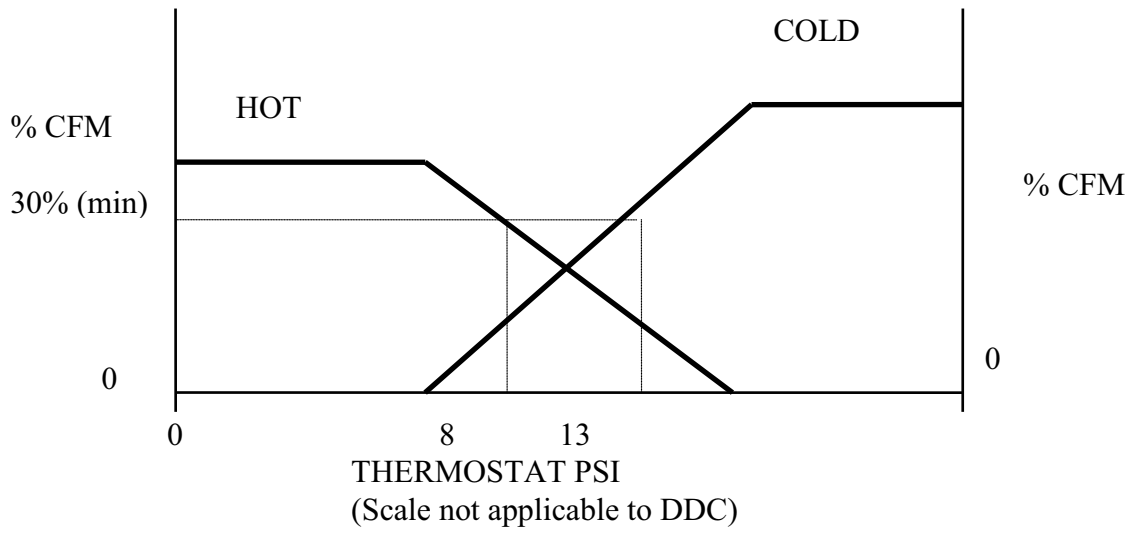
- A. Refer also to requirements included in Part 2 of this specification.
- B. Install in accordance with manufacturer's instructions.
- C. Provide ceiling access doors or locate units above easily removable ceiling components.
- D. Support units individually from structure. Do not support from adjacent ductwork.

- E. Connect to ductwork in accordance with Section 23 31 00.
- F. Install heating coils in accordance with Section 23 82 16.

3.2 TERMINAL UNIT SCHEDULE

<u>Drawing Code</u>	<u>TU-1</u>	<u>TU-2</u>	<u>TU-3</u>	<u>TU-4</u>
Location				
Service				
Manufacturer				
Model Number				
Air Flow Range				
Minimum				
Maximum				
Coil at Minimum Air				
Heat Output				
Entering Air Temp				
Air Temp Rise				
Number of Rows				
Entering Water Temp				
Leaving Water Temp				
Electric Input				





END OF SECTION 23 36 00

SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 WORK INCLUDED

- A. Diffusers.
- B. Diffuser boots.
- C. Registers/grilles.
- D. Door grilles.
- E. Louvers.
- F. Louvered penthouses.
- G. Roof hoods.
- H. Goosenecks.

1.3 RELATED WORK

- A. Division 08 – Openings: Door Louvers.
- B. Division 09 – Painting: Painting of Ductwork Visible Behind Outlets and Inlets.
- C. Division 10 – Specialties: Metal Wall Louvers.
- D. Section 23 00 00 – Basic Mechanical Requirements.
- E. Section 23 31 00 – Ductwork.
- F. Section 23 33 00 – Ductwork Accessories.

1.4 REFERENCES

- A. ADC 1062 - Certification, Rating and Test Manual.
- B. AMCA 500 - Test Method for Louvers, Dampers and Shutters.
- C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- D. ARI 650 - Air Outlets and Inlets.

- E. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.
- F. SMACNA - Low Pressure Duct Construction Standard.

1.5 QUALITY ASSURANCE

- A. Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
- B. Test and rate performance of louvers in accordance with AMCA 500.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.

1.7 SUBMITTALS

- A. Submit product data under provisions of Division 01.
- B. Provide product data for items required for this project.
- C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.
- D. 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.
- E. Submit manufacturer's installation instructions under provisions of Division 01.

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. 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. Selections shall meet the manufacturer's own published data for the above performance criteria. 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. 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, or Metal*Aire.
- 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. Where called for on the schedules, the grilles, registers and ceiling outlets shall be provided with deflecting devices and manual damper. These shall be the standard product of the manufacturer, subject to review by the Architect, and equal to brand scheduled.

2.2 ACCEPTABLE MANUFACTURERS - CEILING DIFFUSERS

- A. Titus.
- B. Krueger.
- C. Metal * Aire.

- D. Price.
- E. Nailor.
- F. Substitutions: Under provisions of Division 01.

2.3 RECTANGULAR CEILING DIFFUSERS

- A. Rectangular, adjustable pattern, stamped, multicore type diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated; refer to plans for manufacturer and model.
- B. Provide appropriate type frame. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabricate of aluminum with baked enamel off-white finish.
- D. Provide radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.4 LOUVERED FACE CEILING DIFFUSERS

- A. Louvered face with fully adjustable pattern; refer to plans for manufacturer and model.
- B. Provide appropriate type frame. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabricate of steel with aluminum frame and baked enamel off-white finish.
- D. Provide radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.5 ACCEPTABLE MANUFACTURERS - CEILING REGISTERS/GRILLES

- A. Titus.
- B. Krueger.
- C. Metal * Aire.
- D. Substitutions: Under provisions of Division 01.

2.6 CEILING SUPPLY REGISTERS/GRILLES

- A. Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection; refer to plans for manufacturer and model.
- B. Fabricate 1-1/4 inch margin frame with concealed mounting and gasket.
- C. Fabricate of aluminum extrusions with factory finish.
- D. Provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

2.7 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A. Streamlined blades, depth of which exceeds 3/4 inch (19 mm) spacing, with spring or other device to set blades, b face; refer to plans for manufacturer and model.

- B. Fabricate 1-1/4 inch margin frame with concealed mounting.
- C. Fabricate of aluminum with 20 gauge (0.90 mm) minimum frames and 22 gauge (0.80 mm) minimum blades, aluminum with 20 gauge (0.90 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Where not individually connected to exhaust fans, 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.

2.8 ACCEPTABLE MANUFACTURERS - WALL REGISTERS/GRILLES

- A. Titus.
- B. Krueger.
- C. Metal * Aire.
- D. Substitutions: Under provisions of Division 01.

2.9 WALL SUPPLY REGISTERS/GRILLES

- A. Streamlined and individually adjustable blades, depth of which exceeds 3/4 inch (19 mm) maximum spacing with spring or other device to set blades, horizontal face, double deflection; refer to plans for manufacturer and model.
- B. Fabricate 1-1/4 inch margin frame with concealed mounting and gasket.
- C. Fabricate of aluminum with 20 gauge (0.90 mm) minimum frames and 22 gauge (0.80 mm) minimum blades, aluminum with 20 gauge (0.90 mm) minimum frame, or aluminum extrusions, with factory baked enamel 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.

2.10 WALL SUPPLY REGISTERS/GRILLES

- A. Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection; refer to plans for manufacturer and model.
- B. Fabricate 1-1/4 margin frame with concealed mounting and gasket.
- C. Fabricate of aluminum extrusions with factory clear lacquer finish.
- D. Provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

2.11 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A. Streamlined blades, depth of which exceeds 3/4 inch (19 mm) spacing, with spring or other device to set blades, horizontal face, as scheduled.

- B. Fabricate 1-1/4 margin frame with concealed mounting.
- C. Fabricate of aluminum with 20 gauge (0.90 mm) minimum frames and 22 gauge (0.80 mm) minimum blades, aluminum with 20 gauge (0.90 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D. Where not individually connected to exhaust fans, 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 Division 09.
- C. Install diffusers to ductwork with airtight 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 Division 09.

END OF SECTION 23 37 00

