DIVISION 15

MECHANICAL SYSTEMS

15.1 General Information - This Division defines general design criteria that applies to the design of heating, ventilation, air conditioning (HVAC), and plumbing systems at DFW Airport as well as those HVAC systems to be served by the Central Utilities Plant (CUP). Division 1 should be consulted for specific Airport regulations and standards that also apply.

Existing HVAC and plumbing information is available through the Airport Maintenance Department. However, it shall be expressly understood that the Airport Board cannot accept any responsibility for the locations shown on "as built" drawings. It shall be the designers' responsibility to verify locations or the adequacy of file information prior to design and construction of HVAC systems. The designer shall coordinate the development of the design at all stages with DFW / Utilities Engineering.

15.2 Airport Central Utilities Plant - Steam and chilled water are produced at the CUP, which is located just north of the FAA TRACON, and distributed through a central utility tunnel. Steam is used to heat hot water through heat exchangers located in the tunnel vaults. Hot water is circulated through buildings served by CUP for space heating and other domestic uses. Chilled water is also circulated from each tunnel vault through the buildings served by CUP. The Central Utilities Plant serves the following buildings:

1. All Terminal Buildings.
2. FAA TRACON (Terminal RADAR Approach Control) Facility.
3. Landside Hotel.
4. DFW Business Center North & South.
5. Airport Train Central Control and Central Utilities Plant Offices.
6. Verizon Telephone Exchange Building.
7. Skylink Maintenance and Storage Facility.

The CUP operating conditions will have a significant influence on the design of new or modified HVAC systems for buildings served by CUP. Variable seasonal Chilled Water System operating supply temperatures will have a significant influence on mechanical design of new HVAC systems.

15.2.1 Chilled Water from Central Plant - The chilled water temperature is reset based on outdoor air temperature. Because of the extensive glass in the Terminal buildings and the reset of chilled water temperature, design loads should be checked for months other than July. Spaces with high loads, such as computer rooms, need to have special design considerations in order for seasonal fifty three (53) degree Fahrenheit (°F) chilled water to provide adequate cooling. In certain instances, it may be necessary to have supplemental cooling for interior high load density areas. It must be emphasized that all control valves shall be two-way.

The water flow through the centrifugal chillers is variable and the chilled water pumping is variable. The tunnel and utility distribution system that serves all of the buildings connected to the CUP runs in a north/south direction slightly east of the centerline of International Parkway. The chilled water supply and return piping is thirty-six (36) inches in diameter. This sizing, under present operating conditions, means there is no appreciable pressure drop in the main piping system. The pressure differential between the supply and return lines at the CUP is essentially the same as the differential at the service entrance of the building served.

The main terminal buildings contain chilled water booster pumps located at each end of the terminal building which are seldom operated. The 4E South Satellite Terminal chilled water booster pumps are continually operated to provide adequate Chilled Water (CHW) system differential pressures at the remote terminal building. The FAA TRACON Control Tower has water to water heat exchangers and secondary building pumps in order to accommodate the building system's higher static head without adversely affecting the entire CUP Chilled Water System (CHWS). A "bridge tender" is utilized to maintain the CHWS return temperature at 64 degree °F. The two (2) Hotels have booster pumps with system return pressure relief valves to provide building system flow and minimum supply and return pressures. Chilled water piping design should provide for a pressure drop through the Terminal buildings at peak load of sixty-five (65) to seventy (70) feet. It may be necessary to install booster pumps in unique areas in order to let the CUP operate economically on a year around basis. As an example, additional large loads near the center of the existing terminal buildings may require that variable booster pumping be added for the complete facility.

The large number of gallons of water available in the central chilled water loop makes it possible to use the loop and building piping for thermal storage under certain load conditions. For the months of December, January, February and March the chiller is run a few hours a day to charge the piping system with chilled water at temperatures as low as thirty-six (36) degrees °F. The lower temperature is used when storage is being used rather than the reset temperature in order to store more thermal energy within the system.

All components of the System cooling load shall be designed to return sixty-four (64) degrees °F water to the CUP when the supply water temperature is forty (40) degrees °F and the load is operating at design flow rates. All loads shall be provided with design flow rate control (i.e.- Griswold or approved equal device).

15.2.2 Steam/Heated Water - The heating comes from steam generated at the CUP and supplied down the spine road utility tunnel. The Heating Steam System (HSS) components are rated at 600 psig at 750 degrees °F. Current operating pressure is 100 psig at 350 degrees °F. At points along the utility tunnel that intersect with ends of terminal buildings, there are vaults that house steam to water heat exchangers. There is usually two (2) heat exchangers for heating water in each vault. Any new service extension of the HSS shall consist of 600 psig rated components. To prevent waterlogging problems, all future expansions shall be the diaphragm type manufactured by Amtrol or approved equal.

The heat exchangers that serve the Terminals are set up for 375 gpm of heating water each, and are rated for steam to heat water to 200 degrees °F. They are currently operated to heat water between 120 degrees °F and 200 degrees °F at the discretion of the terminal operator. There are multiple pumps located at the terminal buildings that serve each heat exchanger. There are system bypasses located in each terminal pump room for maintaining 5 psig differential across the heat exchangers. Existing requirements must be checked before each addition to the load and new heat exchanger capacity must be added as required. Space is available for additional similar units. Hot water piping extends from the vaults to the terminals through vault branch tunnels.

Expansion tanks located in each building pump room are utilized for each buildings Hot Water System (HWS). The tanks control the HWS return pressure between 20 psig to 80 psig. 20 psig is all that is normally required, dependent upon tank. The location of these pump rooms must be considered when adding new heating units at the terminal buildings.

Hot water coil sizing shall be based on a minimum 60 degrees °F delta temperature at 160 degrees °F supply. An exception to this requirement shall be side pocket VAV boxes where commercial availability limits water side differentials to 20 degrees °F at 160 degrees °F supply.

Most building HWS have variable pumping units. Any new system will be required to be variable pump. Work in adjacent areas shall consider increasing existing coil capacity to minimize pumping requirements.

15.2.3 Chilled and Hot Water Metering - Flow measuring is required for all chilled and hot water applications served by the CUP. Flow is measured through the use of orifice plates, flow tubes, and insertion turbine meters and temperature is measured through the use of 100 ohm platinum RTD's that send signals to the CUP Distributed Control System (DCS). The DCS calculates the energy usage using the flow and temperature measured.

15.2.4 Terminal Building HVAC System - The original terminal buildings airside HVAC system consists of high pressure single duct air handling units sized on a modular basis. The original air handling units consisted of sectionalized units. The fans are Class III, air foil centrifugal type. The chilled water coils are maximum ten (10) row utilizing seamless copper tubing, designed for 200 psi working pressure. The filter sections consist of high efficiency air filters with an automatic roll type pre-cleaner and a section where the original charcoal filter was removed. At each inlet to each fan there are adjustable inlet vanes except for systems that have been converted to variable speed motor drives. The original system was designed for 4¼ inch external static pressure (SP). The single duct system supplies jetronic induction boxes. The induction boxes have hot water heating coils designed for 200 psi working pressure. All induction units served by an air unit shall have heating service isolation valves (automatic), located adjacent to the respective air unit, defined in previous sentence to prevent system reheat except during the heating season. The original box design inlet SP is 1.5 inches. Several induction units have been replaced with fan powered variable air / variable volume (VAV) units. The original terminal ventilation air design was for 25 percent outside air. There is a shortage of return air space in all the terminal buildings.

15.3 East Side Plant - Chilled water and thermal storage in the form of ice is produced at the East Side Plant (ESP) which is located on the east side of the Airport off East Airfield Dr. at the end of East 30th Street. The ESP operates automatically with no on-site operator and is controlled locally and remotely from the CUP by the use of an Energy Management System. During the summer months, ice is produced and stored during off time-of-day electrical peak periods and then "burned" for the production of chilled water during these daily time-of-day periods. The time-of-day electrical peak period is currently set from 12:00 p.m. to 8:00 p.m. Monday through Friday during the months of June through September.

The ESP has four (4) ice harvester type chillers for a total capacity of 380 tons of cooling. Peak thermal storage capacity is 6460 ton-hours. Design values for the ESP chilled water system are 40□F entering water temperature and 65□F leaving water temperature. The ESP currently serves the following DFW Airport Board facilities with approximate peak chilled water loads:

Administration Building (150 tons).
Central Warehouse and Procurement Building (45 tons).
Transportation and Vehicle Maintenance Complex (25 tons).
Airport Maintenance Shops Building (60 tons).

15.3.1 Chilled Water from East Side Plant - A variable pumping system is used to pump chilled water through a buried pipe distribution system to all the facilities being served. The majority of the distribution piping is 8 inch bell and spigot, gasketed steel pipe with urethane insulation and PVC outer jacket..

Nominal operating pressure of the chilled water system is 50 PSIG. Facility booster pumps have not been required at current facilities being served by the ESP. However, any future extension of the distribution system will introduce additional pressure drops that may make booster pumps necessary on new facilities at the end of the system.

The chilled water temperature is reset on ambient air temperature ranging from 40□F to 53□F. Design loads should be based on this range of water temperature. Spaces with high loading, such as computer rooms, will require special design considerations for adequate cooling with 53□F chilled water supply temperatures. In certain instances, it may be necessary to have supplemental cooling for interior high load density areas. It must be emphasized that all control valves shall be two-way valves and all cooling coils shall be provided with a design flow rate control device, i.e. a Griswold or approved equal maximum flow control device.

Any new facilities planned for construction adjacent to East Airfield Dr. should be considered for chilled water service from the ESP. Conceptual design development must be coordinated with DFW / Utilities Engineering. Current ESP capacity and utilization is as follows:

ICE MAKING CAPACITY
Tons (32□F)

CHILLER #1	113.8
CHILLER #2	76.2
CHILLER #3	113.8
CHILLER #4	76.2
	380.0

Ton-Hour rating during the time-of-day electrical peak period season noted above is as follows:

16 Hours @ 380 tons X 0.85 = 5168 ton-hours

8 Hours @ 190 tons X 0.85 = 1292 ton-hours

Note: Factor 0.85 is the useful capacity or utilization factor of the ice harvesting chillers and system. Current peak loading is approximately 50% of ESP capacity.

15.4 HVAC System Requirements - All areas used primarily to accommodate people-oriented activities such as offices, concessions, concourses, cafeterias, etc. shall be air conditioned and heated. Areas classified as storage or manufacturing shall be mechanically ventilated and heated to minimum requirements Building Code. The criteria for a particular HVAC system will vary somewhat from building type to building type or project to project which may change certain parameters of initial design considerations.

15.4.1 Terminal Buildings - New HVAC systems or renovations of existing systems serving existing Terminal areas should conform to the basic operating parameters of the systems currently in operation. System design for new Terminal facilities should conform to the basic design parameters and equipment and material criteria described herein. Heat pumps, roof top units and plenum mounted condensing units are not recommended.

15.4.2 Buildings Other Than Terminals - Building use and DFW / Utilities Engineering recommendations shall be used as guides in selecting the type of HVAC system for buildings other than Terminals or not served by CUP. In many instances, rooftop direct expansion (DX) packaged systems are satisfactory. When packaged systems are used, the control system supplied by the manufacturer is acceptable. Thermostatic zoning must not be compromised when using packaged equipment. Split systems are preferred to roof top units. The following criteria shall apply where applicable:

1. Chilled water systems are required for fifty (50) tons and above;
2. Air cooled systems can be used to one hundred (100) tons unit capacities;
3. Water cooled systems are required above one hundred (100) tons unit capacities.

If available, natural gas is preferred as a source of heating. Otherwise, heat pumps shall be used.

15.5 Design Conditions

15.5.1 Heating - The winter inside comfort design temperature shall be 75 degrees °F db, unless otherwise indicated. Humidification is not required except for special purpose facilities.

15.5.2 Cooling - The summer inside comfort design temperature shall be 75 degrees °F db, unless otherwise indicated. The design relative humidity will be 50 percent. The coil shall be designed so the building annual RH range shall not exceed 60 percent RH. Face and by-pass coils should be used on all VAV systems to prevent high humidity conditions during partial load (i.e. control supply air temperature with face and by-pass). The use of face and by-pass coils may be reviewed on a case by case basis.

15.5.3 Outside Design Temperatures – Refer to ASHRAE Handbook of Fundamentals for Dallas/Fort Worth International Airport. These values are 99.6% Winter DB (17ºF), 0.4% Summer DB (100ºF) and 0.4% Summer WB (78ºF).

15.6 Energy Conservation - Every project of new construction shall meet the energy performance standards set forth by the International Energy Conservation Code. Selection of mechanical equipment shall be based on the standards in the code and be the most proven efficient equipment available in the market today.

Special energy conserving features shall be considered where applicable, such as thermal ice storage, variable frequency drives, heat recovery, etc. Motors shall be of high efficiency and power factor. Direct Digital Control (DDC) Energy Management Systems are required in all new or renovated Board facilities other than the terminals. Construction and control specifications will be provided by DFW / Utilities Engineering.

15.7 Piping - Piping shall meet the following requirements:

1. High pressure steam piping - black steel pipe, Schedule 80 welded joints;
2. Low pressure steam piping - black steel pipe, Schedule 80 welded joints;
3. Condense (steam) - K copper or schedule 80 steel welded joints;
4. High pressure condense piping - black steel pipe, Schedule 80, threaded. No cast iron fittings above 15 psig;
5. Low pressure condense piping - black steel pipe, Schedule 80, threaded;
6. Chilled water piping - black steel pipe Schedule 40, welded;
7. Chilled water (inside) - steel or K or L copper;
8. Chilled water (underground) - pre-insulated black steel pipe Schedule 40, welded joints;
9. Hot water piping - black steel pipe Schedule 40, welded joints;
10. Hot water (inside) - steel or K copper;
11. Hot water (underground) - pre-insulated black steel pipe Schedule 40, welded joints;
12. Refrigerant piping - Type K copper.

15.7.1 Hangers and Supports - A pipe stress analysis shall be performed to determine pipe hanger support system and spacing requirements. All hangers and supports shall comply with Manufacturer's Standardization Society (MSS) standards. Vertical pipes must be supported at each floor with pipe clamps.

Pipe saddles shall be galvanized metal (for insulated pipe) extending at least twelve (12) inches in length and covering a minimum of half-pipe circumference. Protection shields shall be provided for all insulated pipe. Generally, the gauge shall be as follows:

Pipe Diameter	USS Gauge
Up to 3 inches	No. 22
3 inches through 6 inches	No. 16
Above 6 inches	No. 12

15.7.2 Pipe Identification - All piping in buildings shall be identified by the use of pipe marker bands, with direction of flow arrows. Pipe marker color coding shall follow standard industry practice ANSI A13.1 "Scheme for Identification of Piping Systems".

15.7.3 Pipe Anchors - A pipe stress analysis shall be performed to determine proper pipe anchor

locations.

15.7.4 Expansion Joints - A pipe stress analysis shall be performed to determine the expansion joint system and spacing requirements.

Joints shall be piston-ring, internally guided, double joint expansion joint or a packless expansion joint.

Expansion joints shall provide 200 percent absorption capacity of piping expansion between anchors. All chilled and hot water piping joints shall be welded, therefore, special consideration must be given to pipe layout for expansion and contraction. The existing medium pressure steam and condense expansion joints are double stainless steel bellows.

15.8 Pumps - Pumps are required to meet the following criteria:

1. Horizontal split case constructed such that removal of pump shaft impeller, seal, bearings, etc. may be possible without the removal of pump casing from the line or disconnecting either suction or discharge connection;

2. Mechanical seal assembly with replaceable remite insert; external split seals are desirable.

3. Flanged or union connection (type depending on size, pipework and space restrictions).

15.8.1 Condensate Pumps and Receivers - Condensate units shall be of the duplex type with two (2) bronze fitted, close coupled centrifugal pumps with pressure gauge taps with stop cocks on both suction and discharge sides.

Receiver tank fabricated of cast iron or steel, as applicable, and equipped with required float switches and alternator to provide automatic alteration of pumps. The receiver shall be provided with condensate return, vent, overflow, and valved drain connections.

15.8.2 Chilled Water and Hot Water Pumps - "Stand-by" pumps are required on most facilities, and especially for facilities containing computer rooms.

Provide pressure gauge taps with stop cocks and gauges on suction and discharge sides of pump.

Booster pumps for chilled and hot water systems shall be controlled via tie-in to the CUP Distributed Control System. All requirements must be verified and approved by the DFW/Utilities Engineering.

Provide thermometer wells on suction and discharge sides of pumps.

Chilled and hot water pumps shall be insulated.

Impellers shall be one piece, hydraulically and statically balanced and keyed to the shaft.

Pumps shall be of a high efficiency design. The pump motor assembly shall be mounted on a common steel or cast iron base.

Pump and motor bearings shall be grease lubricated complete with alemite fittings.

Two (2) pumps of similar capacity and head are recommended rather than one (1) large pump of total building capacity.

Variable volume pumping systems with variable frequency electric drives are required. Where multiple pumps are utilized, a single drive may be utilized with the capability for base loading one pump on constant speed with the other on variable speed.

15.9 Air Handling Units - Air Handling Units shall adhere to the following requirements:

15.9.1 Air Handlers (Package and Built-up Equipment) - Provide a hand operated "start/stop" switch and remote control terminations at each air handler location with properly sized integral heaters. Also provide a fused disconnect switch at each location.

Provide a galvanized drain pan (insulated on both sides) with a drain line not less than ¾ inch in diameter or size of tap on drain pan. Use a plugged tee for all changes in direction rather than ninety (90) degree ell. Condensate shall be drained to the sanitary sewer.

Air handling equipment should be equipped with filters. High efficiency filters shall be provided on equipment over 15,000 cfm.

Generally, space conditioning filters shall be two (2) inch thickness with dimensions of 20" x 20", 20" x 25", 16" x 20" or 16" x 25" are preferred.

Filters shall be two (2) inch thick throw-away, medium efficient, pleated type contained in rigid media frame with supporting maze across leaving faces of media. Two (2) inch filters shall be used in equipment below 15,000 cfm.

Generally, the pressure drop through a clean filter shall not exceed 0.06 wg. for one (1) inch filter panels and 0.12 wg. for two (2) inch filter panels at a face velocity of 500 fpm.

Prefiltering of fresh air is recommended utilizing roll type media filters.

Field lubricated ball bearing equipment is preferred over sleeve bearings. All air handling equipment shall be selected and installed such that bearings can be replaced with minimum demolition of equipment or surrounding structures.

Bearing lubrication points shall be extended to a central external accessible point and fitted with alemite fittings.

Generally, electric motor speeds in excess of 1800 rpm are to be discouraged.

Chilled water and hot water coils shall be of the continuous copper tube type with copper or aluminum fins.

All coils shall be of the cleanable and drainable type. Each tube shall be accessible without piping disconnect. Headers shall be removable at the opposite end (as exemplified by Trane type "K").

Access covers to water coils on the AHU housing shall be readily removed for access to coil headers without piping disconnect or demolition of surrounding structures.

Coil design shall be based on the following water side criteria:

64 degrees °F min. L.W.T. Cooling, 40 degrees °F supply.
60 degrees °F min. delta T heating, 160 degrees °F supply.

Air friction loss across coil shall not exceed 0.7 inches W.C. (Faces velocities below 450 fpm are recommended).

Existing Terminal buildings are based on 500 gpm of 200 degrees °F water. The criteria above may cause problems in some of the buildings. Available water temperature at Terminals shall be verified and conditions and results reported to DFW Utilities Engineering.

Generally, air handling units that require a 7½hp motor or larger shall be selected with a key way shaft and keyed fan hub. Standard size key and key way are preferred.

Chilled water and hot water control valves shall be flanged or set in unions for easy removal.

All water coils shall have maximum flow rate control devices (Griswold or approved equal) in the return line.

15.9.2 Room Fan and Coil Units (Floor and Wall Mounted Equipment) - Generally, the use of fan and coil units (FCU) is discouraged.

FCU's shall have a high-medium-low-off switch where adjustment can be made without removal of access door or unit housing. This switch shall be easily accessible for room or area occupants personal adjustment.

FCU's shall be equipped with permanent galvanized type filters.

15.9.3 Package HVAC System Equipment - Where building use, type, and DFW Utilities Engineering review justifies the use of package equipment, the following shall apply:

1. Rooftop Systems (discouraged) - The rooftop equipment shall be completely self-contained, with factory wired controls and factory assembled components and piping. Equipment shall have two (2) inch thick pleated replaceable media filters. Compressors shall have five (5) year warranty, including parts and labor (5 tons and under).

2. Split Systems (preferred) - Split systems shall consist of furnace, coiling section plenum with direct expansion cooling coil, air-cooled condensing unit or heat pump, piping, controls, etc. All components shall be factory wired and assembled. Furnaces shall have filter rack complete with one (1) inch thick throw-away filters. Compressors shall have five (5) year warranty, including parts and labor (5 tons and under).

3. An E.E.R. of 10 or greater is required.

15.10 Ductwork - All ductwork systems shall be constructed and installed in accordance with SMACNA and ASHRAE guides.

Duct material shall be zinc-coated sheet steel or aluminum of the thickness of the metal and stiffeners as indicated in the SMACNA Manual.

Wherever ductwork is connected to fans, air handling units or other equipment that may cause vibration in the duct, the connection to the equipment shall be by means of a flexible connection constructed of fire resistant flexible canvas or other approved material. The connection shall be suitable for the pressures at the point of installation.

All ducts shall be insulated.

All ductwork installed below the floor in crawl spaces or below grade shall be constructed with watertight joints and shall be tested and proved tight before floors are poured. The underfloor duct system shall be constructed of fiberglass, PVC or other approved non-metallic material.

All variable volume terminal units shall be equipped with at least a five (5) diameter length of straight rigid duct immediately upstream of the volume control devices.

All discharge ductwork shall have acoustical lining inside duct for minimum of 15 feet or past first ninety

(90) degree elbow on downstream side of air handling unit.

Flexible ductwork shall comply with UL 181 Class 1, and shall meet or exceed NFPA 90A-90B rating. Maximum length of flexible duct shall be 5 feet.

15.11 Pipe Insulation - All insulations, jackets, adhesives, coatings, vapor barrier mastics, etc., shall meet the requirements of NFPA Bulletin 90-A, ASTM E 84, and UL 723, with a flame spread of twenty-five (25) or less and smoke developed rating of fifty (50) or less.

All piping and vessels with a surface temperature less than ambient temperature shall have a vapor barrier covering. The vapor seal shall be continuous, unbroken, and adhere to surface so that the insulation is airtight to omit the possibility of vapor draining into the insulation material.

Form fitted polyurethane insulation shall be used on all coil header piping to the extent necessary to include all valves, flow control valves and other appurtenances utilized to evaluate the performance of the coil.

15.11.1 Chilled Water Piping - Generally, chilled water pipes shall be covered with two (2) inch thick insulation. ASHRAE Standards shall be followed if it results in greater thickness. Fittings shall be insulated with two (2) inch thick premolded or shop fabricated polyurethane fitting covers. Insulation on lines in concealed areas shall be jacketed with white reinforced foil-kraft vapor barrier. Insulation on lines exposed in equipment rooms or in occupied areas shall be jacketed with presized glass cloth vapor barrier jacket. Jacket laps and butt strips should be adhered with vapor barrier adhesive or position sealing system. Fittings shall be vapor sealed with vapor barrier mastic. Galvanized steel saddles (16 gauge - 18 inches long) shall be installed at all pipe supports to protect the insulation. Higher density insulating materials should be used at pipe supports, if required to prevent crushing/cutting of insulation. Proper coating/wrapping with appropriate electronic check is acceptable. All exterior exposed pipes shall have aluminum metal jacket as specified below. Direct buried chilled water piping shall be pre-insulated with urethane foam, 1½ inches thick.

15.11.2 Hot Water Piping - Same as chilled water piping except that vapor barrier is required on direct buried pipe only.

15.11.3 Drain, Refrigeration Suction and Chilled Water Piping Two Inches and Smaller - Generally, this insulation shall be ¾ inch thick molded pipe covering with a density of seven (7) pounds, a thermal conductivity not to exceed 0.28 at a mean temperature of seventy-five (75) degrees °F and with a water vapor transmission rate of less than 0.1 per minute. This insulation should be slipped over the open ends of piping prior to joining or fitting of pipe.

Fittings for foamed plastic insulating materials shall be fabricated from the same material by cutting the material to form ells, tees, etc. All exposed exterior pipes shall have aluminum jacket as specified below.

Rigid sections shall be used where required at hanger/support locations with galvanized steel saddles (18 gauge - 12 inches long).

15.11.4 Steam and Condensate Piping - Generally, the insulation for 100 psig steam condensate piping shall be two (2) inches thick. High pressure steam piping greater than 100 psig shall be covered with calcium silicate, three (3) inches thick. Calcium silicate insulation shall be used as required for surface temperatures of five hundred (500) degrees °F and above. Fittings for calcium silicate insulation pipe shall be preformed or shop fabricated calcium silicate of same thickness of pipe insulation.

15.11.5 Tunnel Piping - All steam, chilled water and hot water piping, in tunnels or exposed, shall have a smooth finish aluminum metal jacket on polyurethane insulation or small rib texture aluminum metal jacket on calcium silicate. Minimum jacket thickness shall be .016 inch.

15.11.6 Pump Insulation - Chilled and hot water pumps shall be insulated. Pumps under thirty (30)

hp may not be insulated, however, insulation shall terminate at unions, flanges, etc, in a neat sealing manner, with pump bed plate section designed to drain all moisture.

15.12 Duct Insulation - Generally, all ductwork except exhaust ductwork shall be lined in accordance with temperatures involved and current Fire Code. Ductwork insulation materials shall be selected for the function involved, considering sound absorption coefficients, velocities, etc.. Particular attention shall be given to internal insulation where fire dampers, fuse links, volume adjusters, etc., are installed to ensure that insulation is securely fastened.

15.12.1 Low Velocity (Internal) - Generally, internal ductwork insulation is preferred for economics, sound attenuation, aesthetics and protection from damage by workmen in ceiling where possible. Unless otherwise required, all low velocity internal duct lining shall be ½ inch or 1 inch thick glass fiber acoustical-insulation, plastic coated on air stream side to reduce attrition, and properly secured with adhesives and tin bearing sheet metal screws and washers.

15.12.2 Low Velocity (External) - Where external rectangular ductwork insulation is required, particular attention shall be given to joints, terminating edges, operation of air control devices, etc. External duct wrap may be used where insulation is not exposed to abuse. Unless otherwise required, insulation shall be two (2) inches thick, three (3) pound density glass fiber rigid board duct insulation complete with reinforced foil-kraft integral heavy vapor proof covering on the outside surface. Insulation shall have a minimum compressive strength of 140 psf at a ten (10) percent deformation. Securely fasten all edges, joints, etc. to provide a vapor proof duct.

NOTE: This method is least desirable unless required to prevent condensation or peeling of interior insulation due to velocity.

15.12.3 High Velocity (External) - Generally, high velocity ductwork requiring external insulation shall be insulated with blanket wrap fiberglass insulation, 1½ inches thick, one (1) pound density or minimum thermal resistance of 6.0, complete with scrim kraft jacket. Facing overlapping joints shall be at least two (2) inches and held in place with outward clinching staples on approximately four (4) inch centers. Underside of ducts exceeding twenty-four (24) inches in diameter shall be spot cemented and finally secured with sheet metal screws and washers.

15.12.4 High Velocity (Internal) - This ductwork shall be insulated similar to low velocity (internal) except material, adhesive materials, fastener centering, edge and joint sealing, etc., shall be compatible with velocities and air control devices encountered. A perforated sheet metal inner liner shall be included on all high velocity ductwork where velocity exceeds 3500 fpm.

15.12.5 High Velocity (Flexible Duct) - This ductwork shall be UL 181, Class I, with rating to meet or exceed NFPA 90A-90B and reinforced with a perforated sheet metal inner jacket.

15.13 Air Devices and Boxes - The preferred system in the Terminal buildings is the use of a side pocket Variable Air Volume (VAV) box with a hot water coil. The cold air duct will be closed to zero (0) degrees when cooling is no longer required. The wall thermostat (the thermostats should be mounted on the walls) will control the volume damper and a two-position hot water valve in sequence. On a call for heating, the two-position hot water valve will open, the fan motor will start and run to satisfy the thermostat. When the thermostat is satisfied, the fan motor will cycle off and the two- position valve will close. There is a two (2) degree °F deadband between closing of cold air damper and opening of control valve. A filter will be included on the inlet to the side pocket box to protect the heating coil and fan from dirt. Consideration should be given to static pressure drop. When new side pocket boxes are connected to the existing air handling system, a pressure reducing valve will be used in order to drop the pressure in the supply to the new boxes to a lower value than is needed by the existing induction boxes. Boxes located above finished ceilings will have adequate ceiling access panels or other means of access to box for maintenance and removal. Except for lift out ceiling installation, all access panels will be hinged.

The side pocket VAV system described above is also the preferred system for other building types where numerous temperature control zones are required. The complication of connecting to an existing system will not be a factor in other building types.

Mixed pressure systems are not preferred over separate systems if there is a payback of five (5) years or less.

15.14 Controls - Controls shall meet the following requirements:

15.14.1 Pneumatic Controls - The temperature control systems must be designed such that the operational sequence is as simple as possible. In addition, it must be designed such that future maintenance costs are minimized in respect to reliability. Generally, the control system will provide both heating and cooling twelve (12) months of the year without manual changeover. A manual changeover system (2 pipe system) from summer to winter conditions is not permitted and shall not be considered unless specifically approved by DFW / Utilities Engineering. Generally, a two-coil, four-pipe system utilizing two-way valves to regulate the flow of hot or chilled water on demand is preferred. Normal temperature control and air distribution is, in general, adequate for general purpose facilities. Humidity control shall be considered in special purpose facilities.

All pneumatic lines in exposed areas shall be seamless hard copper tubing. Piping may be virgin polyethylene plastic tubing in accessible areas such as removable acoustical ceilings and equipment panels. When in non-accessible areas, such as plaster ceilings, walls, chases and mechanical rooms, seamless copper tubing shall be used.

Main control air for terminal buildings is supplied from the compressor air system located in the CUP. A separate stand-by air supply system consisting of a compressor, receiver and refrigerated (direct expansion type) moisture condenser, shall be provided for the pneumatic controls in Terminal buildings. Generally, the compressor shall be selected to operate not more than fifty (50) percent of the time while supplying all of the control air requirements. Backup systems shall come on when pressure drops to about 50 psig and shut off at 60 psig, with a maximum of six (6) starts per hour.

15.14.2 Electric Controls - Electric controls systems shall comply with criteria as described in pneumatic control for temperature control systems.

15.14.3 Automation Systems - Where directed by the tenant Project Manager, provisions for any connections to existing automation system controls shall be as required. Where building type or use justifies, complete new automation systems for energy conservation is encouraged.

15.14.4 Individual Space Control - Individual space control is desired for each individual totally enclosed office space or room. Individual VAV units, two position damper or self contained non-system powered variable volume diffusers (8 foot ceiling height maximum) may be utilized.

15.15 Vibration Isolation - To prevent excessive noise or transmission of vibration to the building structure due to the operation of machinery or equipment, or due to interconnected piping, ductwork, or conduit, proper vibration isolation shall be provided.

Static deflection of vibration isolators shall conform to minimum guidelines recommended in the latest ASHRAE Guide and Data Book for the actual floor spans involved, and NFPA 90A. Consideration shall be given to sound transmission by following ASHRAE Guidelines in Design.

The vibration isolation system shall consist of foundation, base, spring isolators and rubber and shear pads, as necessary to provide maximum isolation conforming to ASHREA guidelines.

15.16 Noise Control

15.16.1 Mechanical noise levels shall be controlled by proper design of the noise producing mechanical and electrical equipment such as fans, mixing boxes, diffusers, pumps, transformers, emergency generators, etc. so as not to exceed acceptable levels as set forth by industry standard criteria. The acceptable noise level shall be described in terms of NC (Noise Criteria) as defined by the ASHRAE Handbook, Systems Volume, (Sound and Vibration Control Chapter) latest edition (American Society of Heating, Refrigeration and Air Conditioning Engineers)

15.17 Heat Exchangers - Horizontal Stainless Steel Plate type heat exchangers are preferred, except for steam to hot water service. Locate the units such that tube bundle may be removed/repaired with minimum removal of pipe work, walls, etc.

Heat exchangers to be installed in the CUP utility tunnel vaults shall be of shell and U-tube type, steam in shell, 600 psig steam working pressure, in accordance with ASME Code for Unified Pressure Vessels. Present operating pressure is 100 psig. Provide unit with steam inlet, condensate outlet, vent, water inlet and outlet and other connections as required.

Any steam - to - hot water heat exchanger installed in a separate facility outside of the CUP utility tunnel, but supplied steam from it, may be rated for less than 600psig steam working pressure. Such an installation, however, will require a pressure relief and reducing station for protection of any downstream low pressure-rated heat exchangers and supporting equipment.

15.18 Tests and Balance - The balancing, testing and adjusting of the heating, ventilating and air conditioning systems shall be performed by an independent technical firm or balancing agency not involved in the design. Balancing firm shall be Associated Air Balance Council (AABC) certified. All tests shall comply with certification agencies standards and practices.

PLUMBING

15.19 General Information - This Division defines general design criteria that applies to the design of plumbing at DFW Airport.

15.20 Energy Conservation - The plumbing system designer shall consider using such techniques as controlling hot water temperatures, water pressures, providing faucets with flow restricters. The economic use of thermal insulation, automatic shutdown of water heating and circulating systems, using waste heat from air conditioning systems, using off-peak power, occupancy sensor for automatic flushing, use of automatic closing faucets, and using minimum energy consuming equipment to provide maximum energy efficiency. The plumbing system designer should understand how the building consumes energy. When this is understood, energy conservation design practices should become integrated into the building allowing it to operate more efficiently and use less energy, while meeting the needs of the user.

15.21 Piping - Piping should meet the following requirements:

1. Domestic cold water (inside) - K or L copper with silver solder (95-5) no lead.
2. Domestic cold water (outside) - cast iron mechanical joint Class 150 or PVC.
3. Domestic hot water (inside) - K copper.
4. Domestic hot water (outside above ground only) - K copper or steel.
5. Sanitary sewer (inside) - cast iron above grade, PVC below grade.
6. Sanitary sewer (outside) - PVC.
7. Subsoil drainage - perforated PVC, PVC.
8. AC unit drains - Hard drawn copper drain pipe.
9. Equipment vents - steel.

NOTE: 50-50 solder shall not be used for any pipe jointing. No direct buried copper piping shall be permitted inside or outside facilities. The use of ferrous metal pipe and fittings under slabs shall be reviewed on a case by case basis.

15.21.1 Hangers and Supports - All pipe must be adequately supported throughout. Generally, hangers shall be split ring or clevis type. However, trapeze hangers constructed of steel channels with welded spacers and steel rods may be used. All hangers and supports shall comply with Manufacturer's Standardization Society (MSS) standards. Vertical pipes must be supported at each floor with pipe clamps.

Provide pipe saddles fabricated from galvanized metal (for insulated pipe) extending at least twelve (12) inches in length and covering a minimum of half-pipe circumference. Generally, the gauge shall

be as follows:

Pipe Diameter	USS Gauge
Up to 3 inches	No. 22
3 through 6 inches	No. 16
Above 6 inches	No. 12

15.21.2 Pipe Identification - All piping in buildings shall be identified by the use of pipe marker bands with direction of flow arrows at ten (10) foot intervals in concealed spaces; twenty (20) foot intervals in exposed areas and on each side of any penetrated wall, ceiling or floor. Pipe marker color coding shall follow industry practice ANSI A13.1 “Scheme for Identification of Piping Systems”.

15.22 Water Heaters

15.22.1 Water to Water Hot Water Generators for Use in Terminal Buildings - Shall adhere to the following requirements:

1. Water heaters shall be completely copper lined.
2. Heads shall be cast bronze, coiled tubes shall be copper, and all other internal parts shall be copper and bronze.
3. The tank shall be ASME stamped at or above the scheduled working pressure.
4. Factory furnished and approved accessories, including ASME temperature and pressure relief valve, shall be used.

15.22.2 Standard Water Heaters - Shall adhere to the following requirements:

1. Water heaters shall be glass lined, storage type.
2. Gas water heaters shall have automatic gas shut-off device and be equipped with an American Gas Association certified draft hood. Water heaters shall utilize electric ignition devices.
3. Electric water heaters shall be UL listed.
4. All standard water heaters shall have a ten (10) year limited warranty.
5. All energy saver water heaters shall meet ASHRAE Standards for Energy Efficiencies, latest edition.
6. Water heater drains shall have valves and shall be plumbed to a floor drain with copper piping.
7. All water heaters shall be readily accessible.
8. Electric water heaters located in ceiling/attic spaces shall be accessible by permanent ladder or stairway, an unobstructed walkway (minimum 24" in width) and a 30" x 30" minimum work platform with lights located over the walkway and service area. Locate the switch at the access opening.

15.23 Plumbing Fixtures and Accessories - All exposed metal work at fixtures shall be brass with chromium plate. All faucets, fittings, supply stops for fixtures, and similar devices shall be one (1) manufacturer unless otherwise required. Each fixture shall contain standardized interchangeable operating units made up of separate renewable stem, seat, washer retainer, and nut. All faucets and fittings must close with the water pressure. All fixtures shall be installed with supply stops/valves accessible at the fixtures.

All fixtures and accessories listed apply to Board owned, operated or maintained buildings. Some fixture and accessory preferences may change over time depending upon current maintenance warehouse stocking. Tenants may have different preferences and shall be consulted.

On renovation projects, an effort shall be made to match existing fixtures and trim. On renovation projects where fixtures and trim cannot be matched and on new projects, fixtures shall be water conserving American Standard or an approved equal.

15.23.1 Water Closets - Wall-hung water closets are preferred. Water closets shall be white, vitreous china, siphon jet, elongated bowl, with white open-front seat without cover.

Flush valves for water closets in Terminal buildings shall be as follows:

1. Sloan "Optima" Automatic No. 152 ES-S Flush Valve System.
2. Concealed rough brass hydraulically operated flush valve, one (1) inch wheel handle back-check stops, adjustable tailpiece, solenoid motor operator, sensor, vacuum breaker, elbow flush connection and spud coupling for 1½ inch concealed back spud.
3. Automatic sensor for operation of each water closet, with required transformers, controls and complete wiring diagrams for separate operation in each toilet, all as recommended and approved by flush valve manufacturers.
4. Flush valves as described above are approved, or an approved equal may be used.
5. Flush valves in other facilities shall be Sloan “Optima” Automatic No. 152 ES-S or equivalent wall mounted flush valves.

15.23.2 Urinals - Wall-hung urinals are preferred. Urinals shall be white, vitreous china, wash-out type. Flush valves for urinals in Terminal buildings shall be as follows:

1. Sloan "Optima" Automatic No. 195 ES-S Flush Valve System.
2. Concealed rough brass hydraulically operated flush valve, ¾ inch wheel handle back-check stops, adjustable tailpiece, solenoid motor operator, sensor, vacuum breaker, elbow flush connection and coupling for ¾ inch concealed back spud, wall and spud flanges for each urinal.
3. Automatic sensor for operation of each urinal with required transformers, controls and complete wiring diagrams for separate operation in each toilet, all as recommended and approved by flush valve manufacturers.
4. Flush valves as described above are approved, or an approved equal may be used.
5. Flush valves in other facilities shall be Sloan “Optima” Automatic No. 152 ES-S or equivalent wall mounted flush valves.
6. Meet accessibility requirements.

15.23.3 Lavatories – Wall-hung white enameled cast iron or white enameled cast iron self-rimming lavatories with twenty (20) inches by eighteen (18) inches rectangular basin with splash back are preferred. Faucets shall be “Kohler” brand or equivalent self closing adjustable from five (5) seconds to fifteen (15) seconds.

15.23.4 Electric Water Coolers (EWC) - Wall hung Halsey-Taylor or equivalent electric water coolers are preferred. Electric water coolers shall meet accessibility requirements. Some Terminal buildings have a central water cooling system. The Designer shall investigate the possibility of connecting to this system where it is available.

15.23.5 Service Sinks - Service sinks shall be white enameled cast iron, twenty (20) inches by twenty-two (22) inches, blank back with wall hanger supports. Faucet shall be a “Kohler” brand or equivalent wall-mounted rough plated faucet with valve units, vacuum breaker, wall brace, threaded spout with pail hook.

Trap shall be adjustable standard for three (3) inch pipe connection with cleanout plug and strainer, enameled inside.

Rim guard shall be nine (9) inches and twelve (12) inches stainless steel rim guard, front and sides.

15.23.6 Mop Basins - Mop basins shall be one-piece mop service basin, size twenty-four (24) by twelve (12) inches high outside, with Type 304 stainless steel, 20 gauge cap, continuous on all sides, with wall flashing on back and sides as required. Provide silicone base for full seal at floor. Grout entire installation level.

Service faucet shall be chrome plated “Kohler” brand or equivalent with vacuum breaker, integral stops, adjustable wall brace, pail hook, and ¾ inch hose thread on spout, eight (8) inch spread. Hose and hose bracket shall be thirty (30) inches long flexible, heavy-duty ⅜ inch rubber hose, cloth reinforced, with ¾ inch chrome coupling at one end. Five (5) inch long bracket by three (3) inch wide, with rubber grip.

Mop hanger shall be twenty-four (24) inches long by three (3) inches wide, 18 gauge No. 302 stainless steel attached with flat head, slotted machine screws.

15.24 Pumps

15.24.1 In-Line Circulating Pumps - Pumps shall be all bronze or stainless steel for domestic water service. Provide a line size ball valve on suction and discharge side of pump. Provide unions or bolted flange connection on each side of pump. Pressure taps and thermometer wells are not required on in-line circulators. Sleeve type bearings are acceptable for in-line pumps.

The Designer shall study water usage periods and shall operate pumps just prior to usage periods and limit operation of pumps as much as possible. A 7-day 12 hour timer should be installed to control such pump operation especially during peak demand periods as an energy reduction measure.

15.24.2 Submersible Pumps - Generally, submersible pumps are avoided where possible except electric power manholes where high voltage switches or tap boxes are installed. Diaphragm actuated pumps are preferred rather than float actuated pumps.

15.24.3 Sump Pumps - Generally, duplex sump pumps are required when located in a mechanical/electrical equipment room containing high voltage switchgear or motor control panels. A simplex pump may be used if area does not contain critical equipment.

Provide a mechanical alternator on duplex pumps and provide a separate circuit and circuit breaker for each pump. Provide check valves, and bypass pipe work and valves as required (in-line check valves are not recommended). Pumps shall be complete with automatic float switch with rod, rod guide and copper float.

Pumps shall be of the wet-pit type complete with gas tight sump cover, curb ring, grease lubricated, including alemite fittings extended to pump base plate.

Pumps shall be heavy-duty, vertical centrifugal, open non-corrosive impeller type with vertical drip-proof type motor with anti-friction grease lubricated bearings.

Where sump pumps are installed to provide protection for mechanical/electrical equipment, a high water alarm bell shall be provided in the area and alarm contacts should be provided for a central monitoring system.

15.24.4 Sewer Ejector Pumps - Sewer ejector pump design and selection design criteria are the same as those listed for "Sump Pumps" except sewer ejector pumps shall be of the standard three (3) inch, non-clog type specifically designed and installed for purpose intended.

15.25 Floor and Roof Drains

15.25.1 Floor Drains - All toilet rooms shall be equipped with at least one (1) floor drain, or minimum number as required by code. A trap primer system shall be provided for floor drains in public rest rooms.

Do not locate drains under machinery, cabinets, appliances etc. or within six (6) inches of any wall. All floor drains must be readily accessible.

15.25.2 Roof Drains - Roof drains shall be compatible with roof system.

The Designer shall use six (6) inches per hour as a minimum rainfall intensity guideline for sizing roof drains.

15.26 Backflow Preventers - Where the service line provides potable water for a domestic service a check valve shall be installed when the service line is tapped off a water main. A backflow preventer

shall be installed on any domestic water line serving other closed or chemically treated systems that could foreseeably contaminate the potable water line.

15.27 Air Compressors (House Service) - House service should not be taken from the instrument or control air distribution line or instrument or control air receiver unless specifically approved, except for doors and dry system fire sprinklers in Terminal buildings.

Provide an ASME pressure rated receiver and pressure relief assembly for the working pressure involved. Provide a non-cycling refrigerated air dryer when required. Provide an automatic drain on receiver with drain line piped to floor drain or hub drain. Air compressor assembly shall be provided with adequate vibration isolation. Adequate sound isolation shall also be provided.

Generally, a horizontal tank mounted type unit, with motor and compressor arranged for V-belt drive and mounted on a common steel base supported for the receiver is preferred.

Compressors that are equipped with cylinder unloading devices that will unload compressor on stopping and prevent cylinders from loading or starting until rated motor speed is attained are preferred.

15.28 Shock Absorbers - Provide eighteen (18) inch air chamber at each hot and cold water outlet adjacent to fixture outlet. Diameter of chamber shall be a minimum of 1½ times that of the service line to the fixture device.

Chamber and cap shall be of the same material as supply piping.

Hydraulic shock absorbers may be used in accordance with Water Hammer Arresters Standard, PDI-WH-201, latest revision.

15.29 Insulating Unions and Adapters - Provide dielectric insulating unions or adapters as required between copper and steel pipe and equipment. Dielectric insulators/adapters shall contain nylon insulation.

15.30 Pipe Sleeves - Provide pipe sleeves for all pipes passing through masonry and concrete construction.

The annular space between pipes and sleeves must be permanently sealed and sleeves below grade must be watertight.

Pipe joints should not be made closer than twelve (12) inches to a wall, ceiling or floor penetration, unless such pipe is welded.

15.31 Vibration Isolation - To prevent excessive noise or transmission of vibration to the building structure due to the operation of machinery or equipment, or due to interconnected piping, ductwork, or conduit, proper vibration isolation shall be provided.

Static deflection of vibration isolators shall generally conform to minimum design criteria recommended in the latest ASHRAE Guide and Data Book for the actual floor spans involved.

A single vibration isolation manufacturer shall supply vibration isolation equipment for any one project. The vibration isolation manufacturer and his representative shall have been engaged in the business of vibration isolation for no less than five (5) years.

15.32 Grease Traps - Waste water from disposers, sinks, dishwashers, floor drains and floor sinks in food service facilities shall drain to a grease collection system or through a grease trap or grease interceptor serving one or more facilities. Installation shall comply with the Plumbing Code.

-- END DIVISION --