DIVISION 23 – HEATING, VENTILATING, & AIR-CONDITIONING (HVAC)

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23 00 50 HVAC Design Criteria

A. Refer to the DFCM website for the latest mechanical design requirements. USU design requirements include the DFCM design requirements.

B. Comply with the latest (Utah adopted) edition of the International Codes:
   - International Building Code (IBC)
   - International Mechanical Code (IMC)
   - International Plumbing Code (IPC)
   - International Fuel Gas Code (IFGC)
   - International Energy Conservation Code (IECC)
   - International Fire Code (IFC)
   - National Electric Code (NEC)
   - All state amendments.

C. Comply with all applicable local, state, and federal codes and regulations.

D. Design the HVAC system to comply with the following standards:
   3. ANSI/ASHRAE 90.1-2010: Energy Standard for Buildings
   4. ANSI/ASHRAE Z9.5-2003: Standards for Laboratory Ventilation
   6. ASHRAE/USGB/IES Standard 189.1 Design of High-Performance Green Buildings
   7. SMACNA Sheet Metal and Air Conditioning Contractor’s National Association standards.
   8. Industrial Ventilation: A Manual of Recommended Practice

E. Heating and Cooling Load Calculations: Size the building heating and cooling systems based on undiversified calculated loads for space and process equipment. Include 10% safety factor for the heating load calculations and no safety factor for the cooling load calculations.

F. Infiltration: Consider considerable canyon winds for buildings located on the central campus when calculating infiltration loads and building pressurization controls.

G. Submit HVAC basis of design with schematic design, design development, and 100% review documents for all new buildings and
major remodels. Submit design calculations for all major HVAC systems.

H. Design for Maintainability. Design durable and easy to maintain mechanical systems and system components. Incorporate into the equipment and system design sufficient access and clearance for maintenance, repairs, and replacement.

I. Design for Reliability. Design systems with a high degree of reliability. If an entire building system will be affected by lesser reliability of a component (for example, a pump serving building chilled water system), then a redundant piece of equipment shall be provided to increase overall system reliability. Design for parallel operation is acceptable for redundancy.

J. Design for Energy Conservation. The energy efficiency of building systems and equipment is an essential part of the University design philosophy. Design any new project with state of the art energy efficiencies. Meet or exceed design standards published by American Institute of Architecture (AIA), American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) and the State of Utah.

K. Design for Environmental Awareness. The built environment has a profound impact on our natural environment, economy, health, and productivity. Incorporate environmentally friendly solutions in the building design where possible. Design the building to conform to the U.S. Green Building (USGC) Leadership in Energy and Environmental Design (LEED) guidelines where practical, required, or requested for specific building certification.

L. Design for Construction Commissioning. The design team is responsible for ensuring and developing a systematic process of assuring that a building (mechanical, electrical and plumbing systems) performs in accordance with the design intent and the owner’s operational needs.”

23 00 51 Design Conditions

A. Outside Design Conditions: Use the following climate data from ASHRAE 1993 Fundamental Handbook 24.14 for Logan, Utah

1. Elevation 4785 FT
2. Summer Design Dry Bulb Temp. (ASHRAE 1%) 93°F
3. Summer Mean Coincident Web Bulb (ASHRAE 1%) 62°F
4. Cooling Tower Web Bulb Temp. (ASHRAE 1%) 65°F
5. Winter Design Dry Bulb Temp. (ASHRAE 99%) -3°F
6. Winter Design Dry Bulb Temp. (USU Standard) -20°F
B. Indoor Design Conditions: Use the following indoor design conditions from AHSRAE Standard 55:

1. Classrooms, Auditoriums, Computer Labs, and student spaces:
   - Summer: 72°F ± 4°F
   - Winter: 68°F ± 4°F
2. Laboratory and Laboratory Support:
   - Summer: 72°F ± 2°F
   - Winter: 70°F ± 2°F
   - Relative Humidity (controlled) 30%-59%
3. Mechanical Rooms, Electrical Rooms, and Elev. Equip. Rooms:
   - Summer: 85°F Ventilation Only
   - Winter: 60°F min
4. Telephone/Data/Communication/Server Rooms:
   - Year Round: 75°F (USU Standard)
5. Unoccupied Spaces:
   - Summer: 95°F

C. Noise Criteria: Design the heating, ventilating and air conditioning systems to meet the following:

1. Laboratory Areas with Fume Hoods or BSCs: NC = 50 - 55
2. Laboratory Areas without Fume Hoods or BSCs: NC = 45 - 50
3. Laboratory Support Areas: NC = 50 - 55
4. Open Offices: NC = 40 - 45
5. Private Offices: NC = 30 - 35
6. Conference Rooms: NC = 25 - 30
7. Classrooms: NC = 25 - 30

D. Pressure Relationships: Design the heating, ventilating and air conditioning systems to meet the following:

1. Building: Positive to outside
2. Laboratories: Negative to adjacent spaces
3. Corridors: Positive to laboratories
4. Toilet Rooms: Negative to adjacent spaces

23 00 52 Ventilation Requirements

A. Mechanical equipment rooms shall have adequate ventilation to maintain no more than eighty-five (85°) degrees F. Include provisions to prevent freezing of equipment and piping in winter.

B. Provide equipment and controls to use outside air for cooling whenever possible.

C. Provide a building relief air system to maintain the building to be +0.05-0.08 in. W.G. building static pressure.
D. Connect all ventilation systems to the campus automation system.

E. Provide mechanical exhaust ventilation for kitchens, toilet rooms, custodial closets, garages, steam rooms, laboratories, animal rooms, and mechanical equipment rooms.

F. Design laboratory ventilation according to ANSI/ASHRAE Z9.5-2003.

G. Provide natural ventilation for electrical transformer rooms in the building sized according to the National Electric Code requirements. Forced ventilation is not acceptable.

H. Mechanical rooms shall not be used as return/relief air plenums.

I. Oversize outside air intake louvers to minimize hoar frost especially in make-up air systems.

J. Outside air ducts shall be ducted and insulated with duct wrap. No duct liner shall be used.

K. Locate outside air intakes away from docks, overhead doors, entrances, and other locations where vehicles are located or smoking may occur.

L. Locate relief air outlets, emergency generator exhaust outlets, plumbing vents, and exhaust outlets away from intake air inlets to avoid recirculation.

M. Include space for variable frequency drives, electrical panels, and all other panels in mechanical room design. Avoid locating VFD’s outside. Provide adequate clearance space for all panels.

23 00 53 Maintenance Design

A. Provide a minimum clearance of 30” or more at all equipment and connected piping. Code required clearance shall take precedence.

B. Install all valves, piping, and equipment with clearances to permit disassembly for maintenance purposes.

C. Provide ample space in equipment rooms for removal of coils, cooler tube, impellers and motor rotors, heat exchanger tubes, etc. Offset piping drops to allow removal and provide unions in piping where piping is to be disconnected. Show and label access space on construction drawings.

D. Provide permanent ladders and platforms with guard rails for service and maintenance for equipment mounted on platforms.
E. Provide catwalks and platforms for equipment located two feet or higher above ceilings.

F. Locate all equipment requiring service 10 feet maximum above floor in mechanical rooms.

G. Provide access doors for all equipment located above inaccessible ceilings.

H. Provide restroom walk-in plumbing access doors with sufficient room (30” minimum) to access plumbing piping in the chase between restrooms.

I. Provide sufficient room to adequately hold the required attic stock. Mechanical rooms or spaces are not considered attic stock rooms.

J. Minimize rooftop equipment where possible to reduce roof damage and access requirements.

K. Provide secure permanent rooftop access that will allow for equipment maintenance, repair and replacement.

L. Provide elevator access to all large mechanical rooms. Provide elevator access to all mechanical rooms located in basement or above the main floor.

M. Design all systems such that no equipment, ductwork, piping, conduit, etc. is required to be removed to service, repair, or replace equipment.

N. Locate larger ductwork, piping main, and VAV boxes in the ceiling space above corridors. Locate smaller piping and conduct in adjacent spaces where ceiling space in corridors is limited. Avoid using piping trapezes where access to piping and conduit is limited.

O. Avoid using fan powered boxes, fan coils, and other maintenance intensive mechanical systems.

P. Avoid using roof mounted piping. Use pre-manufactured pipe support systems where roof mounted piping is required for remodels and additions.

23 00 54 Energy Conservation

A. Major energy consuming systems and equipment shall be specified and purchased based on Life Cycle Cost Analysis including maintenance and customer service. Careful evaluation of energy conservation measures shall begin early in the design phase and continue throughout the design process. Include documentation of cost analysis in the basis of design.
B. Building functions that require twenty-four hour a day operation, such as laboratories, computer rooms, and others as defined by the Owner shall be served by a system separate from that of offices or classrooms that are subject to different operating schedules. Provide night setback on systems where possible.

C. Provide economizer cycle cooling that allows the use of outdoor air for free cooling during the winter and intermediate seasons without the use of mechanical refrigeration equipment. Provide humidity control when using water walls.

D. Provide a glycol loop heat recovery system on all central exhaust systems where 100 percent outside air is used.

E. Provide economizer cycle cooling that allows the use of outdoor air for free cooling during the winter and intermediate seasons without the use of mechanical refrigeration equipment.

F. Control all mechanical systems with the Building Automation System (BAS) and connect to the campus central automation system.

G. Provide high efficiency type three phase electric motors.

H. Design air handlers and pumps to be variable volume with variable frequency drives (VFD) to optimize energy efficiency.

I. Select fans and pumps with the highest available efficiency. Evaluate the equipment efficiency after all components of the system have been determined.

J. Size the insulation thickness for chilled water, hot water, steam, and condensate for optimum cost and efficiency rather than code minimum. Provide life cycle economic evaluation of the insulation system.

K. Select cooling towers with fan motors equipped with variable frequency drives (VFD) to allow for energy efficient capacity control.

L. Design variable volume hydronic systems with two-way valves to prevent energy waste.

M. Provide an energy evaluation for the selection of all major equipment including boilers, chillers, air handlers, and heat exchangers. Evaluate the mechanical systems energy efficiency at full and part load conditions.
A. Design new mechanical equipment rooms to have access from the outside, via an opening large enough to facilitate the removal of the largest piece of equipment therein. Access through classrooms, restrooms, etc. is not acceptable. Provide access by truck to equipment rooms where possible through an outside door. Provide areaway equipment access where mechanical rooms are located in basements.

B. Locate all major mechanical equipment within mechanical equipment rooms. Size rooms large enough to allow proper servicing of equipment, allow for future growth, and include access for replacement of all mechanical equipment.

C. Locate mechanical equipment rooms to protect the surrounding areas from equipment generated noise. If sensitive spaces exist above or adjacent to a mechanical room, provide acoustic insulation. Do not locate noisy equipment near or above occupied spaces.

D. Design the layout of equipment within a mechanical equipment room to allow access to all equipment components, including pulling tubes for converters, chillers, and air-handling unit coils. Three feet minimum is required for access to filters, dampers, and valves and as a separation between equipment. Provide lifting eyes in equipment rooms with heavy equipment and where equipment is located above the ceiling.

E. Provide 4” minimum height concrete equipment pads for all major mechanical equipment. Extend the pad 6 inches larger on all sides of the equipment and provide 1” beveled edges. Coat equipment pads in mechanical rooms above the main level with water proof coating prior to setting equipment.

F. Provide storage space in mechanical equipment rooms for air filters, and miscellaneous maintenance items storage. Designate the storage space above the equipment room floor on curbs.

G. Coordinate mechanical equipment rooms to have sufficient lighting that is not obstructed by ductwork or piping. Use column and wall-mounted lighting where necessary. Refer to USU Electrical Design Requirements.

H. Provide mechanical equipment rooms with sufficient duplex convenience outlets suitable for operating small tools and drop cord trouble lights. Refer to USU Electrical Design Requirements.

I. Provide a hose bib in the mechanical equipment room for maintenance and wash down purposes.
J. Provide curbs around the perimeter of mechanical equipment rooms located above the lowest floor to prevent flooding to adjacent spaces.

K. Provide all mechanical equipment rooms with adequate ventilation and temperature control designed to prevent temperature buildup.

L. Mechanical equipment rooms shall not be used as return/relief air plenums.

M. Paint mechanical equipment room floor and housekeeping equipment pads with waterproof coating prior to placing equipment.

N. Locate main information technology (IT) communication rooms near the main mechanical room.

O. Construct mechanical equipment rooms to reduce transmission of sound, vibration, odor, and water to other parts of the building.

23 01 00 General HVAC Requirements

A. Connect new building heating and cooling systems on the central campus to the central steam & condensate and chilled water distribution systems through the existing utility tunnel system. Extend main and branch tunnels as required for building connections. See Division 33 for tunnel requirements. Coordinate all central utility connections with Facilities Design & Construction.

B. Steam and Condensate: Medium pressure steam is distributed from the Central Energy Plant (CEP) through a tunnel system. Some areas of campus have direct buried steam and condensate piping. Install a new steam PRV station in each new building. The steam pressure is currently operating at 85 psig. Design of new steam systems shall be for 150 psig for the building and 300 psig for the tunnel utility system.

C. Chilled water: Chilled water is distributed from the central energy plant (CEP) through the tunnel system using a distributed pumping system. The chilled water supply temperature to buildings is currently 44 deg F. New buildings should be designed for 16 deg F temperature change. Design new building chilled water pumps for the new building piping head requirements and the tunnel piping back to the central energy plant (CEP). The chilled water pressure at the CEP is currently operating at 80 psig.

D. Redundancy: Provide redundancy on all major equipment serving the heating system for the building including boilers, pumps, heat exchangers, etc. Provide redundancy on all major equipment serving critical cooling systems such as data centers and BSL laboratories.
E. Noise and vibration: Locate fans, pumps, and all other equipment away from auditoriums, classrooms, conference rooms, offices, and laboratories. Provide vibration isolation on all fans and pumps. Select equipment for the proper noise criteria. Avoid using 3400 rpm motors where possible. Provide sound attenuators, lined duct, flexible connections, and equipment isolators to reduce noise and vibration in all sensitive areas.


G. Specify all variable frequency drives (VFD) in the electric section of the specifications. Refer to the USU AE design manual.

H. Do not locate mechanical equipment, piping, or plumbing in electrical transformer rooms or in adjacent walls.

I. Pressure test and seal all new and existing ducts in retrofit and remodel projects.

J. Schedule all utility shutdowns 7 days in advance.

23 05 00 Common Work Results for HVAC

A. Replace or repair damage to any existing building where repair or replacement work is performed by a contractor. Provide photo documents of the remodel area prior to start of construction.

B. Schedule a representative of the university to be present when tests on HVAC systems are conducted.

C. Flush, chemically clean & circulate, and pressure test all hydronic and steam piping systems.

D. Provide an appropriate method of filling and draining down each hydronic system. Provide all automatic air vent valves shall be accessible.

E. Extend all drains to floor drains and floor sinks. Provide drain lines that are not routed across walkways.

23 05 13 Common Motor Requirements for HVAC Equipment

A. Provide high efficiency non-overloading VFD rated motors with and ground brushes to protect from transient voltage. Refer to USU Electrical A/E Design Manual.
23 05 19 Meters and Gages for HVAC Piping

A. Steam Meter: Provide Onicon vortex totalizing type steam meter in each building monitored by the campus automation system and a local display.

B. Chilled Water Meter: Provide a chilled water meter on all chilled water systems monitored by the campus automation system. Provide Onicon insertion turbine type meter with temperature sensors and a local display that reads out BTU's, gallons, BTU/hr, gpm, CHW Supply Temperature, and CHW Return Temperature.

C. Provide liquid filled type thermometers. Provide 3" min. dia. metal cased pressure gauges.

D. Provide pressure gauges and thermometers on entering and leaving sides of boilers, chillers, cooling towers, heat exchangers, and pumps.

23 05 23 General-Duty Valves for HVAC Piping

A. Provide accessible shut-off valves in the main piping for isolation purposes. Provide accessible shut-off valves at all branch piping from main.

B. Provide valves listed and rated for intended use.

C. Provide a valve near the main in all branch lines that supply more than one outlet or unit. Provide a union next to the outlet side of the valve.

D. All valves larger than two (2") inches shall be flanged.

E. Provide 250 psig flanged and 300 psig threaded valves for steam valves above 50 psig.

F. Provide a separate shut-off valve upstream of the balancing or triple duty valve. Don’t use balancing or triple duty valves as shut-off valves. Provide a shut-off valve at each VAV box reheat coil.

23 05 29 Hangers and Supports for HVAC Piping and Equipment

A. Provide rust resistant steel hangers, supports, rods and accessories.

B. Provide hangers to accommodate full size insulation system.

23 05 33 Heat Tracing for HVAC Piping

A. Provide propylene glycol in hydronic heating and cooling piping systems where freezing can occur. Avoid using heat tracing for hydronic piping systems.
23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment


B. Provide requirement in contract documents to provide seismic design and installation for all piping, ductwork, and equipment.

23 05 50 Operation and Maintenance Manuals

A. Provide 1 hard copy for use by USU.

B. Provide an electronic file of the complete O&M in PDF format. Include hyperlinks.

C. Provide red buckram binders with easy-view for size 8-1/2 x 11 inch sheets, with expandable capacity from 2 inches to 3-1/2 inches as required by the project. The front cover and backbone shall be foil stamped in white as follows:

OPERATING AND MAINTENANCE MANUAL
FOR THE

(INsert Project Name)

YEAR

VOLUME No. ( )

(INsert Mechanical Engineer)
MECHANICAL ENGINEER

(INsert Architect)
ARCHITECT

D. Provide an index sheet typed on AICO Gold-Line indexes in the front of the binder. The manual shall include the following:

1. SYSTEM DESCRIPTIONS AND BASIS OF DESIGN
2. START-UP PROCEDURE AND OPERATION OF SYSTEM
3. MAINTENANCE AND LUBRICATION TABLE
4. OPERATION AND MAINTENANCE BULLETINS
5. AUTOMATIC TEMPERATURE CONTROL SEQUENCE OF OPERATION, DESCRIPTION OF OPERATION, INTERLOCK AND CONTROL DIAGRAMS, AND CONTROL PANELS
6. AIR AND WATER SYSTEM BALANCING REPORTS
23 05 53 HVAC Piping and Equipment Identification

A. Pipe Identification:

1. Label and color code all pipes with contents clearly identified and arrows indicating direction of flow. This applies to piping run above the ceilings and in pipe tunnels as well as pipe exposed in equipment rooms and finished areas. Identify pipes at the following locations:

   a. Adjacent to each valve.
   b. At every point of entry and exit where piping passes through a wall or floor.
   c. On each riser and junction.
   d. A maximum of every fifty feet (50') on long continuous lines fully exposed to view.
   e. Adjacent to all special fittings or devices (regulating valves, etc.).
   f. Connection to equipment.
   g. Apply markers so they can be read from the floor.

2. Provide all temperature self-sticking permanent labels and markers as manufactured by W. H. Brady Co., 727 West Glendale Ave., Milwaukee, Wisconsin; or Seton Name Plate Corp., 592 Boulevard, New Haven, Connecticut.

3. Provide uniform pipe jacket color-coding throughout the campus and match new systems with existing systems. Provide background colors shall be as follows:

   - Black: Dangerous Materials (high pressure steam, natural gas, condensate, high pressure refrigerant, high voltage, etc.)
   - White: Fire Protection Equipment (Fire Sprinkler Water, Fire Protection Water)
   - White: Protective Materials (Filtered Water)
   - White: Safe Materials (Chilled Water, Cold Water, Instrument Air, Sanitary Sewer, etc.)

4. Provide identification letters two inch (2") high for pipes three inch (3") and larger, and one inch (1") high for pipes two and one-half inches (2 1/2") and under.
B. Duct Identification:

1. Identify all ducts exposed in mechanical equipment room. A sample duct identification is as follows: "Supply Hot Duct-Heating Auditorium Wing."

C. Equipment Identification:

1. Identify all mechanical equipment and all other devices with signs made of laminated plastic with one-eighth inch (1/8") or larger engraved letters. Attach signs securely with rust proof screws or some other permanent means (no adhesives).

2. Include the following information on the equipment identification sign: name of equipment, identification on plans and schedules, design capacity and any other important data not included on factory attached name plate.

3. Attach signs to equipment so they can be easily read. Attach using screws or rivets.

4. A sample identification sign for equipment is as follows:

   "Supply Fan - Auditorium F-2
   Capacity: 49,850 cfm @ 3.5" s.p. (at 4775 ft. elev.)"

   "Heating Hot Water Pump
   Classroom Area
   156 gpm @ 57 ft. head"

D. Removable Ceiling Tile:

1. Provide identification on the lay-in tile tee bar ceiling where valves, mixing boxes, fire dampers, adjustment controls, etc. are located above ceiling tile. Indicate the tile to be removed for access to a particular item.

23 05 93 HVAC Testing, Adjusting, and Balancing

A. Balance all air and water systems upon completion of work. Approved test and balance contractors are: BTC Services, Inc., Certified Test and Balance, Quality Test and Balance, and Danis Test and Balance. Other balancing contractors need to be approved by USU prior to bid.

B. The test and balancing agent shall AABC or NEBB certified.

C. The test and balancing agent shall be contracted directly by the mechanical contractor.
D. The test and balance report shall be completed, submitted, reviewed and corrected prior to building occupancy.

E. The test and balance agent shall be present at the final completion inspection and be prepared to provide random air balance verification testing.

F. Document mechanical system set points such as duct static differential pressure and hydronic system fill pressure in the balancing report.

23 07 00 HVAC Insulation

A. Provide protective jacket in exposed areas and areas subject to damage including mechanical rooms.

B. Insulate all main steam valves, expansion joints, pressure reducing valves, pump traps, heat producing pipe, fittings, and devices.

C. Paint chilled water pumps and components that are not insulated with condensate resistant paint prior to filling the chilled water system.

D. Provide aluminum insulation jacket with stucco finish for all steam and condensate piping systems.

E. Provide equipment insulation blankets temperature rated for equipment application.

F. Provide color coded insulation PVC jacket for all piping systems. The following is the USU mechanical and plumbing insulation jacket color code:

- Heating Hot Water: Yellow
- Chilled Water: Blue
- Condenser Water: Light Blue
- Steam: Aluminum Jacket
- Condensate: Aluminum Jacket
- Glycol (Heating): Yellow
- Domestic: Green
- Industrial: Brown
- Roof Drainage: White
- All Other: White

23 08 00 HVAC Commissioning

A. Complete all mechanical systems commissioning and complete, submit, review, and correct the commissioning report prior to building occupancy. Verify that all systems are fully commissioned and coordinated with all trades.
B. The Owner considers the following elements as a minimum requirement for building acceptance and inherently integral to the Mechanical Designer responsibilities, unless specifically notified otherwise by the Owner.

1. Installation Verification
2. Startup and Checkout
3. Performance Testing and Demonstration
4. Training
5. Closeout

The Designer will include in bid documents the specific support and documentation required of the General, Mechanical, Electrical, Plumbing, and Controls Contractors, Designer, Owner and others as applicable to ensure acceptable commissioning.

23 09 00 Building Automation System

A. Approved building control system manufactures and installers:

1. Johnson Controls
2. TAC Controls installed by Utah Controls

B. Connect all HVAC control systems into the campus central automation system.

C. Coordinate all user interface layout and all details of the control system with USU Facilities Operation.

D. Zone the temperature controls of all major rooms to be individually controlled, as much as practical. Group rooms of similar use and orientation as a zone when required for economical purposes.

E. Replace pneumatic control systems with direct digital control systems when existing systems are modified.

F. Verify complete operation of existing systems where new systems connect or affect an existing system.

G. Coordinate the location of all controls to avoid conflicts with furnishings or uses for the rooms in which controls are located.

H. Provide controls for outside air economizer cooling to be used for building air conditioning requirements when possible.

I. Avoid mounting any control equipment on vibrating surfaces.

J. Physically verify all control valves and devices operate correctly to ensure they are installed, wired, and programmed properly.
K. Install all control wiring in color coded conduit. Color code all wiring for input/output. Local controllers shall be stand-alone type. Indicate what devices are on emergency power or UPS. Indicate monitoring points for VFD’s. Provide all interface with fire alarm and smoke control systems.

23 10 00 FACILITY FUEL SYSTEMS

23 11 23 Facility Natural-Gas Piping

A. The central campus natural gas system is 5 psig used for cooking equipment, laundry facilities, and laboratory gas systems. The central campus natural gas system should not be used for building heating or domestic hot water heating.

B. Use 4 oz. or 2 psig. natural gas system pressure where natural gas piping is installed inside of a building.

C. Provide natural gas piping to be schedule 40 steel ASTM A53 with threaded fittings for 2” and smaller pipe and welded fittings for 2-1/2” and larger pipe.

D. Paint all exterior gas piping.

E. Provide exterior building shut-off valve outside of the building.

F. Provide automatic seismic actuated shut-off valve downstream of gas meter. Install valve anchored to building foundation as per manufacturer’s installation instructions.

23 20 00 HVAC PIPING AND PUMPS

23 21 13 Hydronic Piping

A. Hot Water Heating Systems:

1. Design for reversed return piping system so that the friction drop in piping is approximately the same for all radiation risers. Indicate any deviation from the standard two-pipe reversed return system with a system analysis to indicate reasons for change.

2. Provide air separators and expansion tanks for all hot water heating systems regardless of piping arrangement. Connect air separator into piping system on suction side of circulation pump. Use bladder type expansion tanks. Provide dirt and air separator.
3. Design hot water pre-heat coils to not exceed six feet per second water velocity. Design pre-heat coils for freeze protection using a propylene glycol system. Provide and install BTU meters.

4. Provide suitable air vents at all heat producing equipment (convectors, unit heaters, coils, etc.). Provide automatic air vents at high points of the system.

5. Provide a variable frequency drive (VFD) on the hot water heating system pump to minimize noise during periods of low demand.

6. Provide heating hot water piping to be schedule 40 black steel ASTM A53 pipe with threaded joints for piping 2" & smaller and welded joints for piping 2-1/2" & larger. Piping may also be copper. Weld piping located in inaccessible locations.

7. Grooved joint piping systems may be used only in mechanical rooms. Provide all USA made piping and fittings. Installers must be trained by the grooved joint piping system manufacturer. Approved grooved joint piping system manufacturers are:
   
   a. Victaulic
   b. Gruvlok
   c. Grinnell

8. Provide dielectric nipples rather than dielectric unions. If dielectric unions are needed, provide with Garlock Gylon gaskets.

9. Flush completed piping system with cold water. Chemically clean and circulate piping system as per water treatment provider’s recommendations. Drain and flush system after cleaning.

B. Chilled Water Systems:

1. Provide schedule 40 black steel chilled water piping with welded joints piping in the tunnel system.

2. Provide a separate cooling loop for all data, communication, and process systems.

3. Provide chilled water piping to be schedule 40 black steel ASTM A53 pipe with threaded joints for piping 2" & smaller and welded joints for piping 2-1/2" & larger. Piping may also be copper. Weld piping located in inaccessible locations.

4. Grooved joint piping systems may be used only in mechanical rooms. Provide all USA made piping and fittings. Installers must be trained by the grooved joint piping system manufacturer.
Approved grooved joint piping system manufacturers are:

a. Victaulic
b. Gruvlok
c. Grinnell

5. Direct bury chilled water piping shall be pre-insulated PVC piping with polyurethane insulation and HDPE jacket. All piping shall be buried with 4 feet minimum cover. Refer to the USU AE Utilities Design Manual.

6. Insulate all chilled water piping.

7. Flush completed piping system with cold water. Chemically clean and circulate piping system as per water treatment provider’s recommendations. Drain and flush system after cleaning.

23 21 23 Hydronic Pumps

A. Approved hydronic pump manufacturers:

1. Bell & Gossett
2. Armstrong
3. Taco

B. Install pressure gauges with gauge cocks and snubbers as close to pump suction and discharge as practical.

C. Dynamically balance all pumps by a certified balancer. Complete pump start-up by approved manufacturer representative.

D. Provide a variable frequency drive (VFD) on all chilled water and heating water pumps.

E. Provide isolation valves on the inlet and outlet lines. Provide strainer and flow measuring ports.

F. Provide 1750 rpm motors on pumps where possible.

G. Provide condensate resistant paint on all exposed chilled water pump and components.

H. Provide grounding brushes on chilled water pumps. Provide premium efficiency motors. Use brass and/or stainless steel pump impellers.
23 22 13 Steam and Condensate Heating Piping

A. Provide steam pipe that is exposed to ASTM 53 requirements and underground steam pipe to MSAT A106 requirements.

B. Provide schedule 40 black steel seamless steam piping. Provide schedule 80 black steel or schedule 10 stainless steel condensate return piping. Don’t use stainless steel in mechanical rooms.

C. Provide Gilsulate 500 XR thermal insulation and protection system for direct bury steam and condensate piping. See USU Utilities AE Manual.

D. Design for expansion of piping, using expansion loops, swing joints, offsets, etc., as may be required. Use expansion joints only in vaults when expansion loops, offsets, swing joints, etc. are not practical. When expansion joints are used, provide adequate internal or external guides, supports, and anchors. Do not use swing joints on main runs, but only on risers off the main. All systems shall be engineered and modeled by the design engineer.

E. Design steam mains to be properly dripped and sized. Provide drip legs ahead of all steam pressure reducing valves and steam coils to insure clean, dry steam at the valve.

F. All steam utility piping welds will be subject to weld testing. A minimum of 10% of the welds will be tested.

G. Pressure test steam piping to 1-1/2 times the working pressure. Pressure test condensate piping to 60 psig. and steam to 200 psig minimum.

H. Chemically clean and circulate steam and condensate piping for 48 hours minimum. Drain and flush system after cleaning.

I. Provide a full size steam blow down for 30 minutes minimum of all steam piping.

J. Locate the main steam valve inside the building at floor level. Do not locate the main steam valve in the tunnel.

K. Main steam valves shall have visual position indicators.

L. Extend safety relief discharge pipes inside the building to the building roof.

M. Design all steam piping components such as valves, steam traps, etc. within the building to be accessible.
N. Provide Garlock Gylon 3504 or spiral wound gaskets on all flanged valves. Do not use paper gaskets. Provide anti-seize treatment on all flange bolts.

O. Approved steam valve manufacturers:

1. Bray
2. DeZuric
3. Keystone
4. ABZ

23 22 23 Steam Condensate Pumps

A. Approved condensate pump manufacturers:

1. Spirax Sarco
2. Armstrong
3. Watson McDaniel
4. Kadant Johnson

B. Provide steam driven non-electric condensate pumps where feasible. Use seal-type electric pumps when necessary. Vent receiver to atmosphere through roof.

23 23 00 Refrigerant Piping

A. Seal and paint all exterior refrigerant pipe insulation.

B. Provide pipe stands, supports, and weather covers for all refrigerant piping 5 feet or longer.

23 23 23 Refrigerants

A. All new refrigerant installations shall be CFC free.

23 25 00 HVAC Water Treatment

A. The water treatment contractor currently contracted with USU shall be used for all new water treatment installations.

B. Maintain adequate water treatment in all hydronic and condenser water systems until the building is substantially complete.

C. Label all water treatment equipment and tanks. Indicate the glycol percentage on the label where applicable.
23 30 00 HVAC AIR DISTRIBUTION

23 31 13 Metal Ducts

A. Comply with SMACNA “HVAC Duct Construction Standards”

B. Use spiral wound round ductwork. Longitudinal seams are not acceptable.

C. Fiberglass duct board ductwork is not acceptable.

D. Pressure test 100% of high or medium pressure ducts and 25% of low pressure ducts.

23 32 00 Air Plenums and Chases

A. Outside air shall be ducted and insulated.

B. No plenums shall be used for outside or exhaust air.

C. Seal chase floors and provide method to drain floor.

23 33 00 Air Duct Accessories

A. Use lockable type balancing dampers.

B. Use turning vanes on all elbows 45 degree and larger.

C. Provide access for all balancing dampers, fire dampers, etc.

D. Connect smoke dampers to the building automation system (BAS).

23 34 00 HVAC Fans

A. Provide adequate service access of 30 inches minimum with access doors to all fans, motors, filters, coils, and all components. Provide 24” clearance around all air handlers. Provide adequate space for removing coils.

B. Use a variable frequency drive (VFD) for variable loads. Specify drives in the electrical section. Refer to USU Electrical AE Manual.

C. Use fan motors with 1750 rpm. Avoid using fans with 3500 rpm motors. Provide belt guards for all belt-driven equipment.

23 35 00 Special Exhaust Systems

A. Provide negative pressure exhaust systems.
B. Provide aluminum dryer vents according to dryer manufacturer recommendations.

23 36 00 Air Terminal Units

A. Approved air terminal unit manufacturers:

1. E.H. Price
2. Krueger
3. Titus
4. Phoenix

B. Avoid using fan powered boxes for classrooms, offices, and conference rooms.

C. Use quiet type pressure independent type fan powered boxes where fan powered boxes are used.

D. Provide 6 feet minimum of acoustically lined duct downstream of the air terminal unit prior to any branch take off.

23 37 00 Air Outlets and Inlets

A. Coordinate the fresh air intake and discharge openings of buildings so that no intake will receive air from the discharge opening of exhaust systems, cooling towers, emergency generators, service areas, or drain vents.

B. Do not route piping in fresh air intake ducts.

C. Avoid routing outside air through utility tunnels or unducted shafts to interior fan rooms.

D. Provide motorized building relief air dampers in lieu of gravity dampers.

E. Oversize outside air intake louvers to prevent hoar frost.

F. Locate supply air diffusers centrally in space.

G. Locate return air grilles for optimum efficiency and to minimize short circuiting.

H. Provide radial flow type supply diffusers properly located for critical environments.

23 38 13 Commercial Kitchen Hoods

A. Approved commercial kitchen hood manufacturers:
1. CaptiveAir
2. Greenheck

B. Provide adequate tempered make-up air for kitchen hoods.

C. All kitchen hoods must have approval by the USU Fire Marshal.

23 38 16 Fume Hoods

A. Provide chemical fume hood branch exhaust ducts constructed of 316 stainless steel with welded joints. Provide galvanized main exhaust ducts. Evaluate exhaust duct material based on the chemicals or contaminants being exhausted.

23 40 00 HVAC AIR CLEANING DEVICES

23 41 00 Particulate Air Filtration

A. Provide sectional filter banks over seven (7’) feet high with steel grating catwalk and ladder for access to upper sections.

B. Provide differential pressure gauges for all large filter banks over 2,000 CFM. Connect to the automation system.

C. Provide a pre-filter on all HEPA or bag filters.

D. Provide a complete set of filters after substantial completion, final cleaning, and building air purging and before building occupancy.

23 50 00 CENTRAL HEATING EQUIPMENT

23 52 00 Heating Boilers

A. Provide 60 percent minimum redundancy on all heating water boilers.

B. Provide adequate boiler turn down ratio to meet minimum summer operation.

C. Provide roof type boiler flues for all boilers. Sidewall stack options for high efficiency condensing boilers are not acceptable.

23 54 00 Furnaces

A. Provide high efficiency condensing type furnaces.

B. Allow adequate space for cooling coil installation.
23 57 00 Heat Exchangers for HVAC

A. Provide shell in tube heat exchangers for heating applications and plate & frame heat exchangers for chilled water and snowmelt applications. Provide DDC controls for heat exchangers in lieu of pneumatic controls.

23 60 00 CENTRAL COOLING EQUIPMENT

23 64 00 Water Chillers

A. Approved chiller manufacturers:

1. Carrier
2. Trane
3. York

B. Select chillers based on efficiency, part-load performance, maintenance and noise.

C. Provide motors five horsepower and larger power factor corrected to ninety-five (95) percent or greater. Power factor correction is required for all chiller load ranges.

D. Provide stand-alone type chiller control system to control by-pass valves, chilled water pumps, condenser water pumps and cooling tower. Interface chiller controls with USU campus automation system. A minimum list of points to be controlled shall include start, stop, enable, disable, entering chilled water temperature, leaving chilled water temperature, entering condenser water temperature and leaving condenser water temperature.

23 65 00 Cooling Towers

A. Approved cooling tower manufacturers:

1. Baltimore Air Coil (BAC)
2. Marley
3. Evapco

B. Screen completely roof mounted or ground mounted cooling towers. Design screening to be integral with the building design. Provide access ladders attached to each cooling tower for service and maintenance. Ladders shall be welded steel construction and galvanized.

C. Provide a non-freeze hose bib inside enclosure for cleaning and washing tower.
D. Provide adequate drainage inside tower enclosure to catch all spray, overflow and tower drain.

E. Provide a drainage sump rather than sump heaters for winter operation.

F. Provide a variable frequency drive (VFD) on cooling towers.

G. Provide water treatment for cooling tower as recommended by USU’s water treatment provider.

H. Consider using ceramic cooling towers on larger sizes.

I. Consider using indirect/direct evaporative cooling where a cooling tower is required.

**23 70 00 CENTRAL HVAC EQUIPMENT**

23 73 23 Custom Air-Handling Units

A. Custom Air Handler Manufacturers shall meet the minimum requirements with-in this guideline and be able to demonstrate compliance. The following manufacturers have been determined to comply, others seeking approval shall demonstrate compliance to the owner satisfaction and obtain written prior approval.

1. Temtrol
2. Hunt air
3. Governair
4. Ventrol
5. Climate Craft
6. Unitech
7. Energy Labs
8. Pace Custom

B. Units shall be listed and labeled by ETL or UL. Any unit shipped to the site without an ETL or UL label shall be field certified and labeled at no extra cost to the owner.

C. Fans shall be AMCA certified and bear the appropriate AMCA seal for sound and air performance. All fans shall have inlet safety screens.
D. Where multiple plenum fans in are utilized in parallel as a multiple fan system, individual fans shall have been specifically designed for multiple fan applications and bear the AMCA seal for sound and air performance. Manufacturers of multiple fan systems shall have in-house engineering support and have manufactured such fans for a minimum of three years and must have a minimum of ten working installations that have been in operation for at least two years. A blank-off panel shall be provided properly sized to temporarily blank-off a fan that is not functional or needs to be removed for service. Fans with zero pressure drop isolation dampers do not require a blank-off panel. Multiple fan installations must have at least two fans and have individual motor size not exceeding 10 HP. Each fan/motor shall have a shaft grounding ring or ceramic bearings. The multiple fan system shall meet the minimum sound scheduled in each octave band.

The following manufacturers have been determined to comply with the general requirements listed, others seeking approval shall demonstrate compliance to the owner’s satisfaction and obtain written prior approval.

1. Hunt air
2. Climate Craft
3. Twin City

E. Casings shall be constructed to meet the current energy code and shall meet the following criteria:

1. Deflection at 1.33 x the specified design condition shall be L/240 maximum. Submittals shall contain calculations or testing showing compliance signed by the manufacturer.
2. Air leakage shall not exceed 1% of maximum scheduled cfm at 1.33 x the specified design condition. Factory testing of the largest unit for the project that can be shipped as a single unit to the jobsite is required and shall be submitted. If there are no units that can be shipped as a single unit then one selected unit shall be factory tested. If lead time or some other circumstance doesn’t allow for factory testing a field test shall be conducted at no extra cost to the owner to demonstrate compliance.
3. Manufacturer’s standard finish is acceptable for indoor units unless otherwise specified. Outdoor units shall be weather tight and have an appropriate finish designed for long term corrosion resistance meeting or exceeding (ASTM B-117) Salt Spray Resistance at 95
degrees F 2500 hours and (ASTM D-2247) Humidity Resistance at 95 degrees F 2500 hours.

4. Doors shall be provided for each section and be adequately sized for the purpose they serve. Doors for the fan section of multiple fan systems shall be of adequate size to get an individual fan assembly out for replacement. Door handles shall be demonstrated to be durable. Doors shall have a wire reinforced or tempered glass double pane observation window. Doors shall swing against pressure.

5. Units that are required to ship in multiple sections shall be assembled per manufacturer’s instructions under the direction of a factory authorized representative. A field report signed by the manufacturer shall be provided.

F. Unit bases shall be constructed of structural steel members and be fully welded. Floors shall be adequately reinforced to support routine maintenance without oil canning. Floors shall have water tight collars around all openings and be factory water leak tested. Test reports shall be submitted.

G. Variable Frequency Drives are to be specified by electrical. Refer to USU Electrical A/E manual.

H. Coils shall have minimum 0.035” tube thickness with minimum 0.008” fin thickness. Coil U- bends shall be brazed. Coils shall be hydrostatically tested at the factory. Drain pans for cooling coils shall be type 316 stainless steel and slope ¼” per foot to the drain connection. Drain connections shall be at low point such that all water drains completely.

I. Filters shall be MERV 13.

J. Lights, switches and convenience outlets shall be factory wired.

K. Dampers shall be Ruskin CD 50, Greenheck VCD-43 or Tamco Series 1000. Maximum blade length shall be 48”.

L. The unit manufacturers factory authorized agent shall provide field quality control reports prior to unit start-up and again 30 days after substantial completion.

M. Direct Evaporative Cooling sections shall be designed with velocities to minimize pressure drop and prevent moisture carry over. Cooler
housing shall be 16 gage type 304 stainless steel. Sump shall be 10 gage type 304 stainless steel with water tight all welded corners and shall slope ¼” per foot to the drain connection. Drain connection shall be at the low point such that all water drains completely. A factory flow indicator shall be provided in the pump discharge line for easy observation of proper water flow. All piping in the airstream shall be copper. The GFI outlet shall be located to not have nuisance trips from splashing water.

N. Locate the air handler outside air intake at the top of the unit and the return air in the back of the unit to avoid stratification in the air handler.

23 74 00 Packaged Outdoor HVAC Equipment

A. Approved rooftop air conditioner manufacturers:

   1. Carrier
   2. Trane
   3. York

B. Packaged rooftop air conditioners are not approved for use on the central campus.

23 76 00 Evaporative Air-Cooling Equipment

A. Provide daily drain down on direct evaporative cooling.

23 80 00 DECENTRALIZED HVAC EQUIPMENT

23 81 23 Computer-Room Air-Conditioners

A. An APC in-row chilled water cooling system is currently used for the central campus data center.

23 81 26 Split-System Air-Conditioners

A. Approved split-system air-conditioner manufacturers:

   1. Carrier
   2. Mitsubishi
   3. Fujitsu

B. Use chilled water fan coils where feasible on the central campus.

23 82 16 Air Coils

A. Use propylene glycol where preheat coils are subject to freezing.
B. Avoid using steam heating coils. Where steam coils are required, use face & bypass coils rather than claim shell type.

C. Provide a drip pan under each section of every cooling coil on which moisture may collect. Extend drip pan at least twelve (12”) inches beyond coil.

D. Provide thermometer and pressure gauges on entering and leaving side of all major coils. Provide gauge cocks on entering and leaving side of all coils that do not have pressure gauges.

E. Design all coils to have enough slope to drain completely.

23 82 36 Finned-Tube Radiation Heaters

A. Design finned tube radiation heaters to have adequate clearance for balancing and maintenance. Coordinate furniture layout to allow adequate airflow through the finned tube heater.

23 82 39 Unit Heaters

A. Provide a gas-fired unit heater in the mechanical room where natural gas is available to prevent freezing during a building shutdown.

23 83 00 Radiant Heating Units

A. Use ceiling radiant heat panels where furniture blocks the use of finned tube radiation.

Revision Log:

7/7/14: Avoid VFD’s outside, avoid rooftop piping, mechanical room elevator access, delete ceramic bearings, 1 hard copy & 1 electronic copy of O&M manual, include hyperlinks, insulation jacket colors, test & balance contractors, ATC control revisions, hydronic piping flush and treatment, chilled water pump revisions, steam valve gaskets, condensate pump revisions, duct pressure tests, kitchen hoods, and custom air-handling units