

HEATING VENTILATION AND AIR CONDITIONING DIVISION 23 00 00

Section 23 00 00 Heating, Ventilation, and Air Conditioning

1. GENERAL

1.1. Campus Hydronic Heating and Chilled Water Description

- 1.1.1 The campus has three central plants located in the Computer Science Building (CP2), The Student Center (CP1) and the Clarke Building (CP3).
- 1.1.2 CP1 and CP3 use ground source Heat Recovery Chillers to provide both heating and cooling simultaneously. This is done using an open well system.
- 1.1.3 Plant distribution temperatures are as follows:
 - (A) Hydronic Heating Water: (Winter)
 - (i) 110F Leaving Water Temp
 - (ii) 75F Entering Water Temp
 - (B) Hydronic Heating Water: (Summer)
 - (i) 75F Leaving Water Temp
 - (ii) 70F Entering Water Temp
 - (C) Hydronic Chilled Water: (Summer)
 - (i) 45F Leaving Water Temp
 - (ii) 55F Entering Water Temp
 - (D) Hydronic Chilled Water: (Winter)
 - (i) 65F Leaving Water Temp
 - (ii) 55F Entering Water Temp

1.2. Campus Central Plant Use

- 1.2.1 Where feasible any new building or remodeled building near the campus hydronic loops shall use the campus central plant system.
- 1.2.2 Any building not being supplied by the campus hydronic system shall be approved by the UVU HVAC Lead.

1.3. Workmanship

- 1.3.1 HVAC work performed for Utah Valley University must be executed in a professional manner. Careful consideration should be taken to minimize the disruption of campus operations while performing work during normal operating hours.
- 1.3.2 Mechanical Contractors hired to perform work for Utah Valley University are required to have at least one Journeyman, currently licensed by the state of Utah on site at ALL times while work is being performed

1.4. Deviations for Standards

- 1.4.1 Any deviation from these standards can be allowed if written permission is obtained from ALL of the following individuals:
 - (A) UVU Construction Project Manager – Changes per Project
 - (B) UVU Sr. Director of Engineering
 - (i) Kurt Baxter

- (a) kbaxter@uvu.edu
- (b) 801.863.5619
- (C) UVU Assistant Director Physical Plant
 - (i) Scott Draper
 - (a) jdraper@uvu.edu
 - (b) 801.863.8185

1.5. Temporary Use of HVAC Equipment

- 1.5.1 Building equipment shall not be used to maintain building temperature during construction unless written permission is given by the UVU HVAC Manager.
 - (A) When the contractor is permitted to use the heating and ventilating system during the course of construction, he shall operate the equipment in accordance with manufacturer recommendations. This shall consist of properly treating water, maintaining filters, cleaning traps and screens, lubricating bearings and all other instructions from the manufacturer.

1.6. Mechanical Room Layout

- 1.6.1 Room shall be of adequate size to allow a clearance of 36" around equipment for maintenance.
- 1.6.2 All concrete floors located in mechanical rooms shall slope to floor drains. Clean all concrete floors thoroughly and seal.
- 1.6.3 Allow additional space for tube replacement, tube cleaning, coil removal, etc.
- 1.6.4 Provisions shall be provided to allow equipment replacement.

1.7. Materials and Equipment

- 1.7.1 All HVAC and Mechanical materials and equipment (pumps, valves, chillers, boilers, AHU, FCU, VAV, etc.) must be NEW. Re-furbished or re-purposed materials and equipment of any kind is not acceptable. Utilization of existing, unused materials and equipment must be approved by the UVU Assistant Director Physical Plant.
- 1.7.2 New equipment in stock at supplier that has been discontinued or end of lifed by the manufacture is not acceptable. All parts must be currently supported products.

1.8. Applicable Codes and Standards

- 1.8.1 The most recent of any code adopted by the state of Utah (DFCM) shall be followed. The most recent handbook of the standards referenced here-in shall be followed.
 - (A) International Mechanical Code
 - (B) IBC – International Building Code
 - (C) International Fire Code
 - (D) Internal Energy Conservation Code OR ASHRAE 90.1
 - (E) State of Utah High Performance Building Standard
 - (F) ASHRAE Standards (most current version)
 - (i) 62.1-Ventilation for Acceptable Indoor Air Quality

- (ii) 188 – Legionellosis: Risk Management for Building Water Systems
- (iii) 55-Thermal Environmental Conditions for Human Occupancy
- (iv) 15-Safety Standard for Refrigerant Systems
- (v) 34-Designation and Safety Classification of Refrigerants
- (G) ASHRAE Handbooks (All four volumes)

1.9. Interruption of Existing HVAC Service

- 1.9.1 Do not interrupt HVAC service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary HVAC service according to requirements indicated:
- 1.9.2 Notify Owner no fewer than 10 working days in advance of proposed interruption of HVAC service
- 1.9.3 Do not proceed with interruption of electric service without Owner's written permission.
- 1.9.4 To gain permission please provide the following to the UVU Construction Project Manager, UVU Sr. Director of Engineering, and UVU Assistant Director Physical Plant (contact information is outlined under Deviation of Standards):
 - (A) Date and Time of interruption
 - (B) Duration of Interruption
 - (C) Equipment associated with the interruption
- 1.9.5 Interruptions shall only be approved for Sundays and during the week between 10:00 PM and 6:00 AM.

2. PRODUCTS

- 2.1. None

3. EXECUTION

- 3.1. Install all free-standing equipment on a 4" thick concrete housekeeping pad. This shall include pumps, AHU, expansion tanks, Glycol feed stations, chillers, boilers, floor mounted fan coil units, etc. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported
 - 3.1.1 For AHU systems with an Operating Pressure of greater than 3.5 in.w.c. provide a 6" thick concrete housekeeping pad.
- 3.2. Follow equipment manufacturer's current written anchorage recommendations and setting templates for anchor-bolt and tie locations unless otherwise indicated. Anchor equipment to concrete base.

Section 23 01 00 Operations and Maintenance

1. GENERAL

1.1. None

2. PRODUCTS

2.1. Digital Copy only .PDF

3. EXECUTION

3.1. Valve Location Plaque

3.1.1 For new buildings and building wide HVAC modifications. Contractor shall provide a laminated valve location (full size of drawing) and locate in the main mechanical room. Verify location with the owner.

(A) Plaque shall include:

- (i) Location to shut down each floor and building hydronic heating and chilled water.
- (ii) Location of each terminal device.

3.2. Operations and Maintenance Manuals will include final shut-off valve locations shown on 11x17 PDF drawings.

3.3. HVAC Equipment Access

3.3.1 Access shall be provided a minimum of 24" x 24" in front of all VAV, in-line exhaust fans and any other concealed equipment.

3.3.2 Equipment shall not be located higher than 30" above hard lid ceilings and dropped ceilings.

3.3.3 Equipment shall not be located above permanently installed tables or furniture.

3.3.4 24 x 24 access doors shall be provided where equipment is located above hard lid ceilings.

3.3.5 **Minimum clearances around equipment from any permanent installed fixture.**

Section 23 05 13 Common Motor Requirements for HVAC Equipment

1. GENERAL

1.1. None

2. PRODUCTS

2.1. All motors shall be Premium Efficient as defined by the most recent standard National Electric Manufacturer Association.

2.2. Variable Frequency Drives

2.2.1 Variable Frequency Drives shall be provided by the mechanical contractor and installed by the electrical contractor. The mechanical engineer of record shall define this in specifications and reference requirements in specifications Division 26; however, the actual specification for VFD shall be defined in Division 26 by the electrical engineer of record.

2.2.2 Manufacturers: ABB, Mitsubishi, Yaskawa, Schneider, and Franklin

2.2.3 All VFD shall have a manual bypass to bypass the VFD. There needs to be a bypass status tied to the BMS so we know when a VFD has been bypassed. Also a bypass indicator lamp on the drive enclosure.

2.2.4 Harmonic Filters shall be provided for VFD 5 HP and larger. Harmonic Filters shall keep Voltage and Amperage Harmonic to a Total Distortion of 5% or less as measured at the input terminals. (Total Harmonic Distortion)

3. EXECUTION

3.1. None

Section 23 05 19 Meters and Gages for HVAC

1. GENERAL

1.1. None

2. PRODUCTS

2.1. Pressure Gages

2.1.1 All HVAC pressure gauges will be oil filled, 4" diameter, bourdon type gages. Pressure gages shall include isolation of the pressure gage with a general duty valve.

2.1.2 Pressure range for the gages will be the following:

(A) 0-100 psi for gages located after pumps, at expansion tanks and located before and after air separators with strainers.

(B) -30 in Hg – 100 psi for gages located before pumps or where only a single pressure gage is used on a pump.

(C) Where a single pressure gage is used a 1/2" pipe shall be located on the suction side of the pump and suction diffuser and located at the discharge of the pump.

2.2. Thermometers

2.2.1 All HVAC a 9" Thermometers mercury free liquid in glass with an adjustable angle Provide 2" extension where piping is insulated.

2.2.2 Thermometers ranges shall be as follows:

(A) Chilled Water. Range 0-100F

(B) Condenser Water. Range 0-150F

(C) Heating Water. Range 30-240F

2.3. Provide a digital water meter for makeup water feeding fill valves for Direct Evaporative Media and Cooling Towers.

2.4. Pressure and Temperature Ports (PETE Plugs, PT Ports)

2.4.1 Provide a 1/4" NPT plug with ability to insert a 1/8" diameter probe.

2.4.2 Provide extension pieces where insulated.

3. EXECUTION

3.1. Thermometers shall be located as follows:

3.1.1 Entering and Leaving side of AHU coils (AHU greater than 5,000 CFM)

3.1.2 After Pumps

3.1.3 On leaving and entering side of the following:

(A) Heat Exchangers (both source and load side)

(B) Chillers

(C) Boilers

3.2. Pressure Gages shall be located as follows:

- 3.2.1 Before and after pumps as near to the suction and discharge as possible.
- 3.2.2 Before and after suction diffusers.
- 3.2.3 Next to expansion tanks.
- 3.2.4 On leaving and entering side of the following:
 - (A) Heat Exchangers (both source and load side)
 - (B) Chillers
 - (C) Boilers
- 3.2.5 On the primary loop at each building tie in.

3.3. Provide Pressure and Temperature ports at the inlet and outlet of:

- 3.3.1 Every hydronic coil (including VAV, FCU, CUH, UH, every hydronic coil)
- 3.3.2 Heat Exchanger, both sides.
- 3.3.3 Chiller
- 3.3.4 Boiler
- 3.3.5 Pumps
- 3.3.6 Air Separators

3.4. PT Ports shall be located as near to the coil as possible with no fittings, valves, or circuit setters in-between the coil and PT port and no more than 12" of pipe.

Section 23 05 23 General-Duty Valves for HVAC Piping

1. GENERAL

1.1. None

2. PRODUCTS

2.1. Valve Type

- 2.1.1 2" and Smaller: Use a Ball valves with stainless steel balls. Where valve is installed in insulation provide an extension on the stem.
- 2.1.2 2 -1/2" and larger Butterfly/Ball Valves: All butterfly valves shall have EPDM seat, stainless steel disc, lug body, and appropriate operator. This applies especially to seat and seal materials. Any potential vendor shall be approved in advance by the Owner.
- 2.1.3 Valves located in insulation will have extension stems appropriate for the thickness of insulation.

3. EXECUTION

3.1. HVAC Isolation shall be provided at various level of isolation:

3.1.1 Building Isolation

(A) Where Chilled or Hot Water enters the building an isolation valve shall be provided to isolate the building while allowing water to flow to buildings attached further down the Chilled Water and Hot Water system.

3.1.2 Floor Isolation

(A) Where Chilled or Hot Water comes from a chase to feed a floor an isolation valve shall be provided to isolate the floor while allowing water to flow to other floors attached further down the hydronic water system.

3.1.3 HVAC Equipment Isolation

(A) All HVAC equipment including, pumps, storage tanks, expansion tanks, water heaters, heat exchangers and coils shall be provided with isolation valves for the individual piece of equipment. Equipment shall not be grouped together for isolation but must be individually isolated.

Section 23 05 33 Heat Tracing for HVAC Piping

1. GENERAL

1.1. Heat tracing shall be provided on all HVAC water piping that is expected to operate between Oct 15th and Apr 15th on the exterior of the building.

2. PRODUCTS

2.1. None

3. EXECUTION

3.1. Heat Tracing shall be tied to BMS with a current switch to show when it is operating.

Section 23 05 53 Identification for HVAC Piping and Equipment

1. GENERAL

1.1. None

2. PRODUCTS

2.1. Engraved Laminated: Acrylic or Melamine Label: Adhesive backed with white lettering 3/8" high. Back shall be black for normal power and red for emergency power. Labels shall be punched or drilled and mounted with screws.

2.2. Piping Label: Use UV resistant Outdoor Grade 3.2 mil thick high gloss adhesive backed vinyl film.

2.2.1 Tape shall be applied on both ends with the same color as the marker with 1" of cover over the label and 1" cover of the pipe or insulation.

2.3. Valve Tagging: Use 2" round brass 20 gage type tags with #6 brass beaded chain.

3. EXECUTION

3.1. Labeling of Equipment

3.1.1 All HVAC equipment shall be labeled using engrave nameplates with black background and white lettering.

3.1.2 HVAC equipment on emergency power or generator power shall be labeled using engrave nameplates with red background and white lettering.

3.2. HVAC piping shall be labeled with pressure sensitive markers per color and naming scheme below:

3.2.1 Chilled Water Supply: Label shall read CHWS and label shall be yellow.

3.2.2 Chilled Water Return: Label shall read CHWR and labeled yellow with white striping.

3.2.3 Hot Water Supply: Label shall read HWS and labeled red.

- 3.2.4 Hot Water Return: Label shall read HWR and labeled orange.
- 3.2.5 Cooling Tower Water Supply: Label shall read CWS and labeled green.
- 3.2.6 Cooling Tower Water Return: Label shall read CWR and labeled green.

3.3. All HVAC piping shall be labeled at the following locations:

- 3.3.1 Entering and Exiting a wall, whether the wall is sheet rock to the deck or not.
- 3.3.2 Label next to each isolation valve.
- 3.3.3 Label next to each piece of HVAC equipment.
- 3.3.4 Where more than four hydronic or domestic pipes are in an area label every 25 feet.
- 3.3.5 Where four or less pipes are in an area label every 50 feet.

3.4. All valves shall be labeled with a stamp valve tag indicating the following:

- 3.4.1 Type of service-Abbreviation
 - (A) Chilled Water Supply: CHWS.
 - (B) Chilled Water Return: CHWR.
 - (C) Hot Water Supply: HWS.
 - (D) Hot Water Return: HWR.
 - (E) Condenser Water Supply: CWS.
 - (F) Condenser Water Return: CWR
- 3.4.2 Valve Normal Position-Abbreviation
 - (A) Normally Open – NO
 - (B) Normally Closed – NC
- 3.4.3 Unique Identifying Number
 - (A) This is simply a number (such as 01 or 02) but each valve including the HVAC or Hydronic System valves must contain a unique number. There should not be two valves with the same number.
- 3.4.4 Valves within 72” and within line sight of terminal equipment or coils do not need to be tagged. Unless they are meant for something else other than to shut off hydronic water to the equipment or coil. This is only relevant to coils associated with VAVs, CUH, FCU and UH.

3.5. FSD need to be labeled on the ceiling grid. “Fire Damper”

3.6 BMS Panel boards

- 3.6.1 All panel boards shall have laminated control drawings inside the actual panel boards.

Section 23 05 29 Hangers and Supports for HVAC Piping

1. GENERAL

1.1. None

2. PRODUCTS

2.1. None

3. EXECUTION

3.1. Hangers shall be oversized to accommodate insulation of piping. No hanger, clamp or support shall penetrate insulation.

Section 23 05 93 Testing, Adjusting and Balancing for HVAC

1. GENERAL

1.1. Test and Balance shall be completed on every new building and remodel, including small remodels.

2. PRODUCTS

2.1. Current approved TAB providers: BTC Services, Certified Test and Balance, RSA Analysis

3. EXECUTION

3.1. Testing, Adjusting and Balancing for HVAC shall follow one of the most recent standards.

3.1.1 NEBB TAB Procedural Standard

3.1.2 AABC National Standards for Total System Balance

3.1.3 TABB SMACNA TAB Procedural Guideline

3.2. All recommended procedures and required procedures shall be followed per the standard, including temperature measurements, hydronic pressure measurements, and air measurements.

Section 23 07 00 HVAC Insulation

1. GENERAL

- 1.1. All new Ductwork, Hydronic Piping systems shall be insulated following applicable codes and this standard.

2. PRODUCTS

- 2.1. Fiberglass Pipe Insulation: All Service Jacket; Johns Manville Micro-Lok or approved equal with similar thermal resistance properties.
- 2.2. PVC Jacketing: 20 mil, colors to match selection. Johns Manville Zeston PVC Jacketing or equal.
- 2.3. Duct Wrap: Foil Skrim Type and no less than 2" thickness with a density of 75#

3. EXECUTION

- 3.1. Insulation shall follow procedures outlined in the most recent MICA National Commercial and Industrial Insulation Standards.
- 3.2. All HVAC insulation shall be continuous through all walls. Calcium Silicate shall be used where insulation is supported by hangers, clamps or supports and is subject to be crushed.
- 3.3. HVAC insulation should follow applicable current codes adopted by the State of Utah. In no case shall piping insulation be less than the following per system (based off of .28 BTU-in/(hr-ft²-F) at a mean temperature of 200 F):
 - 3.3.1 Hot Water
 - (A) Pipe Diameter $\leq 1.5"$ – 1.5"
 - (B) Pipe Diameter $>1.5"$ – 2"
 - 3.3.2 Chilled Water
 - (A) Pipe Diameter $\leq 1.5"$ – 1"
 - (B) Pipe Diameter $>8"$ – 1-1/2"
 - 3.3.3 Condenser Water
 - (A) Not required to be insulated indoors.
 - (B) Outdoor insulation will be determined by the Engineer of Record
- 3.4. Exposed HVAC piping insulation located in mechanical rooms, custodial closets, and corridors (where HVAC piping is exposed) shall be PVC Jacketed. PVC jacketing will follow the following color scheme:
 - 3.4.1 Chilled Water Supply: Yellow.
 - 3.4.2 Chilled Water Return: Light Yellow or Yellow with white stripping every 5'.
 - 3.4.3 Hot Water Supply: Red.
 - 3.4.4 Hot Water Return: Orange
 - 3.4.5 Condenser Water Supply: Light Blue.
 - 3.4.6 Condenser Water Return: Dark Blue.

- 3.5. All storage tanks shall be insulated including hot water and chilled water. Thickness shall be to applicable codes but in no case less than one inch for hot water and ½ inch for chilled water.
- 3.6. All valves, pump bodies and any other specialty located in Chilled Water piping shall be fully insulated.
- 3.7. All indoor supply air or outside air duct shall either be insulated or be installed with duct linear. Return, exhaust or relief air duct is not required to be insulated.
- 3.8. Chilled water lines using fiberglass insulation shall be fully sealed every fourth insulation piece on the end. All chilled water lines shall be sealed in accordance with manufacturer recommendations.

Section 23 08 00 Commissioning of HVAC

1. GENERAL

- 1.1. Commissioning shall be performed for HVAC systems. Third-party commissioning firm shall be hired on all projects that exceed 5,000 sq. ft. or where code dictates.

2. PRODUCTS

- 2.1. None

3. EXECUTION

- 3.1. None

Section 23 09 00 Instrumentation and Control for HVAC

1. GENERAL

- 1.1. None

2. PRODUCTS

- 2.1. Utah Yamas using Schneider Controls is the only approved supplier and manufacturer on campus.
- 2.2. Atkinson Controls can be used only for Phoenix Systems.

3. EXECUTION

3.1. Raceways

- 3.1.1 All raceways or conduit for BMS shall be white or use white couplings.
- 3.1.2 All raceway conduits shall be ¾" minimum size.

3.2. Control Valves

- 3.2.1 Control Valves shall be Belimo, or Schneider type and their Cv ratings shall be calculated and a valve provided that is best suited to the Cv calculation.
- 3.2.2 PICV valves must be used on valve body sizes 2" and larger.

3.3. Conductors and Communication Wirings

- 3.3.1 Yellow Wire for BACnet
- 3.3.2 Yellow Wire for Lon
- 3.3.3 Yellow Wire for AO/AI
- 3.3.4 Yellow Wire for DO/DI
- 3.3.5 Green Cat5e cable for IP field devices

3.4. Computer Requirements

- 3.4.1 Provide new computer. One per 20,000 square feet of building space. Max of three.
- 3.4.2 Computer must meet UVU computer standards.

3.5. Automation Servers

- 3.5.1 Number of Automation Servers: One per two floors of the building
- 3.5.2 Devices on IP, BACnet and Lon Trunks: No more than 60 devices

3.6. Input Output Devices

- 3.6.1 Number of Spare Points: 25% of all spare points

3.7. Graphics

- 3.7.1 Graphics to reflect campus standard which is?

3.8. Controls Strategies

- 3.8.1 Duct Static Reset,
- 3.8.2 Room Temp Reset based on OA
- 3.8.3 Pump Setpoint Reset based on Valve position
- 3.8.4 Boiler Temp Reset based on valve position
- 3.8.5 Duct Static Reset based on VAV damper position
- 3.8.6 AHU CO2 OA damper control
- 3.8.7 IDEC

3.9. Points

- 3.9.1 See UVU Points List in Points List Appendices

3.10. Sensors

- 3.10.1 A BMS pressure sensor shall be provided near all expansion tanks that will alarm when pressure is high and low. A pressure gage shall be provided near expansion tanks.

3.11. Equipment Integration to BMS

- 3.11.1 The following pieces of equipment will use BACnet gateways to integrate all available points in the equipment with the BMS system:
 - (A) Chillers, Boilers, VFDs, Air Flow Stations, BTU Meters, Electric Meters, Gas Meters, Generator, ATS, Medical Gas, Refrigerators, Freezers, Vacuum, Lighting Controls, Security

3.12. Network Switches

- 3.12.1 Network switches must meet campus IT Standards.
- 3.12.2 No unmanaged network switches.
- 3.12.3 All Automation Servers shall be permanently attached directly to the Owners Server.
- 3.12.4 A preliminary network shall be provided by the BMS contractor for Commissioning until the final Owner provided switches located in the IDF/MDF rooms are fully functional.
- 3.12.5 All Servers, Automation Servers, Jaces and any other IP device must have a dedicated network drop on the campus utility network.
- 3.12.6 Reference Campus IT Standard.

Section 23 11 23 Facility Natural-Gas Piping

1. GENERAL

- 1.1. None

2. PRODUCTS

2.1. Natural Gas Building Distribution Piping:

- 2.1.1 Pipe Size 2" and Smaller: Black steel pipe; Schedule 40; malleable-iron threaded fittings (exposed), welded fittings and joints (concealed).
- 2.1.2 Pipe Size 2-1/2" and Larger: Black steel pipe; Schedule 40; wrought-steel butt-welding fittings, weld all joints.

3. EXECUTION

- 3.1. All 1 pound gas and higher shall be all welded fittings and joints.
- 3.2. An earthquake valve shall be used at the building entrance to the building and tied to the BMS.

Section 23 21 13 Hydronic Piping

1. GENERAL

1.1. None

2. PRODUCTS

2.1. All piping and fittings shall be made in the USA. No piping shall be directly buried or underground.

2.2. HVAC water piping shall be installed as follows:

2.2.1 Steel Pipe Schedule 40 using groove type fittings or fully welded.

2.2.2 Copper Type L hard drawn using soldered fittings.

3. EXECUTION

3.1. No piping shall be buried directly underground without written permission.

3.2. For flushing requirements of piping refer to 23 25 00 HVAC Water Treatment.

Section 23 21 16 Hydronic Water Piping Specialties

1. GENERAL

1.1. None

2. PRODUCTS

2.1. Expansion Tanks:

2.1.1 Bladder Type for over 10 gallons

2.1.2 Diaphragm type for under 10 gallons

2.1.3 Free Air /Steel Type Expansion Tanks are not allowed

2.1.4 Manufacturer: Wessels Bell and Gossett, Armstrong

2.2. Air Eliminators (Micro-Bubble) and Air Separators

2.2.1 Manufacturer: Spirotherm, Bell and Gossett,

2.2.2 Air eliminators with a minimum of removal of 99.6% dissolved air shall be provided on hot water systems.

2.2.3 Air separators or air eliminators shall be provided on the chilled water system.

2.2.4 Condenser water systems derived from an open cooling tower system do not require air separation.

2.3. Flow Measuring Stations

2.3.1 Triple Duty Valves are not allowed to be used

3. EXECUTION

3.1. Expansion Tanks

- 3.1.1 Expansion tanks will be provided with an isolation valve from the system and a drain valve with a hose-bib between the isolation valve and expansion tanks.
- 3.1.2 A BMS pressure sensor shall be provided near all expansion tanks that will alarm when pressure is high and low. A pressure gage shall be provided near expansion tanks.

3.2. Air Eliminators (Micro-Bubble) and Air Separators

- 3.2.1 Air eliminators and separators shall be provided in systems where the temperature is the highest and pressure is the lowest.
- 3.2.2 An auto air vent shall be provided on top of the Air eliminator with ample access and discharge piped below the air separator.

3.3. Relief Valves

- 3.3.1 Relief valves shall be provided in all closed loop systems. Relief valves located in glycol systems shall discharge back in the glycol holding tank.

3.4. Glycol Feed Stations

- 3.4.1 A glycol feed station shall be provided on all separate glycol systems.
- 3.4.2 A 45 gallon tank with internal controls shall be provided.
- 3.4.3 A BMS sensor shall be interlocked with the GFS to alarm the BMS when the glycol tank is low.
- 3.4.4 A controller shall be provided to control the GFS pump in automatic or manual mode.
- 3.4.5 Pressure sensor shall be located no higher than 6' from the floor.
- 3.4.6 Propylene Glycol
 - (A) Propylene glycol shall be provided in pre-heat coils on AHU units at a 25%/75% glycol/water ratio.

3.5. Check Valves

- 3.5.1 Check valves shall be provided in parallel pump arrangements.

3.6. Flow Measuring Stations

- 3.6.1 A single flow measuring station shall be provided downstream of pumps in the straightest pipe possible while still located in the mechanical room. Valves shall not be provided for balancing of pumps that are served by Variable Frequency Drives.
- 3.6.2 Stations shall be sized based on pressure drop range of the flow station.

3.7. Balancing Valves

- 3.7.1 Balancing Valves shall be provided at all coils and HVAC equipment including boilers, chillers, etc.
- 3.7.2 Balancing Valves shall be sized based on pressure drop range of the balancing valve.
- 3.7.3 Balancing valves shall include a tag with valve model number.

3.8. Strainers

- 3.8.1 Strainers shall be installed before all coils and heat exchangers.
- 3.8.2 Strainer Screens shall be installed as follows with 304 stainless steel screens:
 - (A) 2" or less: #20 Mesh Screen
 - (B) 2-1/2" to 4": 3/64" perforated screen
 - (C) 5" or greater: 1/8"
- 3.8.3 All strainers will be designed with a blown down ball valve, male connection with screw cap and chain.
- 3.8.4 All strainer screens will be removed after flushing and washed clean. The cap will be replaced after pipe dope is applied to the threads.

Section 23 21 23 Hydronic Pumps

1. GENERAL

1.1. Hydronic pumps shall be provided with redundancy N+1.

2. PRODUCTS

2.1. Pumps Manufacturer: B&G, Armstrong, Patterson

2.2. Pumps on VFDs shall be called to have full size impellers.

2.3. Pumps shall be vertical in-line type.

3. EXECUTION

3.1. Pressure gages will be installed before and after or a joined pipe between a single gage the pump in accordance with Section 23 05 19 of this standard and a circuit setter will be installed to test the water flow.

3.2. Where multiple pumps are installed in a lead/lag or duty/standby situation a check valve shall be installed as well.

3.3. Isolation valves shall be installed before and after the pump per Section 23 05 23.

3.4. Use venturi flow stations downstream of parallel pumps and only one per set of pumps per Section 23 21 16 of this standard. Install a valve at the flow station if pumps are not on VFDs otherwise no valve at the flow station.

3.5. Condenser water pumps shall call to have impellers trimmed if water flow needs to be restricted more than 10% at the pump.

Section 23 25 00 HVAC Water Treatment

1. GENERAL

1.1. All new piping shall be flushed and chemically treated prior to introduction to the campus hydronic loop.

2. PRODUCTS

2.1. Manufacturer: ISI Water Chemistries.

3. EXECUTION

3.1. Flushing shall be done in accordance with the following procedure:

3.1.1 The contractor shall provide the gallons in the system either through calculation of volume and linear feet of pipe or through a use of a water meter.

3.1.2 The owner shall witness introduction of chemical and be circulated in accordance with manufacturer recommendations but no less than 72 hours.

Contractor must confirm that all pipe material will not be subject to damage from use of prescribed chemical.

- 3.1.3 The contractor shall provide a report of # of gallons in the system and the amount of cleaning chemical introduced.
- 3.1.4 The velocity in the pipe should not be less than the maximum velocity the system will experience at full load.
- 3.1.5 After chemical flush the water and chemical shall be drained completely.
- 3.1.6 All strainers in the entire system shall be removed (not just blown down) in presence of the Owner or Representative of the Owner and be shown to be fully clean before replacement.
- 3.1.7 New water will be introduced in the system and final chemical will be added and confirmed in presence of the Owner or Representative.
- 3.1.8 A final report of final chemical added and gallons of water in each system shall be provided before final approval.
- 3.1.9 If system is tied to the central plant system, all of this must occur before the system shall be opened to the system.

3.2. Open Cooling Tower Chemical Treatment

- 3.2.1 Use typical open loop chemical treatment as recommended by the Engineer of Record.
- 3.2.2 Attached the blowdown of the system from the chemical treatment controller to the basin sweep blowdown. Do not provide a separate blowdown.
- 3.2.3 The chemical treatment contractor shall provide a chemical treatment station on a secondary container basin.

Section 23 31 00 HVAC Ducts and Casings

1. GENERAL

- 1.1. Ducts shall be installed per the most current edition of the SMACNA Duct Construction Standards.

2. PRODUCTS

- 2.1. Use Galvanized sheet metal for overhead duct.
- 2.2. For underground duct use a water tight sealed system.

3. EXECUTION

3.1. Pressure Class of Duct

- 3.1.1 Duct between Air Handling Units and VAVs shall have a Pressure Class of no less than 6 in.w.c. unless the fan on the fan curve is incapable of achieving a 6 in.w.c. pressure; in this case the Pressure Class of the duct shall be 4 in.w.c.
- 3.1.2 Duct after VAVs shall have no less than a Pressure Class rating of 1 in.w.c.
- 3.1.3 Constant volume fans with no dampers downstream shall have no less than 1 in.w.c. Pressure Class.

3.2. Seal Class of Duct

- 3.2.1 Duct that has a Pressure Class rating higher than 3 in.w.c. shall be Seal Class A.
- 3.2.2 Duct that has a Pressure Class 3 in.w.c. and lower shall be Seal Class B.

3.3. Duct Leakage Test

- 3.3.1 All pressure class Duct 3" or greater shall be leaked tested to their respective design Pressure Class rating and in accordance with the most current SMACNA HVAC Air Duct Leakage Test Manual.
- 3.3.2 A 100% of duct, requiring leakage testing, including all fittings shall be tested up to VAV boxes.
 - (A) Fire Smoke Dampers should be excluded from the test.
- 3.3.3 Leakage Class shall be in accordance with the most recent Duct Leakage Test Manual based on the Seal Class of the duct and not the Pressure Class of the duct.

Section 22 33 00 Air Duct Accessories

1. GENERAL

- 1.1. None

2. PRODUCTS

- 2.1. None

3. EXECUTION

3.1. Volume Control Dampers

- 3.1.1 Volume control dampers shall be provided in branch ducts leading to terminal diffusers.
- 3.1.2 Volume control dampers shall be provided with extension stems to accommodate duct insulation.

3.2. Turning Vanes

- 3.2.1 Turning vanes shall be installed in all 90-degree rectangular duct regardless of air velocities.

3.3. Duct Liner

- 3.3.1 Duct liner shall be installed in accordance with the most recent SMACNA Duct Construction Manual or manufacturer requirements, whichever is more stringent.
- 3.3.2 Duct Liner shall not be provided in ducts with greater than 1000 FPM velocity.
- 3.3.3 Duct Liner shall be provided in all rectangular duct as follows:

- (A) All rectangular duct downstream of VAV boxes, Roof top Units, Fan Coil Units
- (B) 20 feet of rectangular duct before Exhaust Fans
- (C) Do not provide Duct Liner in ducts conveying grease, caustic chemicals or steam.

Section 23 34 00 HVAC Fans

1. GENERAL

1.1. None

2. PRODUCTS

2.1. Exhaust Fans

2.1.1 Direct Drive fans shall be used with exhaust fans.

3. EXECUTION

3.1. All disconnects shall be installed within 6' of equipment and be labeled as such and not located in the exhaust fan.

Section 23 36 00 Air Terminal Units

1. GENERAL

1.1. None

2. PRODUCTS

2.1. Variable Air Volume

2.1.1 Manufacturers: Price, Titus, or approved equal.

2.1.2 VAV boxes will come with no control system as this will be provided by the 230900 contractor.

3. EXECUTION

3.1. Variable Air Volume

3.1.1 VAV shall be installed with access of at least 24" x 24" in front of VAV boxes.

3.1.2 VAV boxes shall be in the interior of the room located over the entrance door for non-sound sensitive rooms. (Includes: classrooms, offices, conference rooms)

3.1.3 Re-Heat Coils shall be designed with entering water temperature of 105F when heating water system is supplied from the central plant.

Section 23 41 00 Particulate Air Filtration

1. GENERAL

- 1.1. The intent of air filtration is to reduce the number of size filters having to be kept on hand at the maintenance warehouse.

2. PRODUCTS

2.1. Minimum Efficiency

- 2.1.1 Minimum filtration shall be MERV 8 on Fan Coil Units.
- 2.1.2 Minimum filtration shall be MERV 13 for Central Air Handling Units.

2.2. Size of Filters

- 2.2.1 4" thick filters are desired and 24" x 24", 24" x 12" or 12" x 12" shall be used in all Fan Coil Units and Central Air Handling Units.
- 2.2.2 When these size filters will not fit in the FCU or AHU filter rack the Engineer of Record shall call for a filter box to be built to accommodate these size filters.

3. EXECUTION

- 3.1. Plans and specifications for call for the contractor to provide three sets of filters for AHU and FCU.

- 3.1.1 First set to be installed before TAB commences.
- 3.1.2 Second Set to be installed at substantial completion or when TAB finishes whichever is later.
- 3.1.3 The last set is an attic stock set and shall be stored in the main mechanical room of the new building.

- 3.2. In the event the contractor plans on using the Central AHU or FCU for temporary heating or cooling, additional sets of new filters (above and beyond the 3 sets already called for) shall be used at the contractor's expense and replaced every 3 months. Using filtration media over filters does not alleviate the contractor for providing additional set of filters. In no event shall any of the three sets of filters called for be used before the timing already outlined in this requirement.

Section 23 52 00 Heating Boilers

1. GENERAL

- 1.1. Boilers are intended to only be installed in Central Plants and where buildings are not attached to the central plant system.
- 1.2. Boilers in a central plant shall be N+1 redundancy.
- 1.3. Boilers in standalone buildings shall be sized each at 60% of the design heating capacity.

2. PRODUCTS

- 2.1. All boilers shall be condensing type.
- 2.2. Heating Water Boilers: Fulton, Aerco, Lockinvar

3. EXECUTION

3.1. Central Plant Boilers Design Temperatures shall be:

- 3.1.1 EWT: 90
- 3.1.2 LWT 130

3.2. Stand Alone Boilers Design Temperatures shall be:

- 3.2.1 EWT: 120
- 3.2.2 LWT 140

- 3.3. Boilers shall be designed with their own dedicated pump in a primary secondary.
- 3.4. For standalone buildings and use of a low-mass boiler a buffer tank rated for 5 minutes of the primary gpm flow shall be provided.

Section 23 57 00 Heat Exchangers for HVAC

1. GENERAL

1.1. None

2. PRODUCTS

2.1. All heat exchangers for HVAC shall be plate and frame type.

3. EXECUTION

3.1. Pressure gages, Pressure Temperature Ports, Isolation Valves, BMS thermometers and Liquid Type Thermometers shall be provided on all inlets and outlets of the source and load side of each heat exchanger.

3.2. Circuit setters or venturi flow meters with a valve shall be provided on the return of the load and source side unless the heat exchanger only feeds a single coil which already has a circuit setter or venturi flow meter.

3.3 Properly sized connections to flush both sides of the heat exchanger.

Section 23 64 00 Packaged Water Chillers

1. GENERAL

1.1. Chillers in a central plant shall be N+1 redundancy.

1.2. Chillers in standalone buildings shall be sized each at 60% of the design cooling capacity.

2. PRODUCTS

2.1. Central Plant Chillers

2.1.1 Type: Centrifugal, Magnetic Bearing

2.1.2 Type: No scroll chillers are allowed.

2.1.3 Manufacturers: Trane, York, or Daiken

2.1.4 Water Source Type

2.2. Stand Alone Building Chillers

2.2.1 Type: Magnetic Bearing, Centrifugal, Scroll

2.2.2 Manufacturer: Trane, York, Daiken

2.2.3 Water Source Type

3. EXECUTION

3.1. Central Plant Chillers

3.1.1 Cooling Only LWT/EWT Condenser: 85/75 F

- 3.1.2 Cooling Only LWT/EWT Evaporator: 45/55 F
- 3.1.3 Heat Recovery LWT/EWT Condenser: 130/90 F
- 3.1.4 Heat Recovery LWT/EWT Evaporator: 45/55 F
- 3.1.5 Primary/Secondary: Chillers shall be piped in a primary secondary setup.

3.2. Standalone Chillers

- 3.2.1 Cooling Only LWT/EWT Condenser: 85/75 F
- 3.2.2 Cooling Only LWT/EWT Evaporator: 45/55 F
- 3.2.3 Primary/Secondary: Chillers shall be piped in a primary secondary setup on both evaporative and condenser side.

Section 23 65 00 Cooling Towers

1. GENERAL

- 1.1. Cooling towers are desired for Indirect Evaporative Cooling and for Water Source Chillers.

2. PRODUCTS

- 2.1. Manufacturers: BAC, Evapco, SPX/Marley

3. EXECUTION

- 3.1. Cooling Towers shall be design as follows:

- 3.1.1 Galvanized Structure with stainless steel basin or TriArmor lined galvanized basin.
- 3.1.2 Permanent Ladder to Motors
- 3.1.3 Leaving Water Discharge shall be located at the bottom of the tower. NOT THE SIDE of the cooling tower.
- 3.1.4 Equalizing Lines shall be used with multiple cooling towers.

- 3.2. A basin sweep not an inline separator shall be used for removing particulates including a solid separator.

- 3.3. The chemical treatment contractor shall provide a chemical treatment station on a secondary container basin. The chemical treatment station shall command the blow down valve of the basin sweep centrifugal filter.

Section 23 72 00 Air-to-Air Energy Recovery Equipment

1. GENERAL

1.1. None

2. PRODUCTS

2.1. Fixed Plate

2.1.1 Fixed plate ERV are only approved. Heat-wheel type shall not be used.

3. EXECUTION

3.1. None

Section 23 73 00 Indoor Central-Station Air-Handling Units

1. GENERAL

1.1. Central Indoor Air Handling Units with VAV-Reheat are preferred.

1.2. Custom Built Indoor Air Handling Units are preferred over packaged systems and shall be used for buildings over 80,000 square feet.

2. PRODUCTS

2.1. Fans

2.1.1 Fan Redundancy (including VFDs): 83% ability with single fan/vfd failure.

2.1.2 Fan Arrays should be designed around 10 HP motors while allowing for the redundancy outlined.

2.2. Filtration

2.2.1 Filtration Requirements: 4" MERV 13 FF, MERV 8 PF

2.2.2 Filtration Rack FPM: 20% less than FPM Max

2.2.3 FPM Max: 500 FPM

2.3. Doors

2.3.1 Windows in Doors: Provide them in all access doors at a comfortable viewing height for an average person height of 6'.

2.3.2 Doors shall swing against the pressure.

2.4. Coils

2.4.1 Max FPI in coils: 10

2.5. Direct Evap:

- 2.5.1 Pan Slope: ½" per foot
- 2.5.2 Sump Capacity: Enough to handle complete drain of pad without overflowing with full tank
- 2.5.3 Evap Piping Material: Copper
- 2.5.4 Evap Drain Time: Drain entire sump in 10 minutes
- 2.5.5 Primary Drain Size: 2"
- 2.5.6 Overflow Drain Size: 4"
- 2.5.7 Moisture Sensors: One on the floor of AHU and one in the overflow

2.6. Casings

- 2.6.1 AHU Walls Pressure Class Rating Minimum: 6"
- 2.6.2 AHU Walls shall be 4" thick with insulation.
- 2.6.3 Flooring shall be diamond steel plate

2.7. AHU Setpoint: Pressures and temperatures shall be reset based on VAV damper position and building load respectively.

3. EXECUTION

3.1. A Hose-bib shall be provided next to all Air Handling Units and an outlet.

3.2. AHU shall be on housekeeping pads of at least 4" unless the fan static pressure is greater than 4" then the house keeping pad shall be as thick as the Fan Total Static Pressure.

Section 23 74 00 Packaged Outdoor HVAC Equipment

1. GENERAL

1.1. Package Outdoor units are undesirable and must be approved in writing.

2. PRODUCTS

2.1. When a packaged unit is allowed only terminals are allowed tied to BMS system.

2.2. No controls from factory are allowed. All controls shall be done using Schnieder BMS system.

2.3. A gateway or BACnet, Lon, Modbus interface is not allowed

3. EXECUTION

3.1. None

Section 23 81 26 Mini-Split Air-Conditioners

1. GENERAL

1.1. Use for IDF/MDF Electrical Rooms only.

1.2. Will consider use when rooms require 24/7 cooling and heating.

2. PRODUCTS

2.1. Manufacturers: Mitsubishi, Fujitsu, LG

3. EXECUTION

3.1. None

Section 23 81 29 Variable Refrigerant Flow HVAC Systems

1. GENERAL

1.1. VRF can only be used for systems less than 180,000 BTU heating and cooling capacity for a complete building.

2. PRODUCTS

2.1. Manufacturer: Mitsubishi, no others are approved.

3. EXECUTION

3.1. None

Section 23 82 19 Fan Coil Units

1. GENERAL

1.1. Fan Coil Units are allowed with Hydronic Coils. DX Coils must have prior approval from Owner.

2. PRODUCTS

2.1. None

3. EXECUTION

3.1. Access: Provide ability to remove entire unit out of the space without any removal of permanent construction, including the T-Grid Mains; provide code NEC required 30 x30 access in front of electrical panels; provide access to both sides of the FCU to access motor.

3.2. Condensate Pumps: No condensate pumps are allowed provide enough access and drain for gravity.

3.2.1 Fan Coil Units shall not be standalone but controlled via the BMS 230900 contractor. No factory controls.

Section 23 82 39 Unit Heaters

1. GENERAL

1.1. Unit Heaters are preferred to be used in Mechanical Rooms, Electrical rooms and typical user non-occupied spaces.

1.2. Cabinet Unit Heaters are preferred to be used in stairwells, where cooling is not required.

2. PRODUCTS

2.1. None

3. EXECUTION

3.1. Unit Heaters and cabinet unit heaters shall be controlled via BMS.

3.2. Unit Heaters and Cabinet unit heaters shall be design with an EWT of 105F.