Division 23 Heating, Ventilating, and Air Conditioning (HVAC)

1.1 230500 – COMMON WORK RESULTS FOR HVAC

A. Code Compliance: All work should comply with the applicable laws and regulations of the City of Omaha and State of Nebraska. Mechanical work shall be performed by persons skilled in the trade involved and shall be done in a manner consistent with normal industry standards. All work shall conform to all applicable sections of currently adopted additions of the following codes, standards and specifications:

1. International Building Code (IBC)
2. Safety and Health Regulations for Construction
3. Occupational Safety and Health Standards (OSHA)
4. National Fire Protection Association (NFPA)
5. Life Safety Code (NFPA #101)
6. American Gas Association (AGA)
7. Underwriters Laboratories, Inc. (UL)
8. Factory Mutual Engineering Corporation or other recognized National Laboratories
9. Environmental Protection Agency (EPA)
10. Omaha Plumbing Code
11. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA).

B. Contract documents shall provide for coordination of connection of all equipment, whether it is provided by other divisions of the specifications or by the Owner.

C. HVAC Submittal Schedule:

HVAC SCHEDULE	PRODUCT DATA	SHOP DRAWINGS	SAMPLES	WARRANTY	OTHER
230500 – Common Work Results for HVAC					✓
230513 – Common Motor Requirements for HVAC Equipment	✓				
230516 – Expansion Fittings and Loops for HVAC Piping	✓	✓			
230519 – Meters and Gages for HVAC Piping	✓				
230523 – General-Duty Valves for HVAC	✓				
230529 – Hangers and Supports for HVAC Piping and Equipment	✓				
230553 – Identification for HVAC Piping and Equipment	✓				
230593 – Testing, Adjusting, and Balancing for HVAC	✓		✓	✓	✓
230700 – HVAC Insulation	✓				

HVAC SCHEDULE	PRODUCT DATA	SHOP DRAWINGS	SAMPLES	WARRANTY	OTHER
230800 – Commissioning of HVAC	✓		✓	✓	✓
230900 – Instrumentation and Control for HVAC	✓	✓		✓	✓
230993 – Sequence of Operations for HVAC Controls	✓	✓		✓	✓
231113 – Facility Fuel-Oil Piping	✓	✓			
231123 – Facility Natural-Gas Piping	✓	✓			
232113 – Hydronic Piping	✓	✓			
232123 – Hydronic Pumps	✓				
232213 – Steam and Condensate Heating Piping	✓	✓			
232223 – Steam Condensate Pumps	✓				
232500 – HVAC Water Treatment	✓			✓	✓
233113 – Metal Ducts	✓	✓			
233116 – Nonmetal Ducts	✓	✓			
233300 – Air Duct Accessories	✓				
233423 – HVAC Power Ventilators	✓				
233600 – Air Terminal Units	✓				
233713 – Diffusers, Registers, and Grilles	✓		✓		
234100 – Particulate Air Filtration	✓				
235700 – Heat Exchangers	✓				
237313 – Modular Indoor Control-Station Air Handling Units	✓				
238216 – Air Coils	✓				
238219 – Fan Coil Units	✓				
238239 – Unit Heaters	✓				
238413 – Humidifiers	✓				
262923 – Variable-Frequency Motor Controllers	✓			✓	✓
336113 – Underground Hydronic Energy Distribution	✓	✓			
336313 – Underground Steam and Condensate Distribution Piping	✓	✓			

D. Contract documents shall require all welders to be certified and to stamp their work.

E. PVC piping shall not be installed in return air plenum.

F. All 2-1/2-inch and larger heating and cooling steel pipes shall be welded or provided with square cut or rolled-grooved joints and fittings.

G. Require cut pipe to be reamed to full inside diameter.

1.2 230513 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

A. All electrical work should be done in accordance with Division 16 requirements.

B. All Electric motors shall be induction-type 1750 RPM, unless approved otherwise.

C. Motors 1/2 horsepower and larger shall be three-phase.

D. All motors should be high efficiency-type.

E. All motor starters should be provided as part of the work described in Division 16-Electrical, unless provided as an integral part of the manufacturer's package equipment.

F. Multiple belts should be factory-matched sets.

G. Require Contractor to provide a complete set of replacement belts to the Owner at project completion.

1.3 230516 – EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

A. Pipe alignment guides and anchors, in conjunction with pipe expansion system, shall be installed in accordance with manufacturer's recommendations and normal engineering practice.

1.4 230519 – METERS AND GAGES FOR HVAC PIPING

A. Acceptable Manufacturers include:

1. Inline turbine flow meter:
    a. EMCO
    b. ISTEC
    c. Venture Measurement
    d. Thermo Measurement
2. Insertion turbine flow meter
    a. ONICON, Inc.
    b. Data Industrial
    c. Thermo Measurement
3. Vortex shedding flow meter
    a. Bailey Fischer & Porter
    b. EMCO
    c. Venture Measurement
4. Turbine Flowmeter
    a. Badger Meter
    b. Bailey Fischer & Porter
    c. AMCO
5. Venturi Flow Meter

a. Armstrong Pumps
b. Badger Meter
c. Bailey Fischer & Porter
d. Flow Design
e. Gerand Engineering
f. Hyspan Prevision Products

B. All utilities should be metered; including electricity, steam, condensate, chilled water, and domestic water.

C. Chilled water meters and steam (or condensate) meters will be provided and installed by the Contractor by Creighton, upon being furnished with design criteria by the project Architect/Engineer. The cost of these meters will be assessed against the project and must be included in the project cost estimates.

D. Chilled water meters shall be of the insertion, vortex flow meter used with either a thread-o-lot or saddle fitting. Meter shall include a pulse output with a 4 to 20 mA analog output.

E. Condensate meter shall be an impeller meter specifically designed to handle hot water up to 250° F and 200 psi. Pulser element shall be a dry contact reed switch.

F. Install meters in straight lengths of pipe the same size at the meter connection. Provide 20 pipe diameters upstream and 10 pipe diameters downstream. Provide isolation valves before and after meters with a manual valve bypass. Valves shall be outside the straight pipe limits.

G. Provide temperature and pressure signals from supply and return and transmit to the EMCS so that BTU calculations can be made.

H. Thermometers and gauges should be legible from the operator floor.

I. Temperature indicators, both thermometers and remote sensors, should be installed before and after each air handling unit coil, chiller, at building entrance and exit, and in other heat exchanging equipment to provide complete operating information.

J. Require Pete's plugs only before and after air-handling unit coils and radiation.

K. Pressure gauges should be installed before and after all items of equipment that cause pressure changes such as pumps, air handling unit coils, compressors, and at the building entrance and exit.

L. Require Pete's plugs only before and after terminal units.

1.5 230523 – GENERAL-DUTY VALVES FOR HVAC PIPING

A. Acceptable ball valve manufacturers:

1. Apollo
2. Watts
3. Nibco

B. Acceptable butterfly valve manufacturers:

1. Dezurik
2. Nibco

C. Note: All butterfly valves 6 inches and over shall be Dezurik.

D. Valves 4 inches and larger should be gear-operated with a chain when 8 feet or more above the floor.

E. Valves shall be installed from horizontal to vertical upright.

F. Isolation valves shall be provided each branch or riser location.

G. Isolation valves shall be provided the supply and return connections to each piece of equipment.

H. All ball valves shall have a minimum of 600 W.O.G.

I. Require horizontal duct supports at each joint and at 4-foot on center maximum in accordance with SMACNA recommendations. Anchor hanging strips to structure. Impact driven anchors in steel or concrete structure should not be permitted.

J. Require vertical duct supports at each floor that will support the weight of ductwork in that section without deflection or distortion.

1.6 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

A. Ductwork:

1. Require ducts passing through masonry walls to be installed in steel angle-iron frames and sleeves. All sleeves and frames shall be securely fastened to the walls. Provide for structural lintels in masonry wall openings.
2. Require sleeves at all sealed duct penetrations through walls, floors, and roofs. Openings through sound-rated partitions shall have annular space stuffed with fiberglass insulation for the full thickness of the wall.
3. Require all ductwork to be substantially and neatly supported on galvanized steel straps or angles, riveted or bolted to duct flanges, and properly anchored to the construction; so the horizontal ducts are without sag or sway, vertical ducts without buckle, and all ducts are free from the possibility of deformation, collapse, or vibration.
4. Require ductwork supports in corrosive environments to be stainless steel.
5. Require aluminum ductwork to have aluminum supports.

B. Piping:

1. Require piping passing through masonry or concrete floors and walls be installed with Schedule 40 pipe sleeves, sized to allow insulated pipe to pass through and with sufficient annular space to allow fire sealant.
2. Require pipe hangers for insulated pipe with vapor barrier jackets be installed around the outside of the insulation and a metal insulation support shield be provided to prevent crushing of the insulation.

1.7 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

A. Identification: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Engineer in cases of variance with names as shown or specified:

PIPE COMMODITY	LEGEND	LETTERING COLORS	BACKGROUND COLORS
Natural gas	"Natural Gas"	Black	Yellow
Propane gas	"Propane Gas"	Black	Yellow
Oil	"Fuel Oil"	Black	Yellow
Steam above 15 psig	"High Pressure Steam"	Black	Orange
Steam 15 psig & below	"Low Pressure Steam"	Black	Yellow
Plant heating hot supply	"Heating Supply"	Black	Yellow
Plant heating hot return	"Heating Return"	Black	Yellow
Plant chilled water supply	"Chilled Water Supply”	White	Green
Plant chilled water return	"Chilled Water Return”	White	Green
Compressed air	"Compressed Air"	White	Blue
Condenser water supply	"Condenser Water Supply”	White	Green
Condenser water return	"Condenser Water Return"	White	Green
Steam condensate return	"Condensate Return"	Black	Yellow

B. Valve Tags:

1. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
2. Valve Tags: 1-1/2-inch round with stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers with

numbering scheme approved by Owner. Provide 5/32-inch hole for fasteners.

a. Material: 3/32-inch-thick laminated plastic.
b. Valve Tag Fasteners: Brass wire-link or beaded chain; or S-hook.
c. Valve Tag Color:
    1) Heating Hot Water: Yellow
    2) Steam: Yellow
    3) Chilled Water: Blue
    4) Condenser Water: Orange
d. Letter Color:
    1) Heating Hot Water: White
    2) Steam: Black
    3) Chilled Water: White
    4) Condenser Water: Black

1.8 230593 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

A. Acceptable TAB firms include:

1. Air and Fluid Management
2. Balcon Air and Water Balancing
3. Prevision Testing and Balancing
4. System Management and Balancing
5. Waldinger
6. Air Balance of Omaha

B. Large projects should require the services of a separate (not part of any contractor or the project) firm to perform TAB procedures for the following systems:

1. Air systems (sheet metal)
2. Hydronic piping systems
3. Steam systems
4. HVAC equipment quantitative-performance settings
5. Kitchen and laboratory hood airflow balancing
6. Space pressurization
7. Vibration measuring
8. Sound level measuring
9. Indoor air quality measuring
10. Coordinate the efforts of factory-authorized service representatives
11. Verify operation of automatic temperature system components
12. Laser alignment of rotary components.

C. Consider requiring an allowance to be included in bids for the cost of changing fan belts and drives that may occur during the TAB phase.

1.9 230700 – HVAC INSULATION

A. Insulation Types:

1. Mineral Fiber: Maximum k value of 0.25 at 100° F; non-combustible; one-piece snap-on; temperature range 0° F to +500° F; nominal density of 4 lbs per cubic foot with ASJ, all service jacket.
2. Unicellular Foam: Flexible, plastic; maximum k value of 0.28 at 75° F; temperature range of -40° to +220° F; minimum density of 6 lbs. per cubic foot. Apply a UV resistant paint for piping with foam insulation installed outdoors.
3. Calcium Silicate: Maximum k value of 0.45 at 200° F; temperature range of +35° F to +1200° F; minimum density of 6 lbs. per cubic foot.

B. Application of Pipe Insulation:

1. Insulation shall be installed only by persons skilled at such work. The appearance of the completed insulation is a significant factor in determining the acceptability of the work.

C. Pipe Insulation Schedule:

1. Chilled water supply and return (40° F and above) – 1-1/2-inch thick and smaller – mineral fiber; 1-inch-thick, 2-inch and larger, mineral fiber; 1-1/2-inch thick.
2. Heating water supply and return (below 200° F) – 1-1/2-inch thick and smaller – mineral fiber; 1-inch thick, 2-inch and larger – mineral fiber; 2-inch thick.
3. Heating water supply and return (above 200° F): 1-1/2-inch thick and smaller – mineral fiber; 1-inch thick, 2-inch and larger – mineral fiber; 2-inch.
4. Steam and condensate (below 350° F) – 1-1/2-inch thick and smaller – mineral fiber; 1-1/2-inch thick, 2-inch and larger – mineral fiber; 3-inch thick.
5. Steam and condensate (above 350° F) – 1-1/2-inch thick and smaller – mineral fiber; 2-1/2-inch thick, 2-inch and larger – mineral fiber; 4-inch thick
6. Provide a thermal blanket enclosure at all valves and expansion joints where periodic access is required and pipe movement would damage a rigid cover.

7. Provide a field-applied jacket over the normal insulation and jacket for all piping in tunnels, exposed to the weather, or in congested areas where damage may occur due to traffic. Jackets may be PVC, aluminum, or stainless steel depending upon the potential for damage and as requested by the Owner.

D. Duct Insulation:

1. Insulation Types:

a. Flexible Mineral Fiber: Maximum k value of 0.29 at 75° F; 0.002-inch flame resistant Foil Reinforced Kraft (FSK); staples lap joint and tape on staples of cooling ducts; approximate nominal density of 0.75 lbs. per cubic foot; temperature range of 40° F to 250° F

b. Rigid Mineral Fiber: Maximum k value of 0.26 at 75° F; 0.002-inch flame resistant FSK facing; stapled lap joint and tape on staples of cooling ducts; approximate nominal density of 3 lbs. per cubic foot; temperature range of 0° F to 450° F

c. Unicellular Foam: Maximum k value of 0.28 at 75° F; approximate nominal density of 6 lbs. per cubic foot; temperature rating -40° F to +220° F.

2. Application of Insulation:

a. Flexible insulation shall be installed with edges tightly butted and shall conform to duct surfaces uniformly and firmly.

b. Secure insulation with vapor barrier lap joints with staples. Seal jacket joints on cold ducts with vapor adhesive or tape to match jacket.

c. Flexible insulation shall be cut slightly longer than perimeter of duct to ensure full thickness at corners. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners on 18-inch centers where duct is over 24 inches wide to prevent sagging.

d. Seal vapor barrier penetrations of mechanical fasteners with vapor barrier adhesive. Seal insulation around access doors and damper operators to allow operation without disturbing wrapping.

e. All duct insulation should be located outside the airstream.

3. Duct Insulation Schedule:

a. Supply and return air, exposed in finished rooms except mechanical rooms – none

b. Low pressure supply air, all except mechanical room – 1-1/2-inch flexible glass fiber insulation, .75 lbs. with FSK vapor barrier jacket

c. Round low pressure supply air, mixing box outlet to air outlet – 1-1/2-inch flexible glass fiber insulation, with FSK vapor barrier jacket

d. Medium pressure supply air – 1-1/2-inch flexible glass fiber insulation .75 lbs. with FSK vapor barrier jacket

e. Return and relief air – 1-1/2-inch flexible glass fiber insulation, .75 lb. with FSK vapor barrier jacket

f. Return air, ceiling return air plenum – none

g. Outdoor and mixed air – 2-inch rigid glass fiber board with FSK vapor barrier jacket

h. Fan and coil plenums – 1-inch rigid glass fiber board with FSK vapor barrier jacket

i. Make-up air supply (60 - 90° F) – none

j. Exhaust air from louver or hood 36-inch into building – 1-1/2-inch flexible glass fiber, .75 lbs. with FSK vapor barrier jacket

1.10 230800 – COMMISSIONING OF HVAC

A. Specify third party commissioning of all mechanical and electrical systems upon direction from the Owner. Commissioning shall be accomplished by an agency that has no business connections with installing Contractors, including, but not limited to common ownership. The cost of commissioning shall be included in Contractor's bid.

B. Commissioning shall include the review of all required tests, verification that all equipment is operating within the design intent, documentation of system deficiencies, and verification that Operation and Maintenance Manuals are complete.

C. Specifications shall require the commissioning plan be submitted prior to the first request for payment. Owner comments shall be returned in 14 days. A revised plan shall be submitted prior to the third request for payment.

1.11 230900 – INSTRUMENTATION AND CONTROL FOR HVAC

A. Temperature indicators, both thermometers and remote sensors, should be installed before and after each air handling unit coil, chiller, at building entrance and exit, and in other heat exchanging equipment to provide complete operating information.

B. Creighton University uses a Invensys control system by Enertech

C. As a general rule, control systems should permit individual room control of temperatures. Where the project budget or some other restriction does not permit this approach, written approval must be provided by the Creighton project representative.

D. Require a two-year warranty on all control programming and components.

E. Require alarm monitoring of all critical components.

F. Require the control system to be able to display fire alarm status.

G. All new installations to the campus EMS must be tied to the Campus LAN. No "dial-up" communication will be accepted.

H. Control system must interface with the Elutrons energy-monitoring system.

I. Require that on the completion of installation, a full set of as-builts, points lists, logical block diagrams and sequences of operation be presented to the Owner within one (1) week.

J. Control systems should be located in rooms that are reasonably conditioned, where ambient temperatures in the range of 50 -90° F are maintained.

K. Require all pump and air handling unit status to be monitored by current sensing relays.

L. Coordinate design with Owner to insure the compatibility of software packages is provided.

1.12 230993 – SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

A. Each air handling unit, pump, heat exchanger, etc., shall have a sequence of operations describing the control requirements. Include a points list and control diagram in addition to the written description.

B. Provide pressure signals on supply and return connections to furthest chilled water load point so that speed of CW pump can be controlled to maintain the most critical requirements. (The furthest load point may not be the most distant but the location having the greatest overall pressure differential.)

1.13 231113 – FACILITY FUEL-OIL PIPING

A. Pipe Schedule:

SERVICE	MATERIAL
Domestic water, buried	Type K copper
Fuel oil piping, buried	Fiberglass reinforced plastic
Fuel oil piping, aboveground	Welded Schedule 40 black steel OR screwed Schedule 40 black steel

1.14 232113 – HYDRONIC PIPING

A. Pipe Schedule:

SERVICE	MATERIAL
Heating water piping	Schedule 40 black steel OR Type L copper tubing, hard drawn (Copper should be used for pipes 4-nch and smaller)
Chilled water piping	Schedule 40 black steel OR Type L copper tubing, hard drawn (Copper should be used for pipes 4-inch and smaller)
Low pressure steam piping	Welded Schedule 40 black steel OR screwed Schedule 40 black steel
High pressure steam piping	Welded Schedule 40 black steel
Condensate return piping	Welded Schedule 80 black steel OR screwed Schedule 80 black steel

SERVICE	MATERIAL
Equipment drains and overflows	Schedule 40 galvanized steel OR Type L copper, hard drawn

B. Require all air vents and coils in strategic areas for control of air to be the automatic-type. Release of these vents should be piped as acceptable by code.

C. Require all expansion tanks to be bladder-type with completely replaceable bladders.

D. The ΔT across cooling coils should be 14° F.

E. The chilled water system for new buildings should be designed utilizing a 14° F ΔT, variable speed pumps and two-way valves on the cooling coils.

F. A modulating control valve in the CWR (preferred) or CWS to the building shall modulate maintaining a 14° F ΔT between building supply and return. The chilled water pump discharging into the building return shall have its speed controlled to maintain required ΔP at the most remote cooling coil.

G. Require the installation of 3/4-inch drain and vent lines on all coils.

H. All reheat coils shall have access panels both upstream and downstream of the coil.

I. Design mechanical spaces to allow for easy removal/replacement of coils and filters.

J. Specify pot feeders for all closed-loop systems and provide recommended treatment method and chemicals.

K. Hydronic heating systems must be designed so that water flow is not stopped and potentially allowed to freeze. Consider 3-way valves at the end of branch lines.

L. Heating systems serving reheat coils in terminal units must be designed so that warm water is available for reheating cold air supply when applicable. The heat exchanger sequence of control may need to be modified.

1.15 232123 – HYDRONIC PUMPS

A. Require all pumps to have 4-inch thick, reinforced concrete pad, with chamfered edges 4 inches larger than the pump on all sides.

B. Require piping to be supported so the weight of the piping does not rest on the pump.

C. Require valves the same size as the piping be connected to the pump.

D. Require isolation valves and strainer on the inlet or suction side of the pump.

E. Require non-slam check, balance, and isolation valves on the pump discharge. Triple-duty valves may be used.

F. Require a pressure gauge across the suction and discharge of each pump.

G. Require that pumps be installed with a minimum of five (5) pipe diameters of straight pipe on the suction side of the pump, or use a suction diffuser if unable to meet these criteria.

H. Require pump vibration isolators on the suction and discharge of each pump. Isolators shall be installed between the casings and valves, on discharge and upstream of suction diffuser, or inlet pipe on suction.

I. Centrifugal pumps shall be separately coupled, base-mounted. End-suction pumps shall generally be used for flows of 500 gpm and smaller, while horizontal split-case double suction pumps used for larger flows.

J. Closed-coupled, inline pumps shall be used for low flow booster applications.

K. Building secondary pumps generally shall be installed in parallel with each pump sized to handle the building demand. Provide a manual valved bypass around the pumps. If only one pump is installed due to budgetary restrictions, make provisions for future parallel pump.

1.16 232213 – STEAM AND CONDENSATE HEATING PIPING

A. Steam Pressure Reducing Valves Acceptable Manufacturers:

1. Fisher.
2. Spirax Sarco
3. LTV

B. Steam Traps Acceptable Manufacturers:

1. Fisher
2. Spirax/Sarco
3. TLV

C. Condensate Return Pumps Acceptable Manufacturers:

1. Roth
2. Skidmore
3. Spirax Sarco
4. Aurora

D. Pipe Schedule:

SERVICE	MATERIAL
Low pressure steam piping	Welded Schedule 40 black steel OR screwed Schedule 40 black steel
High pressure steam piping	Welded Schedule 40 black steel
Condensate return piping	Welded Schedule 80 black steel OR screwed Schedule 80 black steel

E. Steam is distributed at 110 psi, reduced to 50 psi and then further reduced to 10 psi for use in the building. Steam pressure reducing valves shall be pilot actuated, diaphragm type with adjustable pressure range and positive shutoff.

F. Steam Traps:

1. Float and thermostatic (F&T) V traps shall be used on applications with modulating steam control valves like heating exchangers and heating coils.
2. Inverted bucket or F&T traps shall be used where operation against a back pressure is required and at very light loads.
3. Thermostat traps may be used where it is necessary to handle startup air loads, operate against back pressure, and perform at very light loads.

G. Condensate Return Pumps:

1. Pumps shall be centrifugal, close coupled, vertical submerged design that does not require a mechanical seal.
2. Specify condensate return pumps with duplex pump sets and sufficient head capability that slight impeller erosion will not disable the pump. Pumps should normally handle the load alone and alternate, but should also operate together if needed. Tanks should be vented to a safe location outside of the building.
3. Applications that require larger capacities (in excess of 30 CB/hr. condensate) may utilize pumps with mechanical seals with silicone carbide seats suitable from 250° F water. Steam pressure assisted pumps may also be considered specific applications.
4. A pressure assisted condensate pump may be used. This pump utilizes the pressure steam. The pump shall be float operated with a stainless steel mechanism and installed with a F&T trap immediately downstream of the pump.

H. All gaskets on steam systems shall be steel-spun gaskets.

I. Flash steam is created when the pressure of high temperature condensate is reduced. Provide a flash tank or other means of capturing the flash steam for high and medium pressure sources so it can be used as low pressure steam. High pressure return connects to the inlet to the flash tanks. Connect the discharge

from the flash tank to the low pressure supply and the condensate connection to the low pressure return system.

J. Steam is distributed at 110 psi, reduced to 50 psi and then further reduced to 10 psi for use in the building. Steam pressure reducing valves shall be pilot actuated, diaphragm type with adjustable pressure range and positive shutoff.

K. Steam pressure regulators should be furnished with pressure gauges with dampers and cocks, inlet and outlet valves, inlet strainers with blow-down valve, and globe-valved by-pass line installed in the same vertical plane as the main. Each should be vented to outside the facility through a relief valve.

1.17 232500 – HVAC WATER TREATMENT

A. Specify pot feeders for all closed-loop systems and provide recommended treatment method and chemicals.

1.18 233113 – METAL DUCTS

A. Acceptable polyvinyl spiral duct manufacturers:

1. PVS
2. United McGill
3. Semco
4. Norlock

B. Require all low pressure duct for HVAC to be constructed galvanized steel and sealed in accordance with SMACNA and these guidelines.

C. Ductwork shall be constructed to meet low pressure standards; 2500 fpm maximum; -2.0 in W.G. positive or 2.0 in W.G. negative static pressure for all system from terminal units to registers, grilles, and diffusers.

D. Ductwork between the air handling unit and the terminal units shall be constructed to meet medium pressure standards; 4000 fp velocity; 4.0 in W.C. maximum positive or -3.0 in W.G. or greater negative static pressure.

E. Specific applications, supply and exhaust may require high pressure class construction. These situations should be avoided wherever possible. High pressure construction has a velocity greater than 4000 fpm and pressure over 4.0 in W.G. positive.

F. All exhaust systems other than toilet rooms exhausted with individual fans shall be medium pressure construction.

G. Require complete cleaning of the inside of the air distribution system before the fans are turned on, then require filters of the same efficiency as specified to be put

in place prior to operation and be changed during construction if needed, and just before acceptance.

H. Do not allow round duct to be fitted into an oval fitting by collapsing the duct. A round to oval transition should be used.

I. Allow no flexible duct runs over 3 feet in length. Require equalizing grids on the downstream end and require straight section at least equal to the diameter at the diffuser.

J. All flexible ducts must be at least as large as the diffuser neck size. Do not make 90° changes in direction with flexible duct.

K. Require all joints to be sealed air tight with flange type connections. Require joints to be inspected before insulation is applied.

L. Specify maximum transition angles of 20° for convergent airflow and 30° for divergent airflow. Blunt transitions should not be permitted.

M. Transitions between air handlers and ductwork should be designed for maximum efficiency to minimize system effect.

N. Require upstream duct attached to the VAV box to be straight, rigid and without size change for no less than five (5) diameters upstream of box.

O. Require horizontal duct supports at each joint and at 4 feet on center maximum in accordance with SMACNA recommendations. Anchor hanging strips to structure. Impact driven anchors in steel or concrete structure should not be permitted. Require vertical duct supports at each floor that will support the weight of ductwork in that section without deflection or distortion.

1.19 233300 – AIR DUCT ACCESSORIES

A. Acceptable fire damper, smoke damper, and combination smoke and fire damper manufactures:

1. Safe Air
2. Louvers & Dampers
3. Greenheck
4. Ruskin

B. Acceptable backdraft and volume dampers and accessories manufacturers:

1. Greenheck
2. Ruskin
3. Vent Products
4. Safe Air

C. Acceptable duct access door manufacturers:

1. Air Balance
2. American Warming
3. Prefco
4. Ruskin
5. United McGill
6. Ventfabrics
7. Cesco
8. Kees
9. Nailor Industries
10. Safe Air

D. Acceptable Sound Attenuator Manufacturers:

1. Industrial Acoustics
2. McGill Airflow
3. Rink
4. Ruskin
5. Vibro-Acoustics

E. Require fire dampers to have blades outside the air stream to be sealed in the wall with fireproof sealant and to have an adequately sized access into the damper in the ceiling to the damper.

F. Require volume dampers in all duct branches for primary balance and purposes.

G. Sound attenuators shall be factory fabricated and tested, round or rectangular. Fill material shall be inert and vermin-proof fibrous material.

H. Require that all exterior louvers be fitted with a bird screen of not less than ¼-inch x ¼-inch hardware screen.

1.20 233423 – HVAC POWER VENTILATORS

A. Acceptable manufacturers for centrifugal fans, utility/vent sets, ceiling and wall exhaust fans:

1. Acme
2. Barry
3. Cook
4. Greenheck
5. Penn
6. Strobic

B. Acceptable manufacturers for propeller fans:

1. Acme

2. Cook
3. Greenheck
4. Penn

C. General use exhaust fans should be aluminum housed to high efficiency fans, fully vibration isolated, with motor and drive housing completely sealed from the outside exhausted air. Require upstream duct attached to the VAV box to be straight, rigid and without size change for not less than five (5) diameters upstream of box.

D. The maximum RPM for all utility fans should be 1800. If a fan cannot be selected within this range, select a type of fan that is specifically designed to operate at a higher RPM, such as a radial blade-type.

1.21 233600 – AIR TERMINAL UNITS

A. Acceptable Manufacturers:

1. Metal Industries
2. Nailor Industries
3. Anemostat
4. Titus
5. Trane Company
6. Price
7. Enviro-Tec
8. Tuttle & Bailey

B. Terminal units shall be of the type required for the specific application. Constant volume units shall include hydronic reheat coils. Sound attenuator sections shall be included in sensitive noise applications. Damper operators shall be provided that are compatible with Invensys and factory-mounted.

C. Require pipe size to reheat coil to be 3/4-inch, unless capacity requires a larger size.

D. Require Pete's plugs only before and after terminal units.

E. All VAV boxes should have a hospital liner, nylon bearings at both ends of the damper, a center-pivot round disk damper with full shut-off capability, a metal damper shaft through full length blade, and a multiple point flow sensor in the inlet to the box.

F. Require upstream duct attached to the VAV box to be straight, rigid and without size change for not less than five (5) diameters upstream of box.

1.22 234100 – PARTICULATE AIR FILTRATION

A. Acceptable Manufacturers:

1. Nebraska Air Filter
2. American Air Filter
3. Camfil Farr
4. Flanders

B. Provide two extra sets of air filters for all equipment at the time systems are turned over to the Owner.

C. Aluminum mesh filters used to filter debris and insects from outside air intakes shall have a “minimum efficiency reporting value” (MERV) of 3.

D. Throwaway filters, usually 1-inch thick, used in fan coil and cabinet unit heaters, shall have a MERV of 4.

E. Pleated prefilters, 1-inch or 2 inches thick, dust-spot efficiency of 30%, shall have a MERV of 8.

F. Cartridge filters mounted in holding frames shall be of various efficiencies, depending on the user requirements. Normal office/classroom occupancies shall have a 60% to 65% MERV 11. Areas requiring a cleaner air supply like medical/laboratory spaces may use any of the following:

1. 85% dust-spot: MERV 13.
2. 90% dust-spot: MERV 14
3. 95% dust-spot: MERV 15

G. High efficiency particulate air (HEPA) and ultra low penetration air (ULPA) cartridges, MERV 16 to 20.

H. All cartridge filters shall include a pleated prefilter.

I. Provide access for maintenance of filter banks.

J. Update the air handling unit filters on remodel projects to the standards required by the Use/Facilities Management. Increase the air handling unit static pressure, RPM, and motor BHP as required.

1.23 235700 – HEAT EXCHANGERS FOR HVAC

A. Manufacturers:

1. API Heat Transfer
2. Armstrong Pumps
3. Baltimore Air Coil
4. ITT Bell & Gossett
5. Patterson Kelly
6. Taco

B. Steam hot water converters: Provide shell and tube heat exchangers (HX). Use low pressure steam (10 psig) from production of 200° F or lower HWS. Size control valves 2 inches and smaller as a single valve. If the HX requires a 2-1/2 inches or larger valve, provide two valves, one sized at 2/3 load and the second at 1/3 load. Install with isolation and bypass valves around control valves.

1.24 237313 – MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

A. Acceptable manufacturers for air-handling units include:

1. Carrier
2. Trane
3. Airtherm
4. Buffalo
5. Coil Company
6. Engineered Air

B. Design air handling units with supply fans, return/relief fans, and mixing boxes with relief dampers for economizer cooling.

C. Require all air-handling units to have steam preheat coils in the fresh air section designed for a minimum ventilation requirements at -20° F design temperature.

D. Use “plug” fans in all air-handling units except where this type of fan would be inadvisable because of technical reasons.

E. All fans should have adjustable drive sheaves with companion sheaves on the fan axle.

F. Access doors should be provided to all areas of the air-handling unit to provide access to both sides of all coils, fans, filters, dampers, reheat coils, etc. Provide windows in access doors and lights inside compartments.

G. Every unit with a cooling coil should be required to have a condensate pan and drain and drain line with trap to a building floor drain or sink. Require the condensate pan, drain, and drain line be located so they are easily accessible for cleaning and maintenance.

H. Require filtration of all incoming air at a minimum of 30 percent.

I. Require dampers to have extensions extending through the air handler enclosure or ductwork to permit the installation of damper actuators. Shafts should not exceed 1-inch in diameter. Each shaft shall control no more than 16 square foot of damper area.

J. Require all coils to be such as that they can be easily replaced, copper tubing not more than 10 fins per inch, expanded tube, or continuously soldered fins. Coil

ends should have removable insulated casing panels. Coils should have air vents that are automatic and extend out of the casing so they are accessible.

K. Temporary filters, same as required for the unit, should be required to be installed prior to the start-up. Require these filters to be changed as required by static pressure drop readings during construction and again regardless of static pressure drop readings just before acceptance by Creighton University.

L. Specify pre-filters on all 60 percent and higher filter banks.

M. Specify magnanelic gauges across every filter bank.

1.25 238216 – AIR COILS

A. Chilled Water Coils Acceptable Manufacturers:

1. Aerofin
2. Carrier
3. Coil Company
4. Heat Craft
5. Trane
6. USA Coil

B. Preheat Coils Acceptable Manufacturers:

1. Wing
2. Trane
3. Marlo
4. Aerofin

C. Reheat Coils Acceptable Manufacturers:

1. Aerofin
2. Carrier
3. Trane
4. USA Coil
5. Heat Craft
6. Coil Company

D. Chilled Water Coils:

1. Design all chilled water coils for a maximum face velocity of 500 feet per minute.
2. Require that all chilled water coils have extra large drain plugs in the bottom.
3. Design all coils for a minimum of 8 rows.

E. Steam and Hot Water Coils:

1. Preheat coils shall be of the internal face and bypass design with modulating control valves. When temperatures are above 40° F, the capacity shall be controlled with the modulating valve. At temperatures below 40° F, the valve shall be 100% open and capacity is controlled by modulating the face and bypass dampers.
2. Reheat coils shall be of the steam distributing type or hot water with the supply at one end of the tube and condensate return at the opposite end. Discharge air temperature is controlled with a modulating control valve.

1.26 238219 – FAN COIL UNITS

A. Acceptable Manufacturers:

1. Trane
2. McQuay
3. Airtherm
4. Engineered Air
5. Marlo
6. York
7. USA Coil

B. Fan coil units shall be provided to meet the project needs. Units may be vertical cabinets mounted under windows, stacked vertical cabinets mounted in corners of rooms and horizontal exposed or concealed, with or without ductwork. A two-pipe changeover system will generally be used with a single coil. Control valves will be modulating 2-way. Cooling coils should be selected for 14° F ΔT.

C. Require pipe size to reheat coil to be 3/4-inch, unless capacity requires a larger size.

D. The ΔT across cooling coils should be 14° F.

E. Require the installation of 3/4-inch drain and vent lines on all coils.

F. All reheat coils shall have access panels both upstream and downstream of the coil.

1.27 238413 – HUMIDIFIERS

A. Humidification shall be used when directed by the user/facilities management. Humidifiers shall be low pressure steam (10 psig or less) where steam is injected directly into the air stream.

B. Where purse steam is desired in lieu of central plant steam, a self-contained unit using plant steam or electricity may be used to generate steam.

C. The steam supply shall be trapped to insure dry steam. Steam condensate shall be returned to the condensate system.