Boise State University

Division 23 - Mechanical Design Guidelines

Updated Jul 27, 2023

Summary

The purpose of this document is to provide the design team with an easy to reference document containing Boise State University's guidelines for construction projects on campus and is intended as a resource to inform the design process. This document does not remove responsibility from the designer, preclude the use of engineering judgment, or relieve the designer from meeting all adopted code requirements. Questions, clarifications, or suggestions can be directed to the Boise State University Project Manager (PM).

These guidelines have been developed as a joint effort between the Facilities, Operations and Maintenance (FOM) team and the Architectural and Engineering Services (AES) team to help ensure the resiliency of Boise State's campus by considering maintenance needs, sustainability goals, future expansion, and responsible stewardship of our resources. These guidelines are created from both common industry standards and lessons learned through the practice of engineering and maintenance. They are arranged using the Masterspec Divisions to help facilitate a common language.

Related / Supporting Documents

In addition to this document, see the following Boise State University Guidelines:

1. *Utilities and Metering Guidelines*
2. *Preferred Manufacturers - Mechanical*
3. *Building Automation System (BAS) Guidelines*

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Section 230500 – Common Work Results for HVAC

General Requirements

At a minimum, design systems to comply with the latest version of adopted codes in the State of Idaho. These guidelines are intended to indicate areas where the University intends to go above and beyond the minimum requirements of the code.

Maintenance / Access

1. The design and installation of equipment, piping, conduit, etc., will facilitate service, maintenance, and removal / replacement of equipment and components and shall be of the highest priority. Careful coordination between disciplines allowing for said ease of maintenance is expected to be reflected in the final construction documents. The designer shall consider sloped piping and other components that require a "right of way."
2. The designer shall coordinate with the University, equipment representatives, and other disciplines to identify equipment that will require extra structural supports and hoist anchor points for maintenance of large or heavy equipment. The use of mobile cranes shall be minimized. Consider providing a roof mounted davit crane where necessary.
3. Coordinate roof access with architecture. Options are listed below in order of the University's preference:

Roof Access Methods		
1	Elevators	Required for mechanical penthouse's. Preferred option for all roofs with large equipment.
2	Stairs	Provide stair access to all roofs with large equipment.
3	Ships Ladder / Roof Hatch	Non-alternating tread type ships ladder is acceptable instead of providing stairs only when stair access is not feasible. Ships ladder design must be discussed with and approved by the University PM and Facilities team.
4	Access Ladders / Roof Hatch	Coordinate with the University PM and Facilities team to discuss acceptable applications for traditional access ladders and roof hatches.
5	Alternating Tread Type Ships Ladder	Not acceptable.

4. When ceiling access panels are required, the minimum access panel size shall be 24"x24" for ease of maintenance. Coordinate with architecture.
5. Equipment which is located on a rooftop and which requires periodic cleaning shall have a source of water provided at the roof level within 50 feet of the equipment. Hose bibs shall be freeze proof design.
6. Coordinate with electrical to provide lighting for rooftop mounted equipment.

Documents / Drafting / Deliverables

Sheets

1. Clearances for equipment and other areas intended for maintenance / replacement are required **to be identified on the drawings**. These areas shall include enough space / pathways for removal of coils and other large pieces of equipment.
2. General notes and legends are required on the drawings.
3. Section views shall be provided on drawings along corridors and other congested areas where equipment / valve access will require coordination amongst trades.
4. When possible, show furniture layouts on mechanical drawings to ensure that equipment is in an accessible location.
5. Construction documents shall be a complete design.
6. Include floor plans showing all areas of work.

Specifications

1. State that paper and electronic copies of Operations and Maintenance (O&M) Manuals are required.
2. Specifications shall state that electronic O&M manuals will be electronically bookmarked by section.
3. Where O&Ms include manufacturer / product literature that is searchable in its original format, it shall also be searchable in the electronic O&Ms. Handwritten documents or as-builts are not required to be searchable.
4. Owner's Training shall be provided for all equipment and is required to be recorded for the following applications:
    a. New buildings / new construction.
    b. Building Automation System controls.
    c. Sequence of Operations. See 230900, General Requirements note 5 for more information.
    d. General maintenance / procedures on large equipment such as boilers, air handling units, chillers, etc.
    e. When requested by the University Project Manager or Facilities Team.

As-Built Drawings

Record Documents shall contain actual installed inverts and locations of buried piping.

Design Conditions

General

Boise State University regularly sees outdoor conditions significantly higher than the design conditions listed by ASHRAE for Boise, Idaho. Therefore the following design conditions shall be used in heating and cooling load calculations.

Indoor / Outdoor Design Conditions		
	Outside Air Conditions	Indoor Design Conditions (1)(2)

	(°F dB / °F wB)	(°F dB)
Summer	105°F dB / 64°F wB	75°F dB
Winter	0°F dB	70°F dB

1. Coordinate with Boise State for areas requiring non-standard indoor design temperatures.
2. Maintain a minimum temperature of 45°F in mechanical rooms and other spaces where pipes containing liquid are present.

Other Requirements

1. Humidity: Discuss design methods for controlling areas of high humidity with the University PM and Facilities team.
2. Ventilation: At a minimum, ventilation shall be designed per the most current standards adopted in the State of Idaho. Higher ventilation rates may be required by the University in certain spaces or to reduce the risk of infection via airborne diseases.

Sustainability and Energy Goals / Requirements

Design of HVAC systems shall consider the dynamic nature of the University and shall take into consideration future growth, alternative energy sources, and energy saving measures such as:

- Utilizing geothermal heating to the greatest extent possible. At a minimum, consider reserving space for geothermal equipment and accessories for future connections to the geothermal system.
- Implementing solar arrays.
- Combined heat and power (CHP) retro-fits.
- Condensate Recovery.

The total cost of ownership (TCO) shall be a primary consideration when reviewing the cost of construction projects.

Demolition and Retro-Fit Requirements

1. Where piping, ductwork, electrical components, etc. are indicated for demolition, such items shall be removed and capped at the primary source.
2. Coordinate and show items for demolition across disciplines. For example, mechanical equipment identified for removal shall also be identified on electrical, architectural, etc. drawings.
3. General demolition notes shall state that the University reserves the right to salvage any demolished components whether or not they are identified for salvage in the construction documents.
4. General demolition notes shall state that all backflow prevention assemblies identified for removal shall be salvaged to the University.

Mechanical rooms

1. When feasible, provide ventilation to mechanical rooms.
2. All mechanical rooms with sprinkler piping or other liquid systems capable of freezing shall have a permanent source of heating.

3. Pay special attention to boiler upgrades where existing mechanical rooms may not have permanent heat already installed.
4. Coordinate with the University Facilities team to address how drainage requirements for mechanical rooms are being met (e.g. areas with reduced pressure principle backflow preventers).
5. Provide emergency eyewash stations near chemical feed(s).
6. Maintain a minimum temperature of 45°F in mechanical rooms and other spaces where there is a likelihood of freezing. Heating equipment shall send an alarm to the BAS system when the space temperature drops below 40°F.
7. Coordinate with electrical to provide wifi in all mechanical rooms.

Product Requirements

1. Specify a minimum of three (3) manufacturers or products of similar quality for each component. See the Boise State University Preferred Mechanical list for preferred manufacturer's.
2. It is acceptable to sole source Building Automation System (BAS) components in order to maintain compatibility with existing systems. See Boise State University Division 25 Guidelines for more information on BAS system requirements.
3. All sole sourced products must be approved by the Boise State University PM and Facilities team.

Section 230510 – Basic Piping Materials and Methods

1. Drain valves and stub out connections for future use shall include a valve and an end cap to prevent accidental discharge.
2. Indicate low-point drains on drawings.
3. Indicate high point air relief valves on drawings.

Section 230513 – Common Motor Requirements for HVAC Equipment

Variable Speed Motors

1. Controlled by variable frequency drives (VFDs) for motors over 1HP. ECM motors are acceptable for 1HP or below.
2. Inverter duty, premium efficiency rated motors.
3. Installed with hand off auto (H/O/A) controls.
4. Shaft grounding rings shall be included on all motors served by a variable frequency drive. Coordinate with electrical to electrically ground the pump / motor casings as required by the shaft grounding ring manufacturer. Shaft grounding rings shall be by AEGIS or equivalent.

ECM Motors

1. Allowed for 1HP and below. Provide VFDs above 1 HP.
2. Installed with hand off auto (H/O/A) controls.

Variable Frequency Drives

1. Provide a drive bypass on critical equipment. Coordinate with the University project manager.

2. All VFDs shall be provided with reactors to help mitigate system harmonics.
3. See Boise State's preferred manufacturer list.

Section 230516 – Expansion Fittings and Loops for HVAC Piping

No Boise State University requirements at this time.

Section 230519 – Meters and Gauges for HVAC Piping

1. Meters and gauges for pressure and temperature shall be placed for ease of reading and accurate measurements.
2. Install meters and gauges with isolation ball valves for ease of replacement.
3. Use snubbers for pressure gauges to dampen gauge reaction.
4. Round dial gauges shall be 6" diameter for anything installed 7 feet above the finished floor and a minimum of 4" below 7 feet.

Install pressure gauges and thermometers to meet the location requirements in the Thermometer and Pressure Gauge Locations Table below.

Thermometer and Pressure Gauge Locations			
Equipment	**Location**	**Thermometer**	**Pressure Gauge**
Pumps	Suction and Discharge		X
Pressure Reducing Valves	Discharge		X
Water Service Entrance	Outlet		X
Refrigerant Cooled Chillers	Inlet and Outlet	X	X
Water cooled Condensers	Inlet and Outlet	X	X
Heating / Cooling Coils at Large Equipment*	Inlet and Outlet	X	X
Heat Exchangers	Inlet and Outlet	X	X
Heat Recovery Unit	Inlet and Outlet	X	
Each Hydronic Zone	Inlet and Outlet	X	
Boilers	Inlet and Outlet	X	X
Thermal Storage Tank	Inlet and Outlet	X	
AHU Discharge Duct / Plenum	Discharge	X	
Domestic Hot Water Heater	Inlet and Outlet	X	
Other Locations deemed appropriate by Boise State University or the designer		X	X

*Provide testing ports at terminal units and fan coils.

Section 230523 – General-Duty Valves for HVAC Piping

1. Integral locking tabs shall be included on isolation valves for convenience of system or equipment lockout/tagout.
2. Provide 2" and larger valves located more than 7 feet above finished floor in mechanical spaces with chainwheel operators. Chains shall terminate 7' above the finished floor.
3. Control valve actuators for large central equipment such as air handlers, chillers, and boilers shall be modulated with a 0-10VDC or 2-10 VDC proportional control strategy only. See zone level equipment sections for control valve requirements at terminal units, fan coils, etc.

4. Provide Pressure Independent Control Valves when possible.

Section 230529 – Hangers and Supports for HVAC Piping, Ductwork, and Equipment

1. All sheet metal edges shall be hemmed for safety.

Section 230548 – Vibration and Seismic Controls for HVAC Piping and Equipment

No Boise State University requirements at this time.

Section 230553 – Identification for HVAC Piping and Equipment

General

All components that require maintenance must be labeled with a number that corresponds to a ledger.

Valve Tags / Schedule

1. Valve Tags and Schedules shall be required for all projects containing valves for control, emergency shutoff, or similar special uses.
2. In addition to extra copies included with the O&M manuals, provide mounted copies in frames located in mechanical rooms. Include floor plans in the O&M manuals and in mounted frames identifying the location of valves coordinated and tagged according to the valve schedule.

<u>Frames</u>

1. **Snap Type Poster Frame with Laminated Schedules:** Provide valve schedules and floor plans on laminated bond paper. Provide poster frames similar to SnapeZo (SNAP-8.5-11-SB-25MM) such that laminated valve schedules and floor plans can be removed from the frame. Provide frames of aluminum with screws for removable mounting on walls.
2. **Location:** Mount valve schedule frames and schedules in mechanical equipment rooms where directed by the University. Where more than one major mechanical equipment room is shown for a project, install a mounted valve schedule in each major mechanical equipment room, and repeat only main valves which are to be operated in conjunction with operations of more than a single mechanical equipment room.

Ductwork

Ducts shall be labeled with the direction of flow and duct type (supply, return, exhaust, etc.):

1. On both sides of each wall penetration.
2. Inside each room.
3. No more than 50-foot intervals.
4. No more than 25-foot intervals in congested areas.

Piping

Piping shall be labeled with the fluid conveyed and the direction of flow:

1. On both sides of wall or floor penetrations.
2. Once on every straight run of pipe.
3. No more than 20-foot intervals.
4. No more than 10-foot intervals in congested areas.
5. Within 3 feet of each piece of equipment, valve, or control device.

Equipment

Equipment tags shall be color coded and attached in a visible location. Labels shall include:

1. Component identification designation (coordinated with construction drawings).
2. Area served (Including areas or equipment of critical impact if equipment is shut-off).
3. Power source (coordinated with electrical).

Label Color and Size Requirements

All pipes, ducts, and equipment shall be labeled according to ANSI standard A13.1. See table below for examples.

Label Color Schedule Per ANSI A13.1	
Water (Heating, chilled, potable, boiler feed, etc.)	Green Background with White Letters
Compressed Air	Blue Background with White Letters
Natural Gas / Refrigerant / Steam	Yellow Background with Black Letters
Fire Suppression	Red Background with White Letters
Acid Waste	Orange Background with Black Letters
Equipment Labels*	Black Background with White Letters
Supply Duct	Green Background with White Letters
Exhaust Air Duct	Yellow Background with Black Letters
Return / Relief Duct	Blue Background with White Letters
Outside Air Duct	Blue Background with White Letters

*Label all equipment that is on generator power with a Red Background and White Letters

Text Height Requirements		
Equipment Labels	Main Designation Supplemental Info	¾” high text minimum ½” high text minimum

	Large Equipment w/viewing distances beyond 10 feet		3” high text main label
Piping	O.D. of ¾” to 1-¼” O.D. of 1-½” to 2-⅜” O.D. of 2-½” to 7-⅞” O.D. of 8” to 10” O.D. over 10”	Letter Size: ½” high Letter Size: ¾” high Letter Size: 1-¼” high Letter Size: 2-½” high Letter Size: 3-½” high	Marker Size: 8” wide Marker Size: 8” wide Marker Size: 12” wide Marker Size: 24” wide Marker Size: 32” wide
Ducts	All Duct Sizes	Letter Height: 3.5”	
Ceiling Labels	Letter height: ½” Minimum		

Section 230593 – Testing, Adjusting and Balancing for HVAC

The Testing, Adjusting and Balancing (TAB) Specification shall contain, at a minimum:

- TAB balancing criteria
- Immediate notification of non-performing systems
- TAB verification

Balancing Criteria

1. Adjust flows to within five (5) percent below design and ten (10) above. If design flows cannot be obtained within these limits the Balancing Contractor shall perform the following, at a minimum:
    a. Immediately contact the DPW Project Manager, Boise State PM, and Commissioning Consultant explaining the problem.
    b. Consult with the Engineer and appropriate contractor as required and/or requested by the DPW Project Manager and/or Commissioning Consultant.
    c. Perform appropriate measurements to help determine the problem such as measuring and recording major pressure drops in the system.
    d. Upon receiving written directions to proceed and after any corrections are performed, re-balance the affected portion of the system.
2. Contractors shall, when initially filling and treating hydronic systems, measure the total amount of fluid required to fill the system completely, and that volume shall be entered in (1) the operations and maintenance manual and (2) the test and balance (TAB) report.

Retrofits

1. On certain retro fits of controls and other components the existing air and hydronic systems shall undergo a TAB verification before demo / replacement of components. Verification should record the existing conditions so that the equipment can be re-balanced at the end of the project and maintain the existing operating characteristics. Consider the following for each system:
    a. Airflow: CFM, velocity, pressure drop, duct static pressure, fan speed, temperatures, etc.
    b. Hydronic: GPM, system pressure, pump speeds, temperatures, etc.

Commissioning

1. Discuss commissioning requirements with the University Project Manager. Commissioning is desired for most projects on campus. Include provisions for commissioning by a 3rd party agent whenever budget allows, or where required by code.
2. Include provisions such that systems are commissioned seasonally as appropriate for the system.

Section 230700 – HVAC Insulation

Insulation

1. Insulation shall be provided to meet the International Energy Efficiency Code.
2. Provide UV protection for all exterior exposed insulation. Refrigerant piping without a field applied jacket is unacceptable.
3. Removable components such as valves and unions, and manufacturer's label plates and National Board (ASME) stamps, shall be insulated using removable and reusable insulation wraps or covers.
4. Insulation around valves shall have removable blankets and not hard plastic-cased for ease of maintenance, repair or removal of valve.
5. Insulation around pumps shall have access doors adequately sized and situated to allow access to pump strainers. Insulation shall not hinder access of grease fittings for regular maintenance.
6. Hot Pipes/Ducts: All steam and hot water pipes and hot exhaust ducts whose external temperature exceeds 140℉ or is a sufficient temperature to burn a person and which are within seven (7) feet of a floor or working surface, or within fifteen (15) inches measured horizontally from stairways, ramps or fixed ladders, shall be covered with an insulating material or be guarded in such a manner as to prevent contact.

Lining

1. Acoustic liner shall be either Fibrous Glass with an aluminum jacket or acrylic coating to prevent entrainment of fibers into the air system, or Flexible Elastomeric.
2. Line the first 10 feet of supply and return duct from air handling equipment fans with 1" acoustical liner.
3. Transfer boots shall have a minimum of ½" acoustical liner.
4. Internal lining is not acceptable in lab spaces. Coordinate with the University Project Manager, and Facilities team for sound attenuation in lab spaces.

Section 230900 – Instrumentation and Control for Mechanical Systems

In addition to the guidelines below, see *Boise State University - Building Automation System (BAS) Guidelines* for more details concerning BAS systems.

General Requirements

1. BAS systems shall be either Johnson Controls Inc. Metasys system, Siemens Building Technologies building automation systems Desigo CC, or Automated Logic Web CTRL building

automated system. Automatic temperature controls shall be provided by or be fully compatible with one of these systems.
2. Provide a written sequence of operations and control diagrams in the construction documents.
3. Retro-fits and new construction shall include updating existing and creating new graphics for all input points.
4. Differential pressure transmitters shall monitor and display the actual differential pressure.
5. Owners training on the Sequence of Operations of equipment that has been recorded shall be accessible via hyperlink from the graphics.
6. A written sequence of operations shall be accessible via hyperlink from the graphics.
7. Room sensors/thermostats shall be wired and include override capabilities or reset capability unless specifically approved by the University PM.
8. Equipment that operates as lead / lag for equal runtime shall be sequenced as follows. Odd numbered equipment shall be the lead on odd numbered months and even numbered equipment shall be the lead on even numbered months.

Specifications

Specifications shall state the following requirements:

1. The control contractor shall create a new graphical interface from controllers and equipment as necessary to reflect the system layout and floor plan. Graphics shall include all equipment monitored, scheduled, or controlled by the BAS system and shall display the following through the BAS system user interface.
    a. All physical inputs and outputs.
    b. Command states (Ex. occupancy, economizer, etc.)
    c. Setpoints
2. The control contractor shall add trends on all control points that shall be archived on a server for long term storage.
3. Provide a complete graphical interface including the following pages:
    a. Summary Page
    b. Floor Plans with Room Temperature Display
    c. Equipment Location Floor Plan
    d. Mechanical Systems / Equipment
    e. Zone / Room Level Plans
    f. Lighting Control Floor Plans
4. Specifications shall state that “Controls contractor shall coordinate with the agency’s Building Automation Systems Administrator for point naming convention requirements.

Section 231113 – Facility Fuel-Oil Piping

There are no facility fuel-oil systems on campus.

Section 231123 – Facility Natural-Gas Piping

1. Interior rooms and laboratories having natural gas service shall be provided with emergency shutoff valves easily identifiable and accessible from outside of the room or laboratory. See Boise State University Laboratory Room Guidelines for more details on laboratory facilities.

2. The use of flexible gas piping material is not allowed except at equipment or appliance connections. Flexible steel gas piping shall not be embedded in any concrete floor and flexible will not be used in building gas distribution piping.
3. Piping in areas with corrosive or high humidity locations (e.g., pool areas, greenhouse) shall be stainless steel, or similarly corrosion resistant. Corrugated Stainless Steel Tubing (CSST) is acceptable for connections.

Section 232113 – Hydronic Piping

General Requirements

1. Any loop requiring glycol freeze protection shall have a properly sized glycol make-up tank.
2. All underground piping including hydronic lines such as steam, hydronics and geothermal shall have a 14-gauge insulated tracer wire from the point where the line connects to the nearest public utility or other main line to the point of building entry installed for use in locating the line after being covered. Tracer wire shall be installed regardless of piping material.
3. Install an irrigation box for underground utilities to help identify what a tracer wire is tracing.

Piping Materials and Methods

Not every situation is addressed below. Discuss deviations from the following materials with the University PM and Facilities team.

<u>Heating Water Piping</u>

- NPS 2” and smaller
    - Type L hard drawn copper tubing, wrought copper fittings, soldered joints, lead free solder.
    - Schedule 40 black steel pipe, class 150 malleable iron fittings, cast iron flanges and flange fittings, and welded and flanged joints.
- NPS 2-½” and larger
    - Type L hard drawn copper tubing, wrought copper fittings, brazed joints.
    - Schedule 40 black steel pipe, class 150, malleable iron fittings, cast iron flanges and flange fittings,and welded and flanged joints.

<u>Chilled Water Piping</u>

- NPS 2” and smaller
    - Type L hard drawn copper tubing, wrought copper fittings, soldered joints, lead free solder.
    - Schedule 40 black steel pipe, class 150 malleable iron fittings, cast iron flanges and flange fittings, and welded and flanged joints.
- NPS 2-½” and larger
    - Type L hard drawn copper tubing, wrought copper fittings, brazed joints.
    - Schedule 40 black steel pipe, class 150, malleable iron fittings, cast iron flanges and flange fittings,and welded and flanged joints.
    - Mechanical Grooved Fittings. Preferred manufacturer is Victualic.

Equipment Drains and Overflows

- Up to NPS 1:
    - Type M hard drawn copper tubing, wrought copper fittings, soldered joints, lead free solder
- NPS 1-1/4" and larger:
    - Type DWV hard drawn copper tubing, wrought-copper fittings, soldered joints, lead free solder.

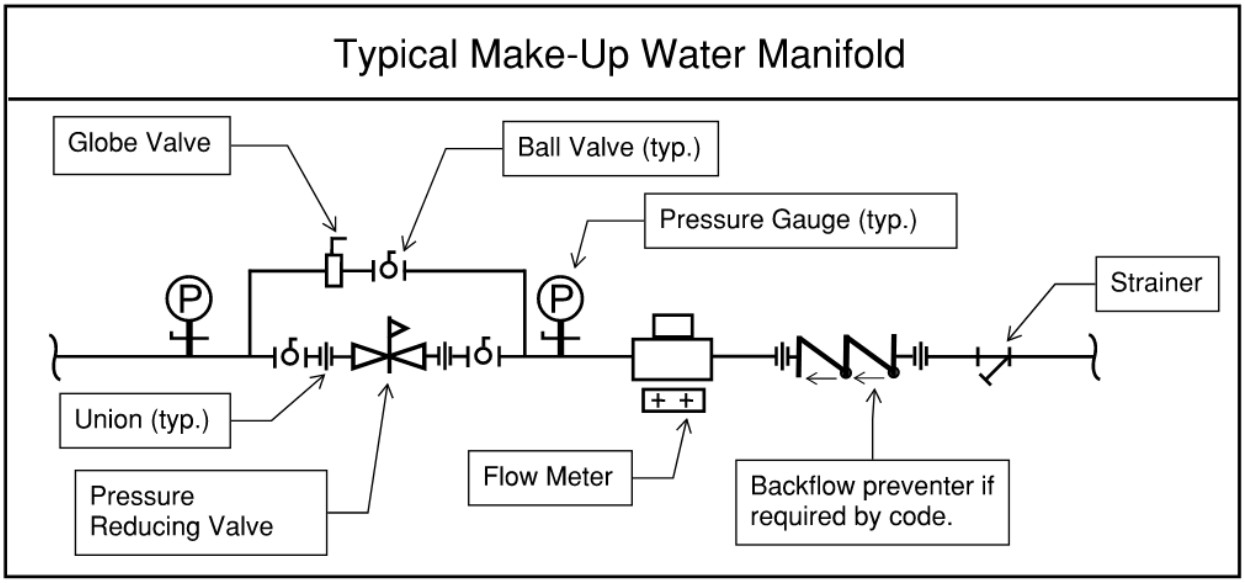
Makeup Water Piping

- Type L or M hard drawn copper tubing, wrought copper fittings, soldered joints, lead free solder.

Make-Up Water Manifolds

Makeup water manifolds shall consist of the following components:

1. Reduced pressure backflow preventer (where required).
2. Pressure regulating valve.
3. Isolation valves on both sides of the pressure regulating valve.
4. Bypass loop with isolation ball valve and adjustable globe valve.
5. Pressure gauges before and after the pressure regulating valve, upstream and downstream of the isolation valves, and a flow meter to measure total makeup water volume.
6. Flow meters and associated alert systems preferred in critical and remote locations.



Section 232116 – Hydronic Piping Specialties

1. Closed loop hydronic systems shall be provided with filter-feeder which will serve as full-time filtration and periodic water treatment.
    a. Filters shall be pleated polyester type and shall be compatible with the temperature of the hydronic system.
    b. The basis of design shall be Harmsco series 801-50 filters (801-50-HT for high temperature systems).

    c. Provide circuit setters set to limit flow to 10 GPM or the recommended flow rate of the filter.
2. Provide floor-mounted bladder-type expansion tanks when possible.
3. Tangential-type air and sediment separators shall be provided for all hydronic systems, unless separate air separators and sediment separators are provided.
4. Sample connections shall be provided for each hydronic system. Connections shall be attached to the side (midline) of the hydronic piping.
5. When triple-duty valves are provided, also provide isolation valves on the supply and return piping for servicing.
6. Strainers that serve cooling tower condenser water or other open loop systems shall have stainless steel internals.
7. Guides shall be provided at all flexible connections and flexible joints. The designer shall evaluate all piping with regard to the stresses imposed by temperature variations. Offset loops shall have dimensions called out and hangers selected to provide support throughout the temperature range. Pipe anchors shall be provided where required. Forces imposed by the piping system shall be provided to the Structural Engineer for appropriate support.

Section 232123 – Hydronic Pumps

1. Separately coupled, base-mounted, end suction centrifugal pumps are preferred. Close coupled, base-mounted pumps may be used only when floor space doesn't allow for separately coupled pumps.
2. All base mounted pumps shall be provided with a suction diffuser.
3. Pumps and motors shall be base-mounted whenever possible. When pumps and motors over 50 pounds are installed above the finished floor, coordinate with the structural engineer to include pick points for maintenance and removal.
4. Pumps serving cooling tower condenser water or other open loops systems shall be provided with stainless steel internals.
5. Provide pumps with VFDs, shaft grounding rings, and premium efficiency inverter duty rated motors.
6. Install pressure gauges for pumps on the inlet and outlet of the pump.
7. Pumps that operate in lead lag for equal runtime shall operate as follows. Odd numbered equipment shall be the lead on odd numbered months and even numbered equipment shall be the lead on even numbered months.

Section 232213 – Steam and Condensate Heating Piping

1. All condensate piping shall be Schedule 80 A53 steel pipe. All underground steam lines shall be installed in steam tunnels with double wall pipe rated for the temperature and the pressure of steam to be transported.
2. Adequate provisions shall be provided for expansion and contraction. Anchor points shall be provided as required by code.
3. Access panels shall be adequately sized and situated to service or replace piping and equipment, shall be located above expansion joints and valves. Access panels shall be designed for one person to open safely. Coordinate with the University for preferred styles.
4. Strainers are required upstream of all control valves and traps.

5. Provide a check valve downstream of traps.

Section 232216 – Steam and Condensate Heating Piping Specialty

1. When shell and tube heat exchangers are installed, consider providing extended shell type.

Section 232223 – Steam Condensate Pumps

1. Electric duplex pumps are preferred over pressure powered pumps due to the increased redundancy. Consult with the University Project Manager and FOM team if pressure powered pumps should be considered.
2. Pumps shall be easily accessible with safety in mind (e.g., not under a stairwell or in a pit). Install condensate pumps with ball valves and unions that allow the pump to be removed.
3. Condensate tank / pump vent piping shall be discharged to a safe location.
4. Condensate receivers shall be adequately sized so that system condensate is contained without discharging to waste during the shutdown periods.
5. Steam Condensate pumps shall be on emergency power. Coordinate with electrical.

Section 232300 – Refrigerant Piping

1. Follow all manufacturer instructions for refrigerant piping installation including suction piping traps, piping slopes, joining methods, and testing procedures.
2. Any vertical rises in suction piping shall be trapped per manufacturer instructions.
3. All refrigerant piping shall be insulated according to industry standards. Insulation shall be closed-cell rubber (Armaflex or equivalent). Exterior piping and insulation shall be protected from UV radiation.
4. All wall penetrations shall be sleeved to protect the piping and insulation.
5. 45 degree fittings are unacceptable.
6. All wall penetrations in fire rated assemblies shall be fire-caulked.
7. All exterior wall penetrations shall be sealed with polyurethane sealant (Vulkem 116 or equivalent).
8. All chillers and large refrigerant systems shall have factory-installed service valves such that serviceable components (filters, driers, etc.) can be serviced without having to remove the refrigerant from the vessel.
9. Liquid, suction, and hot gas lines shall be secured independently with Hydra-Zorb clamps or equivalent with locking nuts. Use Hydro-zorb insulation clamps for insulated piping.
10. All piping shall be purged with dry nitrogen while brazing or welding. All refrigerant rough-in piping shall be pressure tested to 300 lbs and double-evacuated to 500 microns or less.

<u>Refrigerant Piping Material</u>

- Copper type L or ACR, wrought copper fittings.

Section 232500 – HVAC Water Treatment

1. Coordinate with the University Facilities team for current water treatment procedures and service company.

2. Where practicable, non-chemical water treatment systems shall be used. Such systems shall be capable of being monitored by the building automation system.
3. Provide inhibited propylene glycol for systems subject to freezing.
4. The contractor shall provide and apply initial treatment chemicals and maintain treatment for a period of one (1) year from the date of Substantial Completion. Treatment reports shall be provided for initial conditions and at one (1) month intervals until completion of the warranty period. O&M manuals that include treatment reports shall be provided.
5. Closed loop hydronic systems shall be equipped with filter feeder pots. See 232116 Hydronic Piping Specialties for more details.
6. Water softeners shall interface with the building automation system. Coordinate with Division 22 - Plumbing Design Guidelines Section 223100 for other domestic water softening requirements.

Section 233113 – Metal Ducts

1. All duct fittings shall be fabricated to the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) standards.
2. Ductwork shall not be penetrated by piping, conduit, etc.
3. All duct joints shall be sealed with duct sealer.
4. All dampers and air filter accesses shall be labeled and identified on the ceiling grid and ducts.
    a. Refer to Section 230553 - Identification for HVAC Piping and Equipment for required marking of metal ducts.
5. Existing return ducts shall be protected from construction dust during all remodels.
6. Perform duct leakage tests for duct systems designed to 4" water gauge pressure class or higher.
7. Design duct systems with round ducts whenever space permits.
8. Ducts that serve showers, lockers, pool rooms, or other high humidity areas shall be sloped to a drain or back to the diffuser / grille.

Materials

1. Ducts serving high humidity environments such as showers, lockers, and pool rooms shall be either aluminum or stainless steel.
2. G60 or G90 galvanized steel ducts are acceptable in indoor environments. Where galvanized steel ducts are installed externally, they shall be a minimum G90 and protected with insulation and vapor barrier as required.

Fittings

1. Elbows shall be either long radius or mitered with turning vanes to reduce pressure drop.
2. All low-pressure duct take-offs shall be high efficiency taps with 45 degree entries.
3. Medium pressure ducts shall be high efficiency taps with 45 degree entries or conical taps / tees.
4. Straight taps, straight tees, tapered body lateral fittings, and bullhead tees shall not be allowed.

Grease Duct

1. Round, double-walled, fire insulated, continuous-welded stainless steel material, or pre-constructed sections of the same design.
2. Exhaust ducting shall be installed in a vertical orientation to the maximum extent possible.

3. Where the exhaust duct penetrates more than one floor or roof, the exhaust duct shall be protected over its entire length by a fire suppression system.
4. The exhaust duct shall have generously sized and easily accessible maintenance panels for routine cleaning and inspection.

Transfer Boots

1. All transfer plenum boots shall be galvanized sheet metal lined with 1" internal acoustic liner. See 230700 - HVAC Insulation for more information.
2. Transfer boots shall have a minimum of two elbows for sound attenuation whenever space allows.

Painted Duct

1. When duct is designed to be painted, include notes in the design documents indicating that ducts shall be cleaned and primed prior to painting. Common products used for removing oil from the manufacturing process include vinegar, Simple Green, or other wax and grease remover.
2. Coordinate painting requirements with architectural specifications.

Section 233116 – Nonmetal Ducts

1. Duct board shall not be used.
2. Flexible ducts shall be insulated per code. Flexible duct run outs are limited to a maximum of 6 feet. Use a hard duct fitting to make 90 degree turns whenever space allows.
3. Consider other duct materials such as fiberglass and plastic for corrosive environments and chemical storage rooms.
4. Underground ductwork distribution systems are not-desired when it can be avoided. However, if underground duct distribution is approved by the Boise State PM, it shall be BlueDuct or equivalent.
    a. Slope duct to registers.

Section 233119 – HVAC Casings

No Boise State University requirements at this time.

Section 233300 – Air Duct Accessories

1. Access panels for all dampers shall be placed and sized to safely service the equipment. Ceiling mounted access panels shall be a minimum of 24"x24".
2. Design duct systems to withstand a sudden over pressurization caused by the closure of a fire/smoke damper. Acceptable approaches include specifying the duct pressure greater than the maximum fan pressure and making use of pressure relief doors. Pressure relief doors must be coordinated with Boise State to ensure they are accessible, maintainable, and do not pose a risk to occupants.

Fire and Smoke Dampers

1. Dampers shall have position indicators installed on the damper shaft to indicate positive-open/positive-closed positions.

Fire Damper

1. Type B dynamic fire dampers with blades out of the air stream are preferred.

Combination Fire Smoke Dampers

1. Combination Fire and Smoke damper position shall be monitored by the building fire alarm system.
2. An alarm shall be generated whenever a damper is in the closed position, and shall be reported on the building fire alarm panel and the building automation system.
3. Provide combination fire and smoke dampers with 120 V electric actuators and spring return.
4. Provide electric resettable links.

Balance / Control Dampers

1. Provide manual balance dampers instead of opposed blade dampers (OBD's)in the diffuser face whenever possible.
2. If dampers are inaccessible, provide OBD's operated through the face of the grille.
3. Durodyne (or equivalent) remote cable operated dampers with internal mounted cable accessible through the face of the grille are acceptable only when other methods of balancing are insufficient.
4. Manual volume balance dampers shall have a minimum Leakage Class rating of 2 per AMCA Standard 511 (10 cfm/sq. Ft. against 1-inch wg differential static pressure)
5. Control dampers shall have a minimum Leakage Class rating of 1A per AMCA standard 511 (3 cfm/sq. Ft. against 1-inch wg differential static pressure).

Section 233423 – HVAC Power Ventilators

1. Provide power ventilators that are 1 horsepower or less with direct drive ECM motors. Power ventilators greater than 1 horsepower shall be belt drive. See 230513 for more details on motors.
2. Coordinate roof mounted fan curbs with the actual roof installation. Show power ventilator curbs and roof penetration details with the designed roofing system.
3. Provide curbs tall enough to clear snow and consider built up insulation in selecting the curb height.
4. Curbs that are not covered by the roofing membrane and that are exposed to exterior conditions shall be aluminum.
5. Provide outdoor air and exhaust fans with an aluminum bird screen.

Section 233433 – Air Curtains

1. Provide air curtain units as required by code and place them in a serviceable location and orientation.
2. Coordinate control strategies, scheduling, and monitoring with the University Facilities team.

Section 233513 – Dust Collection System

1. Dust collection equipment shall be in an easily accessible location and orientation, and labeled with equipment identification.
2. Dust collection systems shall be designed in accordance with NFPA 68 and 664.

Section 233600 – Air Terminal Units

1. All air terminal units serving exterior zones shall have a minimum of two-row reheat coils.
2. Design air terminal units to have an air pressure drop (APD) of less than 0.25” water gauge.
3. The minimum design coil flow for all air terminal units shall be 0.5 GPM.
4. Provide 36” clearance on the control side of all terminal units with electric reheat coils.
5. Access for all terminal units must include provisions for removal and replacement of the entire unit in the future.
6. When air terminal units are provided with a hot water reheat coil, modulate the control valve with a 0-10VDC, 2-10 VDC proportional control strategy or floating point control. On/off control strategies shall not be acceptable.
7. Fan Powered Air Terminal Units shall not have a filter on the return inlet to the unit and shall have a flexible connection to ductwork.

Section 233713 – Diffusers, Registers, and Grilles

1. The University standard supply diffuser for office spaces is a modular core design with adjustable pattern vanes similar to the Titus MCD Diffuser. Other diffusers styles may be used outside of office spaces.
2. The University standard return grilles are an egg crate style similar to the Titus 50F for ceiling applications and a grilles with ¾” spaced, long adjustable deflection blades similar to the Titus 350RL for wall mounted applications.
3. When diffusers are installed in hard lid ceilings, consider the use of mounting frames such as the Titus TMS such that the diffuser can lift out of the frame providing access to the ceiling space above.
4. Diffusers and grilles installed in shower rooms, pool rooms, or other high humidity areas shall be aluminum or stainless steel construction.
5. Curved duct mounted grilles such as the Titus S300RL shall be provided with an air scoop device for balancing.
6. Provide linear diffusers with adjustable blades for changing the direction of throw.
7. Every take-off shall be individually dampered.
8. Diffusers that are installed around hoods (Type 1, Type 2, Lab Exhaust) shall be designed such that the diffuser airflow pattern does not interfere with the hood operation. Use modular core, laminar flow, or 2-way / 3-way diffusers when needed to avoid throwing air into the hood cavity space. Show diffuser throw pattern on drawings near hoods.

Section 233723 – HVAC Gravity Ventilators

1. Gravity ventilators shall have backdraft or motorized dampers as required by code.
2. Provide outdoor air and exhaust gravity ventilators with an aluminum bird screen.

Section 233813 – Commercial Kitchen Hoods

1. Exhaust fans for commercial kitchen hoods shall be interlocked with the associated makeup air unit or system.
2. Each Type 1 and Type 2 hood shall be individually exhausted to the outdoors whenever space allows.

Section 233816 – Fume Hoods

See Boise State University Laboratory Room Guidelines for details on Fume Hood Requirements.

Section 234100 – Air Filters

1. All equipment having filters shall use standard-sized filters. Custom-sized and proprietary filters are not allowed.
2. Filters for all air handling equipment shall have minimum efficiency of MERV 8.
3. Design zone level HVAC equipment in new construction projects and retro-fit projects to utilize MERV 13 filters whenever possible. In retro-fit projects, evaluation of existing equipment is necessary to ensure that using MERV 13 filters does not negatively impact the system.
4. Equipment with MERV 13 or higher filtration shall have pre-filters installed whenever possible.
5. Specifying or designing around electrostatically charged filters to achieve a MERV rating is not acceptable.
6. See specific equipment sections for more equipment specific details.

Section 235113 – Draft Control Devices

No Boise State University requirements at this time.

Section 235123 – Gas Vents

No Boise State University requirements at this time.

Section 235200 – Boilers

1. All hydronic boilers installed on campus shall be condensing boilers.
2. The boiler pressure and temperature safety valve shall be piped to the closest drain. Coordinate with plumbing to provide drains of sufficient size in mechanical rooms.
3. Provide boilers with condensate traps and neutralization per manufacturer's written instructions.
4. Provide boiler flues with stainless steel flashing. Caps shall be per manufacturer recommendations.
5. When feasible, provide temporary connections to the heating hot water system such that a rental boiler could be piped into the system during a loss of equipment. Coordinate connection terminations with the University Project Manager and Facilities Team. Coordinate with electrical to provide power connections and service outlets.

6. Coordinate with plumbing to provide eyewash stations in boiler rooms near the chemical pot feeder.
7. In heating water systems with multiple boilers the mechanical contractor shall provide and install boiler system temperature sensors in the main HWS line that communicates with each boiler. Provide one per boiler.

Section 235283 – Steam Boiler Blowdown Systems

No Boise State University requirements at this time.

Section 235313 – Steam Boiler Feedwater Pumps

1. Only electric driven feedwater systems shall be utilized for steam. Duplex or triplex feedwater pumps shall be specified, each with sufficient capacity to provide adequate feedwater to the steam-fired boiler.
2. Triplex feedwater pumps can be sized for 50% of the load.
3. Condensate receivers shall be adequately sized so that system condensate is contained without discharging to waste during the shutdown periods.

Section 235316 – Deaerators

1. Coordinate with the University Project Manager and Facilities team to discuss requirements for Deaerator systems.

Section 235400 – Furnaces

1. Provide condensing furnaces with a minimum AFUE of 92%.
2. In areas subject to freezing, consider adding additional backup heat to protect the condensing furnace.
3. Provide with a minimum of MERV 8 filters. University preference is for MERV 13 primary filters with a prefilter.
4. Route flue and combustion air piping to outdoors. Concentric vents are acceptable.
5. Provide the furnace with a thermostat to integrate with the building BAS system.
6. Provide a condensate neutralization kit.
7. Provide with an external condensate pump if needed.

Section 235513 – Fuel-Fired Duct Heaters

1. Direct-fired gas heating units are not permitted to serve indoor spaces. Fuel-fired duct heaters shall be in an easily accessible location and orientation, and labeled with equipment identification.

Section 235523 – Gas-Fired Radiant Heaters

1. Gas-fired radiant heaters shall be in an easily accessible location and orientation, and labeled with equipment identification.

Section 235600 – Solar Energy Heating Systems

No Boise State University requirements at this time.

Section 235700 – Heat Exchangers for HVAC

1. Heat exchangers for use with the Boise City Geothermal System shall use 316 stainless steel plates and EPDM gaskets or equivalent for use with the highly corrosive geothermal water.
2. See section 230519 for pressure gauge and thermometer installations.
3. Provide isolation valves on the inlet and outlet of heat exchangers.

Section 236313 – Air-Cooled Refrigerant Condensers

1. Air-cooled condensers shall have a sound rating of no more than eighty-five (85) dBA at three (3) feet from the noise source.
2. VFD fan motors shall be used where possible.
3. Coordinate with the University Facilities team for use of cotton seed screens.
4. Lids, with or without fans, covering air-cooled coils shall be hinged and capable of being opened for access to the coils for cleaning.
5. Units placement shall be situated and adequately sized to provide easy access, and have four foot clearance from landscaping or obstructions.
6. Air cooled condensers shall not be installed indoors.
7. Coils shall be rated to a minimum 105 degrees Fahrenheit ambient temperature.
8. Provide cat-walks where portions of the equipment requiring maintenance are 5 feet above adjacent grade. Designs with cat-walks are required to show detailing and elevations coordinated with mechanical equipment. Service areas for coil replacements, compressors, condenser fans and other maintenance items shall be maintained and indicated on the drawings.
9. Coordinate with MFGR to understand maintenance needs for condenser motors and compressors. Do not block access with catwalks or other structures.

Section 236333 – Evaporative Condensers

1. The manufacturer representative is required to provide documentation that evaporative condensers with galvanized coils have been passivated.

Section 236400 – Chillers

General Requirements

1. Chillers shall be specified based upon non-standard part load value (NPLV).

2. Units shall have a sound rating of no more than eighty five (85) dBA at three (3) feet from a noise source.
3. Chillers and large AC units shall include service valves installed such that serviceable components (filters, driers, etc.) can be serviced without having to remove the refrigerant from the vessel.
4. Coordinate with plumbing to provide eyewash stations in chiller rooms near the chemical pot feeder.
5. When feasible, provide temporary connections to the chilled water system such that a rental chiller could be piped into the system during a loss of equipment. Coordinate connection terminations with the University Project Manager and Facilities Team. Coordinate with electrical to provide power connections and service outlets.
6. The sound criteria shall be specified on the drawings or in the specifications.
7. No refrigerant blends are allowed.
8. All chilled water systems shall be provided with a flow meter to monitor usage throughout the system. See Boise State University - *Utilities and Metering Guidelines* for information on meter requirements.

Water Cooled Chillers

1. Chiller compressors shall have a minimum five (5) year warranty.

Air Cooled Chillers

1. Chiller compressors shall have a minimum five (5) year warranty.
2. Cotton seed screens may be required. Coordinate with the University Facilities team.
3. Provide with water side economizers.
4. Provide cat-walks where portions of the equipment requiring maintenance are 5 feet above adjacent grade. Designs with cat-walks are required to show detailing and elevations coordinated with mechanical equipment. Service areas for coil replacements, compressors, condenser fans and other maintenance items shall be maintained and indicated on the drawings.

Absorption Water Chillers

1. Where the design team believes absorption water chillers should be considered, coordinate with the University Project Manager and Facilities team.

Section 236433 – Refrigerant Monitoring and Safety Equipment

1. Refrigerant monitoring and safety equipment shall have power provided by the emergency generator system, when provided. The power requirements shall be coordinated with the Electrical Engineer. Such systems shall be wired to the safety strips of the chiller per ASHRAE 15.
2. Emergency make-up air and exhaust systems shall be provided.

Section 236513 – Forced-Draft Cooling Towers

1. Cooling towers shall be a complete certified UL assembly and shall incorporate remote lubrication fittings.

2. When possible, provide cooling towers with stainless steel coils and basin. If the budget doesn't allow stainless steel, provide cooling towers with passivated galvanized steel coils and a stainless steel basin.
3. Cooling tower passivation is required for towers with galvanized coils. Manufacturer representative is required to provide documentation that the cooling tower has been passivated.
4. Cooling towers shall incorporate gear drives for damper actuation.
5. Provide a permanent catwalk or other means of access for cooling tower fans. If cooling towers are installed on roofs, provide extra structural and rigging supports for motor change out and other maintenance items.
6. Where cat-walks are provided, See Section 236313 – Air-Cooled Refrigerant Condensers note 8 for requirements.
7. Strainers and pumps that serve cooling tower condenser water or other open loop systems shall have stainless steel internals.

Section 237200 – Air-to-Air Energy Recovery Equipment

1. Provide differential pressure (DP) sensors across each filter. The sensor shall indicate actual differential pressure on the controls graphic.
2. Provide with hinged access doors.

Section 237300 – Modular and Custom Indoor Air-Handling Units

General Air Handling System Requirements

1. When possible, condensate from rooftop equipment shall be piped to a drain. Provide heat tape and neutralization kits from high efficiency gas burners as needed. When there is not a suitable drain for condensate disposal, condensate may be allowed to discharge onto a concrete paver or rubber walk-off mat at the roof. Condensate that contains chemicals such as from lab-exhaust applications shall not be allowed to discharge onto the roof.
2. Curbs that are not covered by the roofing membrane and that are exposed to exterior conditions shall be aluminum.
3. Provide rooftop equipment curbs with sufficient height to accommodate built-up insulation and snow.
4. Provide with filter pressure monitoring across each filter bank and integrate to the building BAS system. Monitoring shall display actual pressure drop.

Modular and Custom Indoor Air-Handling Unit Specific Requirements

1. In air handlers that employ fanwall technology, each fan/motor cube shall be provided with its own independent backdraft damper. Coordinate the specified number of VFDs with the Owner for each application to ensure sufficient redundancy.
2. Premium efficiency motors only. Provide air handling unit variable speed fans with shaft grounding rings.
3. The designer shall specify the minimum sound energy levels allowable to achieve acceptable room coefficient (RC) sound levels in occupied space served by the unit.

4. Provide a permanent catwalk or other means of access for the upper portion of multi level air handling units. Where cat-walks are provided, coordinate the layout with the University Facilities team.
5. Air handling units shall be provided with double-walled panels with a minimum of 2 inches of fiberglass insulation, 16 gauge exterior galvanized steel; and 22 gauge internal galvanized steel.
6. Outdoor air dampers shall be insulated, low leakage type.
7. Design air handlers with pre-filters and a minimum of MERV 13 final filters unless otherwise requested by Boise State University. Filters shall be a standard size. For units that service laboratories and clean rooms consider incorporating an after-filter at the unit discharge.

Section 237400 – Packaged Outdoor HVAC Equipment

General Packaged System Requirements

1. The general requirements for Section 237300 Modular Custom Air Handling Units shall apply.

Packaged Outdoor HVAC Equipment Specific Requirements

1. Direct expansion rooftop units shall have thermal expansion valves (TXVs). Orifice plates are not acceptable.
2. Economizer control for free cooling capabilities. Relief air dampers shall be sized to relieve one hundred (100) percent of design supply air.
3. Provide units with powered exhaust. Barometric relief is acceptable for units that serve a single room.

Section 237433 – Dedicated Outdoor Air Units (DOAS)

General Air Handling System Requirements

1. The general requirements for Section 237300 Modular Custom Air Handling Units shall apply.

DOAS Specific Requirements

1. Provide with insulated low leakage outdoor air dampers.
2. Outdoor air from any DOAS units that is supplied direct to the space shall be tempered to room neutral temperature.
3. Design DOAS units with pre-filters and a minimum of MERV 13 final filters unless otherwise requested by Boise State University. Filters shall be a standard size. For units that service laboratories and clean rooms consider incorporating an after-filter at the unit discharge.

Section 237500 – Custom-Packaged Outdoor HVAC Equipment

General Air Handling System Requirements

1. The general requirements for Section 237300 Modular Custom Air Handling Units shall apply.

Custom-Packaged Outdoor Specific Requirements

1. Economizer control for free cooling capabilities. Relief air dampers shall be sized to relieve one hundred (100) percent of design supply air.
2. Design air handlers with pre-filters and a minimum of MERV 13 final filters unless otherwise requested by Boise State University. Filters shall be a standard size. For units that service laboratories and clean rooms consider incorporating an after-filter at the unit discharge.
3. Provide a permanent catwalk or other means of access for the upper portion of multi level air handling units. Where cat-walks are provided, coordinate the layout with the University Facilities team.

Section 237600 – Evaporative Air-Cooling Equipment

No Boise State University requirements at this time.

Section 238113 – Packaged Terminal Air Conditioners

1. Packaged Terminal Air Conditioners shall not be allowed.

Section 238119 – Self-Contained Air Conditioners

1. Self-contained air conditioners shall not be allowed.

Section 238123 – Computer-Room Air-Conditioning Units

1. Computer, server rooms, and critical switch rooms deserve special attention and shall be designed with special temperature and humidity requirements in mind. Coordinate with Boise State Project Manager and Campus Operations Information Technology (OIT) for specific requirements.
2. Computer and server rooms shall be designed with stand-alone cooling systems.
3. Coordinate with the University for emergency power requirements.

Section 238126 – Split-System Air-Conditioning Units

Condensers and Air Source Heat Pumps

1. The University preference is to provide the highest efficiency model for heat-pumps and condensing units. However, at a minimum all condensing units and heat pumps shall be selected such that their efficiency ratings are at least 10% above the rating required by federal rules and regulations. Ratings include but are not limited to:
    a. Energy Efficiency Ratio (EER)
    b. Seasonal Energy Efficiency Ratio (SEER)
    c. Heat Seasonal Performance Factor (HSPF)
2. Provide with drain pan heaters or heat tape.
3. Split-system air-conditioning units shall include a low ambient kit and crank case heater.
4. Provide BACnet connections to integrate with campus Building Automation System (BAS).

5. Install split-system unit condensers or heat pumps on condenser stands similar to Miro Model HD.

Section 238214 – Chilled Beams

No Boise State University requirements at this time.

Section 238216 – Air Coils

1. When hydronic air coils with 1-½" or less control valves are provided, modulate the control valve with a 0-10VDC / 2-10 VDC proportional control strategy, or floating point control. On/off control strategies shall not be acceptable.
2. Hydronic coils with control valves larger than 1-½" shall be modulated with a 0-10VDC or 2-10 VDC proportional control strategy only.
3. All hydronic coils that serve exterior zones shall be 2-row minimum.

Section 238219 – Fan-Coil Units

1. Fan coil units must be situated to enable access for service.
2. Boise State preference is for fan coils to be supplied with outdoor air direct to the return of the fan coil for better mixing and reduced cold calls rather than direct to the room.
3. Modulate the control valve with a 0-10VDC / 2-10 VDC proportional control strategy, or floating point control. On/off control strategies shall not be acceptable.
4. Provide differential pressure (DP) sensors across each filter. The sensor shall indicate actual differential pressure on the controls graphic.

Section 238223 – Unit Ventilators

No Boise State University requirements at this time.

Section 238229 – Radiators

No Boise State University requirements at this time.

Section 238233 – Convectors

No Boise State University requirements at this time.

Section 238236 – Finned Tube Radiation Heaters

No Boise State University requirements at this time.

Section 238239 – Unit Heaters

1. Unit heaters shall be monitored and scheduled through the BAS system.

Fuel Fired

1. Fuel-fired unit heaters shall be in an easily accessible location and orientation, and labeled with equipment identification.
2. When fuel fired unit heaters are provided they shall be the direct vent type with both combustion air and flue gasses ducted direct to the outdoors.
3. Concentric venting kits are acceptable.
4. Direct heating gas-fired units are not allowed.

Hydronic

1. When hydronic unit heaters are provided, modulate the control valve with a 0-10VDC / 2-10 VDC proportional, or floating point control strategy. On/off control strategies shall not be acceptable.

Section 238246 – Water-Source Heat Pumps

1. Water-source heat pumps are less desired on campus due to the high maintenance requirements of the system. If the designer believes Water-Source Heat Pumps should be considered, coordinate with the Boise State University Project Manager and Facilities, Operations, and Maintenance (FOM) personnel to discuss pros and cons. When possible, provide a life cycle cost analysis (LCCA) comparing multiple system types.

Section 238313 – Radiant Heating Electric Cables

1. Electric resistance radiant heating is not allowed.

Section 238316 – Radiant Heating Hydronic Piping

No Boise State University requirements at this time.

Section 238326 – Gas-Fired Radiant Heaters

1. Unvented gas-fired radiant heaters are not allowed.

Section 238413 – Humidifiers

1. Humidifiers must be selected for maximum serviceability and long-term life.

Section 238416 – Mechanical Dehumidification Units

No Boise State Requirements at this time.