SECTION 23 00 00: General Mechanical

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Section includes general provisions for Mechanical HVAC.

1.2 General Design Guidelines
a. Not applicable.

1.3 Submittals
a. Submittal information will only be reviewed as related to this section.
b. Submittals should have sufficient detail to determine compliance with specifications.
c. Incomplete submittals will be rejected without review.
d. Submittals should be for this complete specification section and not individual sections.
e. Where appropriate, provide drawings and diagrams to indicate location and connections.
f. BIM Execution Plan (BEP) to be followed for all equipment and drawings.
g. Building system zoning requires CPFM and Owner's Rep review and approval.
h. O&M documents – electronic searchable .pdf.
i. Training plans.
j. Mock-ups as required by Owner.

1.4 Qualifications
a. Manufacturer: Company specializing in manufacturing products specified in this section with minimum thirty (30) years documented experience.
b. Installer: Company specializing in installing products specified in this section with minimum five (5) years documented experience.

PART 2 – PRODUCTS
a. As specified in each section.
b. Substitutions by formal request and should be demonstrated to perform as specified.

PART 3 – EXECUTION

3.1 Installation
a. All serviceable components to be accessible for maintenance and removal. Owner to approve acceptable distance to components.
b. Exterior placement of equipment must be approved by Owner.
c. No items to be abandoned in place. All deleted items MUST be removed.
d. Systems or components installed which require special tool to maintain or replace must be approved by Owner.
e. All main risers must be provided with an access door (3'X7').
f. Locate serviceable equipment/components within corridors or above doorways.
g. Components requiring regular maintenance should not exceed 14', and 7' in mechanical or electrical rooms.

h. Isolation:
   - All floors at the main risers
   - Each zone or area of service
   - Drain down valves at low points
   - All equipment coil connections
   - Building service entrance
   - Both sides of control valves
   - Both sides of pumps

i. Refer to individual sections for specific requirements.

3.2 Accessibility of Equipment & Components

a. Per the 'Design Review Requirements' a drawing layer of 'Maintenance Access' is to be incorporated into ALL drawings and system designs. This layer MUST be maintained through all phases of design and construction.
b. Access must be provided to read gages, thermometers, monometers, meters, etc.
c. ALL intakes require access to properly maintain and clean.
d. In mechanical and electrical rooms any components requiring routine service/maintenance must be installed / mounted below 7ft in height. Prior to installation of any component above 7ft requires onsite review and explanation with FS Maintenance and/or FS Electrical Supervisor.

a. Inaccessible Equipment:
   - If after meetings, reviews, comments, etc., there are documented and/or discussed changes not incorporated into the construction documents and installed equipment is not accessible for operation and maintenance, equipment shall be removed and reinstalled at no additional cost to the UO or the project. Discussions of payment will occur with the design team.
   - 'Accessible' is defined as being capable of being reached without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and ductwork. Access must not exceed 14ft in height, a typical ladder working height.

3.3 Mechanical Penthouses

a. Penthouse construction is to be water tight, not air tight.
b. If system(s) within a penthouse is hydronic and has drainage, then epoxy or water proofed floor is required in the penthouse. Epoxy or waterproofing is to extend up walls 6 inches at a minimum.
c. Space shall be provided for storage of 1 full change of filters at a minimum. Storage may be located on top of a unit IF space is water tight and dry.

3.4 Piped Systems

a. All piped systems with supply and return piping require the following:
   - Dividing supply system into zones, areas of service, or by floor
   - Isolation of each zone, area of service, or floor level from the main distribution lines.
   - Drain down valves shall be provided at the low point in each zone, area of service, or floor level.

3.5 Interface with other products

a. Installation must not compromise installation or access to other building systems or components.

3.6 Testing

a. All testing to be witnessed by Owner.
b. Startup of equipment to be scheduled to allow for Owner witness.

3.7 Training

a. Furnish training plan for review by Owner at least two weeks prior to training.
b. Training by qualified technicians knowledgeable in HVAC systems and components.
c. Required hours will be determined by individual project complexities.
d. At a minimum, training for all devices and equipment to include the following:
    - Preventative maintenance procedures
    - Confirmation that labeling is complete and correct
    - Review location of all devices
    - Verify all specified testing is complete with associated documentation complete and submitted to Owner.

SECTION 23 05 14 Motor Control Devices for HVAC Equipment

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

a. Section includes the following:
   - Variable frequency drive controller

1.2 General Design Guidelines

a. Not applicable.

1.3 Submittals

a. Product data.
b. Shop drawings.
c. Control information and wiring diagrams for packaged equipment.
d. Operating and maintenance data for each product.

1.4 Qualifications

a. Startup and testing to be performed by manufacturer certified agent.

PART 2 – PRODUCTS

2.1 Variable Frequency Drives

a. Basis of design: ABB
   - Third party, brand labeled, or packaged VFD's not permitted.
   - Equipment only sold by the authorized Oregon sales representative of ABB products.
b. Display and control interface
   - Communications
     i. BTL listed for BACnet, compatible with building automation system
     ii. MSTP or Siemens P1 protocol
   - Interface capable of displaying the following operating information:
     i. Speed
     ii. Output frequency
     iii. Output voltage
     iv. Current
     v. Power
     vi. Status
     vii. Configurable alarm
     viii. Calculated motor power - kW
c. Input and output functions and points:
   - Digital inputs:
     i. Remote start / stop
     ii. Emergency stop

- Digital outputs:
  i. Drive run/off status
  ii. Drive alarm
- Analog inputs:
  i. Control input signal: 4 to 20 mA DC
  ii. Remote speed control setpoint: 4 to 20 mA DC
- Analog output speed feedback: 4 to 20 mA or 0 to 10 VDC

d. Accessories and Enclosures
- Provide integral circuit breaker disconnect
- Provide removable display capable of remote mounting.
  i. Remote mount the displays when drives are installed within enclosures that require a disconnect in the off position to open enclosure.
    - Do not provide bypass systems.

e. Warranty: Two year from substantial completion.
- Include parts, labor, travel time, software, and access tools at no additional cost to the Owner.
- 24 hour support line shall be available on a toll free line.

PART 3 – EXECUTION

3.1 Installation

a. During construction provide temporary filtering / protection required for cooling fan inlet / outlet.
b. Vacuuming the interior of enclosure is required for final completion.
c. Mounting motor controls inside of motor control centers or inside fan units is not permitted.

3.2 Interface with other products

a. Building automation system.
b. Motors.

3.3 Testing

a. Contractor to notify Owner a minimum of two weeks prior to equipment startup.
b. Certified factory startup shall be provided for each drive by a factory authorized service center.
c. A certified startup form shall be filled out for each drive with a copy provided to the Owner and a copy kept on file at the manufacturer.

3.4 Training

a. Provide training for all motor controls devices to include the following:
- Review of programmed parameters
- Confirmation displayed parameters are correct per Owner requirements
- Review of maintenance procedures
- Confirmation that enclosure has been adequately vacuumed and cleaned
- Confirmation that certified factory startup form is complete

SECTION 23 05 19 Meters and Gauges for HVAC Piping

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

a. Section includes meters and gauges for HVAC piping:
   - Pressure gauges
   - Compound pressure gauges
   - Thermometers
   - Flow meters
   - Test plugs

1.2 General Design Guidelines

a. Pressure gauges for pumps to be compound and installed on inlet and outlet of pump.
b. Provide thermometers in the following locations:
   - Inlet and outlet of coils, heat exchangers, chilled water supply and return to building.
c. Provide isolation valves on gauges and thermometers for maintenance and replacement.

1.3 Submittals

a. Product data, if product data submittal includes a listing of models, sizes, and options it is the responsibility of the Contractor to indicate specifics to be used on project.

1.4 Qualifications

a. Not applicable.

PART 2 – PRODUCTS

2.1 Pressure Gauges

a. Basis of design: Ashcroft
b. Case: Liquid filled
c. Size: 4.5" diameter
d. Mid Scale Accuracy: 1 percent
e. Range:
   - Chilled Water: 0-160 psi
   - Heating Water: 0-100 psi
   - Steam: 0-100 psi
   - Condensate: 0-100 psi

2.2 Compound Gauges for Pumps

a. Basis of design: Ashcroft
b. Case: Liquid filled
c. Size: 4.5" diameter
d. Mid Scale Accuracy: 1 percent
e. Range:

- 30 IMV – 160 psi

2.3 Thermometers
a. Basis of design: Ashcroft
b. Case: Sealed, stainless steel
c. Size: 5" diameter
d. Connector type: Adjustable angle
e. Mid Scale Accuracy: 1 percent
f. Range:
   - Chilled Water: 25-125 degF
   - Heating Water: 20-240 degF
   - Condensate: 50-300 degF

2.4 Turbine Flow Meters
a. Description: Vertical turbine flowmeter with sensor, indicator, and internal strainer.
b. Basis of design: Mueller
c. Odometer type totalizing display.
d. Required for makeup water.

2.5 Test Plugs
a. Test port must extend past insulation.
b. Provide at all digital and analog temperature and pressure sensors.

PART 3 – EXECUTION

3.1 Installation
a. Installed gauges and thermometers such that the face is able to be read from the floor without a ladder.

3.2 Interface with other products
a. Not applicable.

3.3 Testing
a. Not applicable.

3.4 Training
a. Provide training for equipment and components covered in this section in the general mechanical systems training.

SECTION 23 05 23 General Duty Valves for HVAC Piping

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

a. Section includes valves for plumbing service.
   - Ball valves
   - Globe valves
   - Butterfly valves
   - Gate valves
   - Check valves
   - Drain valves

1.2 General Design Guidelines

a. Square head curb stop shut-off valves required at exterior locations.
b. Building service shutoff / isolation valves
   - 2" and smaller: Ball valve
   - 2.5" and larger: Gate valve with rising stem
   - Valves to provide 100% positive shutoff
c. Drain valves
   - Ball valve with threaded hose adapter and cap.
   - Provide at all coils and downstream of isolation valves.
d. Provide stem extensions for valves in insulated piping.
e. Valves 2.5" and larger located more than 10 feet from floor in mechanical rooms provide with chain operators.
f. Provide full insulation around valve bodies where insulation is required.
g. Provide chainwheel operators for valves 2.5" and larger installed more than 10 feet above the ground
h. Threaded or flanged end connections only.
i. Provide isolation valves at each floor in an accessible space adjacent to piping riser and at every connection to equipment.
j. Install threaded union on both sides of every threaded valve connection.
k. Valves in insulated piping to have stem extension that extends beyond insulation.

1.3 Submittals

a. Product data, if product data submittal includes a listing of models, sizes, and options it is the responsibility of the Contractor to indicate specifics to be used on project.

1.4 Qualifications

a. Not applicable.

PART 2 – PRODUCTS

2.1 Ball Valves

a. Basis of design: Apollo
b. 2" and smaller
   - SWP: 150 psig
   - CWP: 600 psig
   - Body: Two piece bronze
   - Ends: Threaded
   - Seats: Reinforced Teflon (PTFE)
   - Stem: Bronze
   - Ball: Stainless steel
   - Port: Full
   - Packing: Adjustable

2.2 Globe valves

a. Basis of design: Apollo
b. 2" and smaller
   - Class: 150
   - CWP: 300 psig
   - Body: Bronze with integrated set and screw in bonnet
   - Ends: Threaded
   - Stem and Disc: PTFE
   - Handwheel: Malleable iron, bronze, or aluminum.
c. 2.5" and larger
   - Class: 150
   - CWP: 500 psig
   - Body: Gray iron with integrated set and bolted bonnet
   - Ends: Threaded
   - Stem and Disc: PTFE
   - Operator: Handwheel or chainwheel

2.3 Butterfly Valves

a. Basis of design: Apollo
b. 2.5" and larger
   - SWP: 150 psig
   - CWP: 200 psig
   - Body: Ductile iron
   - Seats and liners: EPDM
   - Stem: Stainless steel
   - Disc: Bronze
   - Packing: Adjustable
   - Body and stem seals

- Operators: Lever lock
- Lug style only

2.4 Gate Valves

a. Basis of design: Apollo
b. 2" and smaller
   - Class: 150
   - CWP: 300 psig
   - Body: Bronze
   - Ends: Threaded
   - Stem: Non-rising, bronze
   - Bonnet: Bronze
   - Disc: Solid wedge, bronze
   - Packing gland: Brass, re-packable under pressure (not required for steam applications)
   - Hand wheel: Malleable iron or bronze
c. 2.5" and larger
   - Class: 150
   - SWP: 150 psig
   - CWP: 200 psig
   - Body: Gray iron
   - Ends: Flanged
   - Stem: Non-rising, bronze
   - Trim: Bronze
   - Bonnet: Bolted
   - Disc: Solid wedge
   - Packing gland: Brass, re-packable under pressure (not required for steam applications)
   - Hand wheel: Cast iron

2.5 Check Valves

a. Basis of design: None
b. 2" and smaller
   - Class: 150
   - CWP: 300 psig
   - Body: Horizontal flow
   - Body material: Bronze
   - Ends: Threaded
   - Disc: Bronze, renewable seat and disc
c. 2.5" and larger
   - Class: 150
   - CWP: 300 psig
   - Body: Horizontal flow
   - Body material: Gray iron
   - Ends: Flanged
   - Disc: Iron, renewable seat and disc

- Trim: Bronze
- Bolted bonnets only

2.6 Drain Valves

a. Basis of design: None
b. 2" and smaller
    - CWP: 600 psig
    - Body: Two piece bronze ball valve
    - Ends: Threaded with ¾ inch male hose threaded adapter
    - Seats: Reinforced Teflon (PTFE)
    - Stem: Stainless steel
    - Ball: Stainless steel
    - Port: Full
    - Packing: Adjustable
    - Cap: Brass with EPDM gasket and brass chain.

PART 3 – EXECUTION

3.1 Installation

a. Valve handle should swing in the direction of flow.
b. Soldered valves, if exemption provided for use, must have a minimum of 12" between main and branch pipe.
c. Any piping installations with more than three pipes on a single support requires mockup for Owner to review pipe spacing is adequate for maintenance and repair.

3.2 Interface with other products

a. Not applicable.

3.3 Testing

a. Not applicable.

3.4 Training

a. Provide training for equipment and components covered in this section in the general mechanical systems training.

SECTION 23 05 33: Heat Tracing for HVAC Piping

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Section includes electrical heat tracing components and controls used to prevent pipe lines from freezing

1.2 General Design Guidelines
a. Not applicable.

1.3 Submittals
a. Product data
b. Wiring diagrams

1.4 Qualifications
a. Not applicable.

PART 2 – PRODUCTS

2.1 General
a. Required for all piping exposed to the exterior.
b. System integration with building automation system to monitor status and alarms.

2.2 Electrical Heat Trace System
a. Basis of design: None
b. Display and control interface
   - Communications
     i. BTL listed for BACnet, compatible with building automation system
   - Interface capable of displaying the following operating information:
     i. Temperature
     ii. Control temperature
     iii. Heating cable current
     iv. Ground fault
     v. Programming parameter values
     vi. Alarm values
c. Input and output functions and points
   i. Digital inputs:
      - None
   ii. Digital outputs:
      - System status on/off
      - General alarm
   iii. Analog inputs:
      - None

PART 3 – EXECUTION

3.1 Installation

a. Not applicable.

3.2 Interface with other products

a. Building automation system

3.3 Testing

a. Contractor to notify Owner a minimum of 7 days prior to equipment startup.
b. Certified factory startup shall be provided for each system installed.

3.4 Training

a. Provide training for all devices and equipment to include preventative maintenance, verify labeling is complete and correct, review location of all devices, and verify all testing is complete with associated documentation.
b. Training to include preventative maintenance procedures, alarms.

SECTION 23 05 48 Vibration and Seismic Controls for HVAC

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Section includes vibration isolation and seismic restraint for equipment, piping, and ductwork.

1.2 General Design Guidelines
a. Not applicable.

1.3 Submittals
a. Product data
b. Shop drawings

1.4 Qualifications
a. Not applicable.

PART 2 – PRODUCTS

2.1 General
a. Provide vibration isolation on all rotating equipment, equipment piping connections, and equipment duct connections.

PART 3 – EXECUTION

3.1 Installation
a. Not applicable.

3.2 Interface with other products
a. Not applicable.

3.3 Testing
a. Not applicable.

3.4 Training
a. Not applicable.

SECTION 23 05 53 Identification for Plumbing Piping and Equipment

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Section includes identification for piping and valves, including nameplates, tags and markers.

1.2 General Design Guidelines
a. None.

1.3 Submittals
a. As required by Section 23 00 00.
b. Valve Schedule for each piping system, in tabular format.
c. Equipment tag schedules, damper label schedules, access door schedules, in tabular format.
d. Valve naming and format.

1.4 Qualifications
a. None.

PART 2 – PRODUCTS

2.1. Equipment Nameplates
a. Laminated plastic, engraved white letters on black background. Letter size ½ tall.
b. Use self-tapping stainless screws, and contact adhesive where screws cannot or should not penetrate equipment.

2.2. Valve Tags
a. Metal – brass with stamped lettering.
b. Solid brass chain fastener with S-hooks.

2.3. Pipe Labels
a. Pipe sizes ¾" through 2 ¼ " – flexible vinyl tape with adhesive backing, 1"x8" marker with ¾" lettering.
b. Pipe sizes 2.5" through 7" - flexible vinyl tape with adhesive backing, 2.25" marker with 1.75" lettering
c. Pipe sizes 8" through 10" – flexible vinyl tape with adhesive backing, 4" x 24" marker with 2.5" lettering.
d. Pipe sizes over 10" – flexible vinyl tape with adhesive backing, 4"x32" marker with 3.5" lettering
e. Union Labels
    a. White vinyl, self adhesive, permanent.
    b. Red lettering, minimum ½ inch tall
    c. Labels at unions and di-electric unions to read "UNION".

2.4 Ceiling Labels
a. Label ceilings or ceiling grid (not the tile) where key serviceable components such as valves, equipment, etc. are located, with a clear adhesive label and bold black lettering ½" tall indicating equipment ID.

2.5 Duct Labels
a. Flexible vinyl tape with adhesive backing, 4" x 32" marker with 3.5" lettering.

2.6. Access Door Labels
a. Clear adhesive tape, ½" black letters

PART 3 – EXECUTION

3.1 General
a. Identify all key shutoff valves.

3.2 Piping System Identification
a. Label equipment and piping with description and direction of flow.
b. Label piping every 10 feet, and on either side of penetrations through walls.
c. Locate labels at intervals not to exceed 20 feet on center, within 3 feet of valves / equipment connections / branch connections / wall, floor, or ceiling penetrations.

3.3 Valve Identification
a. Identify valves with brass tags using system identification and valve sequence number as detailed in the University of Oregon's BIM execution plan. If the project is not required to perform BIM this document can be requested for use in this application.

3.4 Access Panel Identification
a. Label all access doors with equipment name or general purpose of equipment behind access door with stenciled sign or markers.

3.5 Duct Identification
a. Label ductwork with description and direction of flow
b. Label bottom of ducts at minimum intervals of 25 feet and in each room.

3.6 Access Door Identification
a. Label all access doors with designation of equipment accessed through door.

3.7 Interface with other products
a. None

3.8 Testing
a. None

3.9 Training
a. Review location of identification and labeling with Owner for approval.

PART 4 – MECHANICAL LABEL LEGEND

GREEN BACKGROUND / WHITE LETTERING	
Chilled Water Supply / Return	Process Chilled Water Supply / Return
YELLOW BACKGROUND / BLACK LETTERING	
Steam Medium Pressure	Steam Low Pressure
Steam Clean / Untreated	Steam Treated
Steam Vent	Condensate High Pressure
Condensate Low Pressure	Condensate Pump Discharge
Heating Water Supply / Return	Process Heating Water Supply / Return
Supply Air	
BLUE BACKGROUND / WHITE LETTERING	
General Exhaust Air	
RED BACKGROUND / WHITE LETTERING	
Acid Exhaust Air	
YELLOW BACKGROUND / WHITE LETTERING	
Fume Exhaust Air	

SECTION 23 05 93 Testing, Adjusting, and Balancing for HVAC

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Section includes requirements for testing, adjusting, and balancing air and water systems.

1.2 General Design Guidelines
a. Not applicable.

1.3 Submittals
a. Systems ready to balance checklist
b. Pre-balance report

1.4 Qualifications
a. NEBB certification

PART 2 – PRODUCTS

2.1 General
a. Approved contractors: Air Introduction and Regulation
b. Pre-demolition scope
   - Required for projects utilizing existing systems.
   - Verify existing system air flows, water flows, and pressures throughout the system. Scope to be included in base project scope.
c. Existing system rebalancing
   - Required for existing systems that are modified as part of a remodel. Scope to be included in base project scope.
d. Duct leakage testing
   - Performed by TAB contractor, witnessed by Owner.
   - Test all supply and return ductwork from air handling unit to inlet of terminal devices.
   - Test all ducts within shafts including exhaust and outside air intake ducts.
e. Sound level testing
   - Not a requirement.
f. Systems ready to balance checklist included at the end of this section required to be completed by Contractor prior to commencing TAB work.

PART 3 – EXECUTION

3.1 Installation
a. Not applicable.

3.2 Interface with other products

a. Building automation system
   - Control programming to be complete prior to commencing TAB work.

3.3 Testing

a. Pre-balancing meeting required 30 days prior to start of TAB to discuss equipment startup schedule, status of control work, overall project schedule and phasing, and coordination of access.
b. Access to work
   - Ceiling tiles should not be installed prior to TAB in areas where access to equipment is required. If tiles are installed prior to TAB they will need to be removed.
   - Balancing devices above ceiling will be marked with flagging by installing contractor prior to balancing.

3.4 Training

a. Not applicable.

PART 4 – SYSTEMS READY TO BALANCE CHECKLIST

4.1 General

a. The following checks must be included in the construction documents, verified by the Contractor, and submitted to the Owner prior to commencing TAB work.

4.2 Hydronic Systems

a. Electrical service provided for all pumps, and all electrical connections are complete.
b. All pump VFD's are set up with the correct operating frequency.
c. Pumps have been laser aligned as required by specifications.
d. All piping connections to pumps have been verified correct with respect to flow.
e. All normally open hydronic system manual isolation and balancing valves are in the fully-open position.
f. To the extent possible, air has been vented from all pump casings, piping systems, and system tanks.
g. Piping has been thoroughly flushed prior to the TAB contractor beginning balancing.
h. All coil piping connections are complete, with flows in the correct direction.
i. All coil isolation valves are open.
j. All required provisions for TAB measurement have been provided prior to the start of balancing activities. (This includes BAS workstation access, balancing valve access, access hatches for devices above hard ceilings, remote balancing devices where required, P/T ports are provided and accessible in all required locations.)
k. Correct rotation of all pumps has been verified and observed by UO.
l. All required gauges have been provided and verified by UO.
m. Piping flush plan has been submitted and approved by UO.
n. Piping flush and cleaning is complete, all strainers are cleaned, UO has observed cleanliness of water and strainers.
o. Piping pressure testing plan has been submitted and approved by UO.
p. Piping pressure testing report has been completed and submitted to UO for review.
q. VFD startup reports are complete and submitted to UO for review.
r. Pump startup reports have been completed and submitted to the UO for review.

4.3 Air Systems

a. Electrical service provided for all fans, and all electrical connections are complete.
b. All fan VFD's are set up with the correct operating frequency.
c. Correct rotation of all fans has been verified and observed by UO.

d. All manual balancing dampers locked in the fully open position.
e. All fire (smoke) dampers are open, accessible, and operation verified by UO.
f. All registers and diffusers are installed.
g. All windows, doors, ceiling plenums, access doors, and other openings installed and sealed prior to TAB activities.
h. Construction phase filters changed prior to balancing.
i. All ductwork sealed per contract documents. Leakage is not evident.
j. Construction activities that produce dirt, dust, or debris are complete or moved outside the building.
k. All required provisions for TAB measurement have been provided prior to the start of balancing activities. (This includes BAS workstation access, balancing damper access, access hatches for devices above hard ceilings, remote balancing devices where required.)
l. VFD startup reports are complete and submitted to the UO for review.
m. AHU startup reports and complete and submitted to UO for review.

4.4 Plumbing Systems

a. Electrical service provided for all pumps, and all electrical connections are complete.
b. All pump VFD's are set up with the correct operating frequency.
c. Correct rotation of all pumps has been verified.
d. All piping connections to pumps have been verified correct with respect to flow.
e. All normally open plumbing system manual isolation and balancing valves are in the fully-open position.
f. To the extent possible, air has been vented from pump casings and all piping systems.
g. Piping has been thoroughly flushed prior to the TAB contractor beginning balancing.
h. All required provisions for TAB measurement have been provided prior to the start of balancing activities. (This includes BAS workstation access, balancing valve access, access hatches for devices above hard ceilings, remote balancing devices where required, P/T ports are provided and accessible in all required locations.)

4.5 Building Automation System

a. BAS graphics are complete, and provide a correct representation of all systems.
b. Uninterrupted BAS workstation access is provided for the duration of TAB activities.
c. Point to point checkout of all BAS points is complete.

SECTION 23 07 00 HVAC Insulation

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Section includes insulation for ductwork.

1.2 General Design Guidelines
a. Provide vapor barrier and insulation for ductwork with any potential to condense. This includes ductwork with surface temperatures below ambient temperatures.
   - Insulation for ductwork requiring a vapor barrier must be closed cell type.

b. Internally lined ductwork is only permitted for specific project sound attention requirements.
   - Supply ductwork with interior lining or interior insulation is required to be non-shedding type.

1.3 Submittals
a. Submittal information will only be reviewed as related to this section.
b. Submittals should have sufficient detail to determine compliance with specifications.
c. Incomplete submittals will be rejected without review.
d. Submittals should be for this complete specification section and not individual sections.
e. O&M documents – electronic searchable .pdf.
f. Training plans.

1.4 Qualifications
a. Not applicable.

PART 2 – PRODUCTS

a. Duct Insulation Materials
   - Duct wrap
     i. Fiberglass and elastomeric foam are acceptable.
   - Duct liner
     i. Elastomeric foam and polymide foam are acceptable.

PART 3 – EXECUTION

3.1 Installation:
a. Supply ductwork externally insulated should have continuous vapor barrier, through penetrations, and be supported on the outside of the insulation.

3.2 Interface with other products
a. Not applicable.

3.3 Testing
a. Not applicable.

3.4 Training

a. Not applicable.

SECTION 23 07 19 HVAC Piping Insulation

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Section includes HVAC piping insulation, insulation accessories, and insulation covers.

1.2 General Design Guidelines
a. Not applicable.

1.3 Submittals
a. Product data.

1.4 Qualifications
a. Not applicable.

PART 2 – PRODUCTS

2.1 Chilled Water
a. Above ground
- Cellular glass
- Polystyrene
- Elastomeric foam

b. Outdoor, Underground - See division 33 for additional requirements.
- Elastomeric foam
- Cellular glass

c. Fiberglass not permitted.
d. Acceptable insulation includes: Extruded Polystyrene, Polyisocyanurate, closed cell elastomeric foam, cellular glass.
e. All piping components and accessories also require insulation with vapor barrier. Valve stems should extend beyond insulation.

2.2 Heating Water
a. Above ground
   i. Fiber glass

2.3 Steam / Condensate
a. Above ground
   i. Fiber glass

2.4 Field Applied Jacketing
a. Concealed piping – not required.
b. Exposed indoor piping

i. Mechanical room, food service, or areas exposed to cleaning
1. PVC 30 mils thick

c. Exposed indoor piping all other areas
i. PVC 20 mils thick

d. Exposed outdoor
i. Aluminum weather proof jacketing

PART 3 – EXECUTION

3.1 Installation

a. Provide continuous insulation through walls, floors, partitions.
b. Provide insulation on all valves, fittings, and piping specialties.
c. Valve and expansion joint blankets are to be easily removable and reusable. No Velcro fastening.
d. Insulation inserts required at all points of piping support, insulation to be continuous.
e. Pipe sleeves required at all penetrations.
f. Hard pak / insulation inserts required at all points of support with aluminum shield provided at contact with hangar / support
g. Valve and expansion joint blankets are to be easily removable and reusable. No Velcro fastening.

3.3 Interface with other products

a. Piping accessories and specialties, required to be insulated as part of piping system.

3.4 Testing

a. Not applicable.

3.5 Training

a. Not applicable.

SECTION 23 09 13: Instrumentation and Control for HVAC

Document revision history: In Development

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

1.2 General Design Guidelines

1.3 Submittals

1.4 Qualifications

PART 2 – PRODUCTS

PART 3 – EXECUTION

3.1 Installation

3.2 Accessibility of Equipment & Components

3.3 Interface with other products

3.4 Testing

3.5 Training

SECTION 23 09 23: Direct-Digital Control System for HVAC

Document revision history: In Development

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

1.2 General Design Guidelines

1.3 Submittals

1.4 Qualifications

PART 2 – PRODUCTS

PART 3 – EXECUTION

3.1 Installation

3.2 Accessibility of Equipment & Components

3.3 Interface with other products

3.4 Testing

3.5 Training

SECTION 23 21 13: Hydronic Piping

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

a. Section includes pipe, fittings, and joining methods for HVAC systems:
   - Chilled water piping
   - Heating water piping
   - Refrigerant piping
   - Air Vent piping
   - Instrumentation piping
   - Dielectric Unions
   - Grooved piping

1.2 General Design Guidelines

a. Not applicable.

1.3 Submittals

a. Provide pipe flushing plan
   - CHW filled with plant water not city water
b. Provide pressure testing plan
c. Provide water chemistry report after flushing – See HVAC Water Treatment 23 07 19 for additional requirements.

1.4 Qualifications

a. Not applicable.

PART 2 – PRODUCTS

2.1 Heating Water Piping, Above Ground

a. 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
b. NPS 2-1/2" 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
c. Terminal device runouts
   - Type L hard drawn copper tubing, wrought copper fittings, soldered joints, lead free solder
d. Chilled beams
   - Type L hard drawn copper tubing, wrought copper fittings, soldered joints, lead free solder
   - PEX piping, fittings, no unions or couplings, no pre-insulated tubing.

- If PEX is used, manifolds required on supply and return water connections to each chilled beam zone. Each chilled beam will be fed individually from the manifold and the piping must be continuous without fittings from the manifold to the chilled beam.

2.2 Chilled Water Piping, Above Ground

a. 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

b. NPS 2-1/2" 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

c. Terminal device runouts
   - Type L hard drawn copper tubing, wrought copper fittings, soldered joints, lead free solder

d. Chilled beams
   - Type L hard drawn copper tubing, wrought copper fittings, soldered joints, lead free solder
   - PEX piping, fittings, no unions or couplings, no pre-insulated tubing.
   - If PEX is used, manifolds required on supply and return water connections to each chilled beam zone. Each chilled beam will be fed individually from the manifold and the piping must be continuous without fittings from the manifold to the chilled beam.

2.3 Equipment Drains and Overflows

a. Up to NPS 1:
   - Type M hard drawn copper tubing, wrought copper fittings, soldered joints, lead free solder

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

2.4 Refrigerant Piping

a. Copper type L or ACR, wrought copper fittings.

2.5 Makeup Water Piping

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

2.6 Instrumentation Piping

a. 3/8 inch stainless steel tubing and Swagelok compression fittings
b. Type L hard drawn copper tubing, wrought copper fittings, threaded joints

2.7 Dielectric Unions

a. Dielectric unions – not permitted
b. Provide threaded brass nipple, brass or bronze union / coupling, or bronze valve to separate dissimilar metals.

2.8 Mechanical Grooved Pipe Connections

a. Not permitted.

PART 3 – EXECUTION

3.1 Installation

a. Provide owner with mockup of repetitive system piping connections, i.e. terminal unit coil connections, chilled beam connections, fin tube radiator connections, etc..
b. Contractor to demonstrate system cleanliness to Owner after flushing by providing samples of water and a site inspection of strainers.
c. Provide drain valves at low point of each zone, area of service, or floor level, and at every coil connection.

3.2 Interface with other products

a. Installation must not compromise installation or access to other building systems or components.

3.3 Testing

a. Water pressure testing to be provided at minimum 150 psig
b. All testing to be witnessed by Owner.
c. Startup to be scheduled to allow for Owner witness.

3.4 Training

a. Furnish training plan for review by Owner at least two weeks prior to training.
b. Draft O&M's submitted prior to first training session.
c. Contractor as built documents submitted prior to first training session.
d. Labeling of equipment, piping, and accessories is complete prior to first training session.
e. Training by qualified technicians knowledgeable in plumbing systems and components. Sales representatives are not acceptable to teach training courses unless approved by Owner prior to training.

3.5 Piping Details

a. Not applicable.

SECTION 23 21 23: Hydronic Pumps

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

a. Section includes base mounted and in line centrifugal pumps.

1.2 General Design Guidelines

a. In line pumps cannot be installed such that one pump is directly above a lower pump. Stacked pumps should be offset such that any leaks from the higher pump cannot fall onto the motor of the lower pump.
b. Inline pumps cannot be installed more than 6 feet above the floor.
c. Inline pumps weighing over 50 pounds must have overhead pick point for use in maintenance and replacement.
d. Compound pressure gauges required on both inlet and outlet of pumps. If suction diffuser is installed provide additional gauge on outlet of suction diffuser.
e. Motors controlled by variable frequency drives to be premium efficiency inverter ready.

1.3 Submittals

a. Submittal information will only be reviewed as related to this section.
b. Submittals should have sufficient detail to determine compliance with specifications.
c. Incomplete submittals will be rejected without review.
d. Submittals should be for this complete specification section and not individual sections.
e. O&M documents – electronic searchable .pdf.
f. Training plans.

1.4 Qualifications

a. Startup technician to be factory authorized.
b. Training teacher to be a technician knowledgeable in pump operation and maintenance.

PART 2 – PRODUCTS

2.1 In-line centrifugal pumps

a. Fractional horsepower circulators
    - Basis of design: Grundfos close coupled pumps
    - Casing: Cast-iron, provide with gauge / vent / drain tappings
    - Trim: Bronze
    - Impeller: Bronze or stainless steel
    - Shaft: Stainless steel or carbon steel
    - Sleeves: Stainless steel or bronze
    - Bearings: Permanently sealed
    - Seals: Mechanical
    - RPM: 1750 or 3500
b. Vertical In line pumps

- Casing: Cast-iron, provide with gauge / vent / drain tappings
- Trim: Bronze.
- Impeller: Bronze.
- Shaft and sleeves: Stainless steel
- Bearings: Permanently sealed
- Seals: Mechanical
- RPM: 1750 preferred

c. Small circulators (1 hp to 10 hp)
- Basis of design: Bell & Gossett series e-80 closed coupled
- Casing: Cast-iron, provide with gauge / vent / drain tappings
- Trim: Bronze
- Impeller: Bronze
- Shaft and sleeves: Stainless steel
- Bearings: Permanently sealed
- Seals: Mechanical
- RPM: 1750 preferred

d. Large circulators (15 hp and greater)
- Basis of design: Bell & Gossett series e-80SC split coupled.
- Casing: Cast-iron, provide with gauge / vent / drain tappings
- Trim: Bronze
- Impeller: Bronze
- Shaft and sleeves: Stainless steel
- Bearings: Permanently sealed preferred
- Seals: Mechanical
- RPM: 1750

2.2 End suction pumps

a. Basis of design: Bell and Gossett Series e-1532 close coupled base mounted end suction or Series 1510 split coupled.
- Casing: Cast-iron, provide with gauge / vent / drain tappings.
- Trim: Bronze.
- Impeller: Bronze or stainless steel.
- Shaft: Stainless steel.
- Bearings: Permanently sealed preferred
- Seals: Mechanical.
- Coupler: Close coupled preferred for motor sizes less than 15 hp
- RPM: 1750

PART 3 – EXECUTION

3.1 Installation

a. All pumps with flexible couplers are required to be field aligned by a factory technician.
b. Startup performed by factory authorized service representative.
- Owner to witness startup.
- Owner to witness removal of startup screens and cleaning of strainers.

3.2 Interface with other products

a. Installation must not compromise installation or access to other building systems or components.
b. Pump startup to occur concurrently or after motor control device startup.
c. Building automation system.

3.3 Testing

a. All testing to be witnessed by Owner.
b. Startup to be scheduled to allow for Owner witness.

3.4 Training

a. Furnish training plan for review by Owner at least two weeks prior to training.
b. Draft O&M's submitted prior to first training session.
c. Contractor as built documents submitted prior to first training session.
d. Labeling of equipment, piping, and accessories is complete prior to first training session.
e. Training by qualified technicians knowledgeable in hydronic systems and components. Sales representatives are not acceptable to teach training courses unless approved by Owner prior to training.
f. Provide 2 hours of training per pumping system.
g. Review all pump components in detail, show locations of zinc fittings, drain valves, etc.
h. Review all preventative maintenance procedures, provide list of acceptable lubricants and grease, provide intervals of maintenance for all components.
i. Review pump sequence of operation, control strategy, location of pressure sensors, motor control devices.
j. Review spare parts and tools required to be furnished by Contractor.
k. Review spare parts suppliers and source of procurement procedures.

SECTION 23 22 00 Steam and Condensate Piping and Pumps

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

a. Section includes pipe, fittings, joining methods, specialties, and pumping units for steam and condensate systems.
   - Steam and Condensate piping
   - Steam Specialties
     i. Isolation valves / Shutoff valves
     ii. Control valves
     iii. Pressure reducing valves
     iv. Safety valves
     v. Steam traps
     vi. Strainers
     vii. Vacuum breakers
     viii. Flash tanks
   - Condensate pumps

1.2 General Design Guidelines

a. All steam condensate must go to 1 location / 1 line that are then pumped to the condensate main in the tunnel. This line back to the tunnel main must be metered.
b. A check valve is to be located on the main steam condensate line before it is connected to the tunnel condensate main.
c. Do not locate condensate pipes in conduit casings with steam pipes.
d. Overflows on condensate sets shall not be higher that the lowest point of a heat exchanger tube bundle and the vent must dump to a floor drain in a safe location; safe locations are outside of circulation or egress areas.
e. If utility piping is approved by CPFM to leave the tunnel and continue underground all the piping must be sleeved / cased with a direct-buried piping system: condensate, steam, chilled water, etc. All sleeves must continue into the building a minimum of 12 inches.
f. Unions required at valves and equipment connections on piping 2 inches and smaller.
g. Flanges required at valves and equipment connections on piping 2.5 inches and larger.
h. Drip legs required at low points of piping and upstream of control valves and pressure regulators.
i. Strainers required upstream of all valves and traps. Full port ball valve required on blowdown connection to strainer for all pipe sizes.

1.3 Submittals

a. Provide pipe flushing plan
b. Provide pressure testing plan

1.4 Qualifications

a. Not applicable.

PART 2 – PRODUCTS

2.1 Steam and Condensate Piping

a. Low pressure maximum 15 PSIG
b. Low pressure 2" and smaller:
   - Schedule 40 black steel pipe, class 125, cast iron fittings, threaded joints
c. Low pressure 2.5" and larger:
   - Schedule 40 black steel pipe, class 150, wrought steel fittings, welded and flanged joints
d. Medium pressure 2" and smaller:
   - Schedule 40 black steel pipe, class 125, cast iron fittings, threaded joints
e. Medium pressure 2.5" and larger:
   - Schedule 40 black steel pipe, class 150, wrought steel fittings, welded and flanged joints
f. Steam condensate 2" and smaller:
   - Schedule 80 black steel pipe, class 125, cast iron fittings, threaded joints
g. Steam condensate 2.5" and larger:
   - Schedule 80 black steel pipe, class 150, wrought steel fittings, welded and flanged joints

2.2 Steam Specialties

a. Isolation Valves / Shutoff valves – See division 33 for utility / tunnel requirements.
   - Gate valves only for steam and condensate.
   - 150 lb minimum.
b. Steam control valves
   - Steam control valves are to have stainless steel seats and disks.
   - Steam control valves to hydronic heat exchanger are to be normally closed
c. Pressure reducing valves – See division 33 for utility / tunnel requirements
   - Basis of design: Spirax Sarco
   - No bypass allowed around pressure reducing valves
d. Safety Valves
   - Safety valve vent piping required to extend through the roof.
e. Steam Traps
   - Basis of design:
     i. Float and thermostatic: none
     ii. Inverted bucket trap: none
f. Strainers
   - Basis of design: none
g. Vacuum Breakers
   - Basis of design: none
h. Flash tanks
   - Basis of design: none

2.3 Condensate Pumps

a. All condensate pumps are to have the optional isolation valve between the condensate tank and the pump.
b. Condensate sets will have a valve between the pump and the tank and a duplex pump system.
c. The steam condensate receiver minimum size is 30 gallons.
d. Balance valve required on pumped discharge piping

PART 3 – EXECUTION

3.1 Installation

a. Not applicable

3.2 Interface with other products

a. Not applicable.

3.3 Testing

a. Water pressure testing to be provided at minimum 150 psig
b. All testing to be witnessed by Owner.
c. Startup to be scheduled to allow for Owner witness.

3.4 Training

a. Furnish training plan for review by Owner at least two weeks prior to training.
b. Draft O&M's submitted prior to first training session.
c. Contractor as built documents submitted prior to first training session.
d. Labeling of equipment, piping, and accessories is complete prior to first training session.
e. Training by qualified technicians knowledgeable in plumbing systems and components. Sales representatives are not acceptable to teach training courses unless approved by Owner prior to training.

3.5 Piping Details

a. Not applicable.

SECTION 23 23 00 Refrigerant Piping

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Refrigerant piping for HVAC systems.

1.2 General Design Guidelines
a. Not applicable.

1.3 Submittals
a. Product data.

1.4 Qualifications
a. Not applicable

PART 2 – PRODUCTS

2.1. Piping
a. Copper type L or ACR, wrought copper fittings.

PART 3 – EXECUTION

3.1 Installation
a. Not applicable.

3.2 Interface with other products
a. Not applicable.

3.3 Testing
a. Pressure testing
   - Owner to witness pressure testing, minimum 150 psi

3.4 Training
a. Not applicable.

SECTION 23 25 00: HVAC Water Treatment

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change
3/18/20	3.1 Installation	Clarification of flushing and cleaning process

PART 1 – GENERAL

1.1 Summary
a. Section includes cleaning and treatment for closed loop hydronic systems

1.2 General Design Guidelines
a. Not applicable.

1.3 Submittals
a. Submittal information will only be reviewed as related to this section.
b. Submittals should have sufficient detail to determine compliance with specifications.
c. Incomplete submittals will be rejected without review.
d. Submittals should be for this complete specification section and not individual sections.
e. Flushing and cleaning plan and report.
f. O&M documents – electronic searchable .pdf.
g. Training plans.

1.4 Qualifications
a. Chemical engineer or technical representative to direct flushing, cleaning, and pre-treatment.

PART 2 – PRODUCTS

2.1 Basis of design: U.S. Water Services
a. All closed loop hydronic systems to be cleaned and flushed.
   - US Water “Boil Out” for organics such as pipe dope, welding slag, cutting oils.
   - US Water “Ferroclean” for iron
   - US Water “Towerclean 819” for vulnerable systems
b. HVAC systems that require passivation use US Water “CWT-3231” Molybdate based closed loop treatment or approved equivalent.
   - Molybdate Mo6+ level shall be tested by US Water representative and maintained between 112 ppm and 224 ppm
c. Systems dosed with US Water “Biotrol 102” or “Bitrol 114” after cleaning and flushing is complete.

2.2 Chemical feeding equipment
a. Pot feeders / filters
b. Basis of design: Griswold DB-SB 5 gallon

PART 3 – EXECUTION

3.1 Installation

a. Flushing and cleaning
   - Preparation
     i. Performed by Mechanical Contractor, witnessed by Owner.
     ii. Flushing and cleaning plan submitted by Contractor and reviewed by Owner prior to initiating cleaning process.
     iii. All system pressure testing complete and test logs submitted to project team.
     iv. All system valves opened by contractor including balance valves, control valves, isolation valves, etc.
         1. Valve position to be confirmed by Owner inspection.
     v. Fill the piping system with potable water and circulate water at a velocity of 5-7 ft/s to force loose debris to low point drains and strainers. Circulate water for a minimum of 8 hours.
         1. Continue flushing until discharge water is clear and free from all debris.
     vi. 25 micron filter in pot feeder / side stream filter should be used during flushing and cleaning.
     vii. Remove, clean, and replace strainer screens or filters.
     viii. Remove and clean suction diffusers on pumps.
     ix. Blow down air dirt separator and all low point drains.
   - Cleaning
     i. Performed by U.S. Water, witnessed by Owner
     ii. All valves opened by Contractor including balance valves, control valves, isolation valves, etc.
         1. Valve positions to be confirmed by Owner inspection.
     iii. Introduce cleaning compound into system and circulate at a velocity of 5-7 ft/s for a minimum of 24 hours in accordance with manufacturer's recommendations.
     iv. 25 micron filter in pot feeder / side stream filter should be used during flushing and cleaning.
   - Flushing
     i. Performed by U.S. Water and Mechanical Contractor, witnessed by Owner
     ii. Drain cleaning compound from system and dispose of as permitted by the City of Eugene.
     iii. Flush with potable water until the system water meets the following requirements:
         1. Concentration of cleaning agent is less than 10 ppm
         2. pH is within 0.5 of makeup water
         3. System water drawn from any branch is clear when observed in a white cup
     iv. Remove, clean, and replace strainer screens or filters.
     v. Remove and clean suction diffusers on pumps.
     vi. Blow down air dirt separator and all low point drains.
   - Treatment
     i. Performed by U.S. Water, witnessed by Owner
     ii. Add corrosion inhibitor and circulate in system for a minimum of 8 hours. If concentration is below manufacturer's recommendation add more and repeat until required level is obtained.

b. Reporting
   - Contractor to submit report documenting flushing and cleaning process, chemicals used, and test results.

3.2 Interface with other products

a. Not applicable.

SECTION 23 31 00 HVAC Ducts and Casings

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

a. Section includes ductwork, insulation, and liner.

1.2 General Design Guidelines

a. SMACNA design standards to be followed for metal ducts, fittings, etc.
b. Mechanical rooms are not to be used as air plenums.
c. Non-ducted plenum returns not permitted;
   - Return grilles are to be connected with duct work back to HVAC unit.
   - Use of transfer ducts must be approved by Owner.
d. No auxiliary mechanical equipment is to be mounted inside of an HVAC system air side compartment other than dampers, damper actuators, fan assemblies, coils, and filters.
e. No duct-board or fiberglass duct work.
f. Fume hood exhaust duct should be rolled stainless steel fully welded.
g. Flexible connections required on all inlet and discharge duct connection.
   - This is not required if AHU has internal vibration isolation.
h. All duct work must be inside penthouses or building structure. Exposed rooftop ductwork requires UO review and if approved it must be constructed of welded stainless steel.
i. All duct mounted accessories including dampers, coils, etc. must have duct access hatches for maintenance and cleaning. Motor actuators for dampers must be externally mounted with minimum 6" clearance from shaft to wall.

1.3 Submittals

a. Materials and catalog data
b. Shop drawings
c. Duct pressure testing report
d. Construction IAQ management plan
   - HVAC equipment may not be used for temporary construction heating / cooling / or ventilating.
   - Ductwork cleanliness to be reviewed by UO at end of construction and fully cleaned by a third party cleaning service if found to be dirty.

1.4 Qualifications

a. Not applicable.

PART 2 – PRODUCTS

2.1 Ductwork

a. Flexible ductwork
   - Acceptable for use in runout connections to diffusers and grilles, maximum length 10 feet.
b. Duct liner

- Non shedding material required

c. Insulation
   - No requirements.

PART 3 – EXECUTION

3.1 Installation

a. Open ductwork, fans, coils, units, equipment, etc. to be covered during construction to reduce possibility of dirt entering system.
b. If construction debris, dust, dirt, contamination, etc. is found in system, the contractor is responsible for cleaning of all duct, fans, coil, units, equipment, etc. and/or replacement as needed.

3.2 Interface with other products

a. Not applicable.

3.3 Testing

a. Duct pressure testing to be performed by Testing, Adjusting, and Balancing contractor not mechanical contractor.

3.4 Training

a. Not applicable.

SECTION 23 33 00 Air Duct Accessories

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

a. Section includes:
- Combination Fire/smoke dampers
- Manual balance dampers
- Automatic dampers
- Constant airflow regulators
- Air flow monitoring stations
- Airflow straighteners

1.2 General Design Guidelines

a. Combination fire smoke dampers require unobstructed maintenance clearance to smoke detector and damper actuator, maintenance working zone minimum is 24”x24”x24”.
- Duct access door required for visual inspection, minimum 12”x12” opening.
- Hinged access door required for rectangular ductwork.

1.3 Submittals

a. Product data
b. Shop drawings
c. Control information and wiring diagrams for packaged equipment.
d. Operating and maintenance data for each product.

1.4 Qualifications

a. Not applicable.

PART 2 – PRODUCTS

2.1 Fire/Smoke dampers:

a. Basis of design: none
- End switch contact required for building automation system monitoring.

2.2 Manual balance dampers:

a. Basis of design: none
b. Positioner should having locking quadrant.
c. Concealed damper cable controls
- Basis of design: Young Regulator
- Provide for all dampers installed above hard ceilings.

2.3 Automatic dampers:

a. Basis of design: Tamco

b. Control damper drive shaft is to be secured to the damper blade.
c. No jack shafts or socket style mounts to blades

2.4 Constant airflow regulators
a. Basis of design: none
   - Not permitted for use without UO approval.

2.5 Air flow monitoring stations
a. Basis of design: none
   - Minimum 24"x24" hinged access door required.

2.6 Air straighteners
a. Basis of design: none
   - Upstream air filters required with maintenance access to installed straightener, minimum 24" x 24" hinged access door.

PART 3 – EXECUTION

3.1 Installation
a. Manual balance dampers should be flagged during installation to indicate installed position to TAB contractor.

3.2 Interface with other products
a. Building automation system should monitor position of fire smoke dampers.

3.3 Testing
a. Combination fire smoke damper testing to be witnessed by UO.

3.4 Training
a. Provide training for all devices and equipment to include preventative maintenance, verify labeling is complete and correct, review location of all devices, and verify all testing is complete with associated documentation.
b. Training to include preventative maintenance procedures, alarms.

SECTION 23 34 00 HVAC Fans

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Centrifugal Fans
b. Roof Exhaust Fans
c. Small Cabinet Fans
d. In-line Fans
e. Ceiling Fans

1.2 General Design Guidelines
a. No axial fans allowed.
b. Direct drive fans preferred.
c. Fan bearings and shafts must be accessible for replacement.

1.3 Submittals
a. Product data
b. Shop drawings
c. Control information and wiring diagrams for packaged equipment.
d. Operating and maintenance data for each product.

1.4 Qualifications
a. Startup and testing to be performed by factory authorized service representative.

PART 2 – PRODUCTS

2.1 In Line Centrifugal Fans
a. Basis of Design: None
b. General:
   - AMCA Class B spark resistant construction
   - Connect to ductwork using flexible connections.
c. Housing:
   - Heavy gauge steel, continuously welded throughout, welded steel supports.
   - Removable panels for access to all interior equipment
   - Inlet and outlet collars for slip fit duct constructions
   - ¾" NPT external threaded located at lowest point of fan housing.
d. Bearings and Drives:
   - Direct driven preferred.
   - Air handling quality bearings, minimum life of 80,000 hours (ABMA-9 L-10)
   - Heavy duty pillow block type bearings, grease lubricated, grease fittings extended to an accessible location.
   - Sized for 150% of motor horsepower, cast ion adjustable sheaves, V-belt type, sheaves statically and dynamically balanced, multiple belt drives on all units over 2 HP.

- Provide fixed sheave units for motors as required.
- Replace fan sheaves as required to obtain desired results.
- Include allowance for one sheave change for fans with fixed sheaves.

e. Motors:
- Premium efficiency inverter ready motors required for use with variable frequency drives.
- Internally installed static rings for use with variable frequency drives.
- 1800 RPM maximum with pre-lubricated sealed ball bearings.

f. Accessories:
- Metal belt guards as required

g. Inlet / Outlet Screens:
- Removable

h. Vibration Isolation:
- Required

2.2 Roof Mounted Exhaust Fans

a. Basis of Design: None

b. Housing:
- One piece gauge spun aluminum construction or louvered type with heavy gauge extruded aluminum louvers, steel inlet bell, arranged for curb mounting.

c. Bearings and Drives:
- Direct driven preferable.
- Air handling quality bearings, minimum life of 80,000 hours (ABMA-9 L-10)
- Heavy duty pillow block type bearings, grease lubricated, grease fittings extended to an accessible location.
- Sized for 150% of motor horsepower, cast ion adjustable sheaves, V-belt type, sheaves statically and dynamically balanced, multiple belt drives on all units over 2 HP.

d. Motors:
- Premium efficiency inverter ready motors required for use with variable frequency drives.
- Internally installed static rings for use with variable frequency drives.
- 1800 RPM maximum, with pre-lubricated sealed ball bearings.

e. Accessories:
- Metal belt guards as required
- Disconnect switch required under enclosure
- Backdraft damper required, gravity or motor operated acceptable.
- Bird screen

f. Curb:
- Required, account for roof slope to provide level mounting, removable baffles or hinged curb for access to backdraft dampers

g. Vibration Isolation:
- Required on fan motors.

PART 3 – EXECUTION

3.1 Installation

a. Startup performed by factory authorized service representative
- Owner to witness startup.

b. Fans during construction:

- Building fans may NOT run until final completion of all construction. Pre-Functional Checklist (PFC), startup, and commissioning schedules / activities that require running fans will be negotiated.
- System should be sealed off from anything that may cause debris, dust, dirt, or other contamination to get into the system during construction activities.
- If construction debris, dust, dirt, contamination, etc. is found in system, the contractor is responsible for cleaning all duct, fans, coil, units, equipment, etc. and/or replacement as needed.

3.1 Interface with other products

a. Building automation system

3.2 Testing

a. All testing to be witnessed by Owner.

3.3 Training

a. Furnish training plan for review by Owner at least two weeks prior to training.
b. Draft O&M's submitted prior to first training session.
c. Contractor as built documents submitted prior to first training session.
d. Labeling of equipment, ductwork, and accessories is complete prior to first training session.
e. Training by qualified technicians knowledgeable in HVAC systems and components. Sales representatives are not acceptable to teach training courses unless approved by Owner prior to training.
f. Provide 2 hours of training per pumping system.
g. Review all fan components in detail, show locations of zirc fittings, motor access, backdraft dampers, etc.
h. Review all preventative maintenance procedures, provide list of acceptable lubricants and grease, provide intervals of maintenance for all components.
i. Review fan sequence of operation, control strategy, location of any pressure or airflow sensors, motor control devices.
j. Review spare parts and tools required to be furnished by Contractor.
k. Review spare parts suppliers and source of procurement procedures.

SECTION 23 36 00 Air Terminal Units

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

a. Variable Air Volume Terminal Units
b. Duct Mounted Air Measuring Control Damper
c. Parallel Fan Powered Terminal Unit
d. Venturi Type Air Valve

1.2 General Design Guidelines

a. Pressure independent venturi air valves should be used for laboratory pressure control systems.
b. Accessibility of Equipment & Components:
   - All Variable Volume (VAV) and Terminal Unit (TU) boxes require 36" clearance on all sides possible with a clear approach from below. At a minimum 36" clearance is required on the control side of the TU with a clear approach from below.
   - No equipment shall be accessed via restrooms.
   - Equipment above ceilings shall be located within corridors or above doorways.
   - All equipment must be accessible for removal, replacement, and serviceability.
   - Service access shall not include and/or require any disassembly. This includes all surrounding components including, but not limited to, ceiling grids, piping, ducts, conduits, equipment and other installed items.
   - Access panels and clearance is required to ALL coils for replacement and cleaning.
   - Access panels are required at all dampers.
   - All equipment MUST allow for access of personnel and equipment required for future removal and replacement of such equipment.

1.3 Submittals

a. Product data
b. Shop drawings
c. Control information and wiring diagrams for packaged equipment.
d. Operating and maintenance data for each product.

1.4 Qualifications

a. Startup and testing to be performed by factory authorized service representative.

PART 2 – PRODUCTS

2.1 Variable Air Volume Terminal Units

a. Basis of Design: None
b. Components:
   - Cabinet:
     i. Bottom access door on inlet side of coil / downstream of volume damper.

2.2 Duct Mounted Air Volume Control Damper

a. Basis of Design: None
b. Components:
   - Cabinet:
     i. Bottom access door to inspect damper.
   - Airflow sensor:
     i. Multiple sensing point differential pressure airflow sensor. Use of thermal dispersion airflow sensors in branch ductwork not permitted.

2.3 Parallel Fan Powered Terminal Unit

a. Basis of Design: None
b. Components:
   - Cabinet:
   - Bottom access door on inlet side of coil / downstream of volume damper.
c. Equipment leakage rate to be less than 5% including internal dampers

2.4 Venturi Type Air Valve

a. Basis of Design: Siemens
b. General:
   - Pressure independent air valves for use in laboratory pressurization control.

PART 3 – EXECUTION

3.1 Installation

a. Startup performed by factory authorized service representative
   - Owner to witness startup.
b. System should be sealed off from anything that may cause debris, dust, dirt, or other contamination to get into the system during construction activities.
   - If construction debris, dust, dirt, contamination, etc. is found in system, the contractor is responsible for cleaning all duct, fans, coil, units, equipment, etc. and/or replacement as needed.

3.1 Interface with other products

a. Building automation system

3.2 Testing

a. All testing to be witnessed by Owner.

3.3 Training

a. Furnish training plan for review by Owner at least two weeks prior to training.
b. Draft O&M's submitted prior to first training session.
c. Contractor as built documents submitted prior to first training session.
d. Labeling of equipment, ductwork, and accessories is complete prior to first training session.
e. Training by qualified technicians knowledgeable in HVAC systems and components. Sales representatives are not acceptable to teach training courses unless approved by Owner prior to training.
f. Provide 2 hours of training per air terminal device type on project.
g. Review all fan components in detail, show locations of zirc fittings, motor access, dampers, etc.
h. Review all preventative maintenance procedures, provide list of acceptable lubricants and grease, provide intervals of maintenance for all components.

i. Review fan sequence of operation, control strategy, location of any pressure or airflow sensors, motor control devices.
j. Review spare parts and tools required to be furnished by Contractor.
k. Review spare parts suppliers and source of procurement procedures.

SECTION 23 37 00 Air Outlets and Inlets

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Section covers grilles, registers, diffusers, louvers

1.2 General Design Guidelines
a. Air intake locations must be determined with consultation of CPFM.
b. Penthouse and/or mechanical enclosures must have an exterior entry or access for cleaning at the air intake.
c. No insect screening on louvered air intake.
d. Provide access in duct to clean air intakes bird screen.
e. Frame for louvered air intakes with bird screen to be installed on hinges for maintenance to swing open and clean.

1.3 Submittals
a. Not applicable.

1.4 Qualifications
a. Not applicable.

PART 2 – PRODUCTS

2.1 Grilles, Registers, Diffusers
a. Basis of design: none
b. Perforated face supply diffusers not permitted.
c. Thermal variable volume diffusers not permitted.

2.2 Louvers
a. Basis of design: none
b. Bird screen required on outside air intakes or exhaust air outlets. Access to screens for cleaning required.

PART 3 – EXECUTION

3.1 Installation
a. Not applicable.

3.2 Interface with other products
a. Not applicable.

3.3 Testing
a. Not applicable.

3.4 Training
a. Not applicable.

SECTION 23 40 00 HVAC Air Cleaning Devices

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

a. Section includes:
   - Pleated filters
   - Frames and housings

1.2 General Design Guidelines

a. Provide filter switches for monitoring and integration with building automation system.

1.3 Submittals

a. Product data.

1.4 Qualifications

a. Not applicable.

PART 2 – PRODUCTS

2.1 Pleated filters

a. Basis of design: Purolator
b. Pleated is minimum quality filter acceptable.

2.2 Frames and housings

a. Basis of design: none
b. Provide holding frames for final filters.
c. Spring tension fasteners not permitted.

PART 3 – EXECUTION

3.1 Installation

a. Filters required to be installed prior to equipment operation. Provide MERV 8 during construction.
b. Provide new filters when the building is substantially complete and provide one set of spare filters for all equipment.

3.2 Interface with other products

a. Building automation system should monitor filter switches.

3.3 Testing

a. Not applicable.

3.4 Training

a. Not applicable.

SECTION 23 57 00 Heat Exchangers for HVAC

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Shell and Tube Heat Exchangers
b. Plate and Frame Heat Exchangers

1.2 General Design Guidelines
a. Provide plate and frame heat exchangers on chilled water systems when system operation could cause mixing of central chilled water system and building heating closed loop systems.
b. Provide pressure temperature safety relief valve on water side of heat exchangers, piped to floor drain.
c. Provide isolation valves on water inlet / outlet.
    a. Use lug type butterfly valves on piping 2.5" and larger on both inlet and outlet of heat exchangers.
    b. Use ball valves on piping 2" and smaller with unions between valves and inlet / outlet.

1.3 Submittals
a. Product data
b. Shop drawings
c. Operating and maintenance data for each product.

1.4 Qualifications
a. Not applicable.

PART 2 – PRODUCTS

2.1 Shell and Tube Heat Exchangers
a. Basis of Design: None
b. General: Front head should be removable from tube bundle.
c. Construction: None.

2.2 Plate and Frame Heat Exchangers
a. Basis of Design: None
b. General: None.
c. Construction: None

PART 3 – EXECUTION

3.1 Installation
a. Tube-bundle shall be removable without requiring the removal of other equipment, piping, etc. to gain access. Minimum of 3ft clear on all sides.

3.2 Interface with other products

a. Not applicable.

3.3 Testing

a. Not applicable.

3.4 Training

a. Furnish training plan for review by Owner at least two weeks prior to training.
b. Draft O&M's submitted prior to first training session.
c. Contractor as built documents submitted prior to first training session.
d. Labeling of equipment, piping, and accessories is complete prior to first training session.
e. Training by qualified technicians knowledgeable in hydronic / steam systems and components. Sales representatives are not acceptable to teach training courses unless approved by Owner prior to training.
f. Provide 2 hours of training.
g. Review all components in detail
h. Review all preventative maintenance procedures, provide intervals of maintenance for all components.
i. Review spare parts and tools required to be furnished by Contractor.
j. Review spare parts suppliers and source of procurement procedures.

SECTION 23 73 00 Air Handling Units

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary
a. Section includes air handling units

1.2 General Design Guidelines
a. Return fans are required in systems when economizing is included.

1.3 Submittals
a. Product data
b. Shop drawings
    a. Dimensions and weight
    b. Required clearances for maintenance
    c. Shipping splits
c. Control information and wiring diagrams for packaged equipment.
d. Operating and maintenance data for each product.

1.4 Qualifications
a. Startup and testing to be performed by manufacturer certified agent.

PART 2 – PRODUCTS

2.1. Custom Air Handling Units
a. Basis of Design: Energy Labs, Haakon, Nortek
b. General: Condensate drain pans required to be piped to floor drain.
c. Fan accessories:
    - Airflow monitoring: Ebtron only acceptable manufacturer.
d. Hydronic coils:
        - Chilled water minimum velocity 3 feet per second
e. Air filtration: Filter switches required integrated with building automation system.
f. Control dampers: Jack shafts not permitted.
g. Heat recovery
    - Heat pipe: Preferred method of heat recovery where possible.

2.2. Packaged Air Handling Units
a. Basis of Design: Daikin, Carrier
b. Control package: Integration with building automation system required via BACnet. Preference for full building automation control of unit excluding refrigerant functions.

PART 3 – EXECUTION

3.1 Installation
a. Startup performed by factory authorized service representative.

- Owner to witness startup.

3.2 Interface with other products

a. Installation must not compromise installation or access to other building systems or components.
b. Building automation system.

3.3 Testing

a. All testing to be witnessed by Owner.
b. Startup to be scheduled to allow for Owner witness.

3.4 Training

a. Furnish training plan for review by Owner at least two weeks prior to training.
b. Draft O&M's submitted prior to first training session.
c. Contractor as built documents submitted prior to first training session.
d. Labeling of equipment, piping, ductwork, and accessories is complete prior to first training session.
e. Training by qualified technicians knowledgeable in hydronic systems and components. Sales representatives are not acceptable to teach training courses unless approved by Owner prior to training.
f. Provide 2 hours of training per air handling unit type.
g. Review all fan components in detail, show locations of zirc fittings, disconnects, etc.
h. Review all preventative maintenance procedures, provide list of acceptable lubricants and grease, provide intervals of maintenance for all components.
i. Review unit sequence of operation, control strategy, location of pressure sensors, airflow sensors, motor control devices, etc.
j. Review spare parts and tools required to be furnished by Contractor.
k. Review spare parts suppliers and source of procurement procedures.

SECTION 23 80 00 Decentralized HVAC Equipment

Document revision history: 08/2019 – Original Publication

Date	Section	Description of Change

PART 1 – GENERAL

1.1 Summary

a. This section includes:
    a. Split System Air Conditioning Units
    b. Chilled Beams
    c. Air Coils
    d. Unit Heaters
    e. Radiators
    f. Radiant Floor Heating
    g. Humidifiers

1.2 General Design Guidelines

a. Convection units (fin tube, baseboard) are to have an accessible service panel or door so the control valves and balancing valves can be accessed without the removal of the convection unit cover or cabinet.
b. Water to water flat plate heat exchanger required for the following hydronic systems:
    - Radiant floor used for heating and cooling
    - Two pipe chilled beams used for heating and cooling.
c. No window mounted AC units without prior CPFM and FS approval.

1.3 Submittals

a. Product data
b. Shop drawings
    a. Dimensions and weight
    b. Required clearances for maintenance
    c. Shipping splits
c. Control information and wiring diagrams for packaged equipment.
d. Operating and maintenance data for each product.

1.4 Qualifications

a. Startup and testing to be performed by manufacturer certified agent.

PART 2 – PRODUCTS

2.1. Split System Air Conditioning Units

a. Basis of Design: Mitsubishi
    - General: Thermostats must be hardwired to the unit; no remote style thermostats.
    - Commercial grade must be used.
    - Gravity drains required, ¾" individually piped drain lines.

2.2. Chilled Beams

b. Basis of Design: None.

c. General: Four pipe beams preferred for heating and cooling type.

2.3. Air Coils

d. Basis of Design: None.
e. General: Maintenance access for coil pull must be shown in design documentation.

2.4. Unit Heaters

f. Basis of Design: None.
g. General: None.

2.5. Radiators

h. Basis of Design: None.
i. General: None.

2.6. Radiant Floor Heating

j. Basis of Design: None.
k. General: None.

2.7. Humidifiers

l. Basis of Design: None.
m. General: None.

PART 3 – EXECUTION

3.1 Installation

a. Startup performed by factory authorized service representative.
   - Owner to witness startup.

3.2 Interface with other products

a. Installation must not compromise installation or access to other building systems or components.
b. Building automation system.

3.3 Testing

a. All testing to be witnessed by Owner.
b. Startup to be scheduled to allow for Owner witness.

3.4 Training

a. Furnish training plan for review by Owner at least two weeks prior to training.
b. Draft O&M's submitted prior to first training session.
c. Contractor as built documents submitted prior to first training session.
d. Labeling of equipment and accessories is complete prior to first training session.
e. Training by qualified technicians knowledgeable in hydronic systems and components. Sales representatives are not acceptable to teach training courses unless approved by Owner prior to training.
f. Provide 1 hour of training per equipment type.
g. Review all preventative maintenance procedures, provide intervals of maintenance for all components.

h. Review spare parts and tools required to be furnished by Contractor.
i. Review spare parts suppliers and source of procurement procedures.