

DIVISION 23 – HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

23 22 00 STEAM AND CONDENSATE PIPING AND PUMPS

PART 1 - GENERAL

1.01 SYSTEM DESCRIPTION

- A. Steam Distribution System: Steam is the primary heat source for a variety of functions throughout the Pullman campus of Washington State University. Saturated steam is generated at the Grimes Way and College Avenue Steam Plants and distributed via a looped piping system which operates at 100 psig (338°F). Design conditions for the steam supply are 125 psig saturated and 353°F. The distribution system serves all sections of the campus core. Discuss the expected maximum load steam volume for design conditions with the WSU Project Manager and Engineering Services.
1. The preferred method and majority of distribution steam piping is located in directly accessible tunnels allowing maintenance access, additional future utility installation, inspection, and pathway for high pressure condensate recovery. Direct bury steam and/or condensate piping or piping systems are not acceptable.
- B. Condensate Return System: The condensate return system operates with up to 180°F condensate, parallel with the steam piping. All uncontaminated condensate shall be returned. If condensate will become contaminated (by process equipment, domestic water, etc.), the Design Consultant shall ensure it is cooled and discharged to the sanitary sewer. Condensate pump shall be designed to overcome existing system pressure at the connection point. Consult with WSU Engineering Services regarding existing pressures at building point of connection.
- C. The WSU Pullman campus district steam system chemical treatment is operated and maintained as “Food Grade” and is suitable for direct injection humidification use.

1.02 SCOPE

- A. Reference WSU Standard Detail drawings for typical installations and associated assemblies:
1. Drawing 23 22 00 M1 for typical single-stage piping schematic and miscellaneous details.
 2. Drawing 23 22 00 M2 for typical two-stage pressure reducing station.

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- B. No later than 50% Design Development drawings, the Consultant shall submit a Process and Instrumentation Drawing (P&ID) for each major system, illustrating all subcomponents of that system, for review by the WSU Project Manager and Engineering Services. Steam/Condensate P&IDs shall illustrate all tie-ins to the campus steam/condensate system; all equipment located within the building relating to steam usage including but not limited to: pipe sizes and weights, isolation valves, safety valves, pressure reducing valves, check valves, unions, strainers, manual bypass valves, pipe drain valves, flanges, steam supplied devices, drip legs, steam traps, steam & condensate drain and vent pipes, pressure gauge locations, expansion joints, pipe anchors, pipe guides, drip pan elbows, condensate receiver, condensate pumps, condensate meter, conductivity meter, and steam BTU meter.
1. For renovation and renewal projects, the Process and Instrumentation Drawing (P&ID) shall illustrate all subcomponents of the existing systems, together with the connections and integration of all new work.
 2. P&IDs shall also reference temporary steam heating during construction.
- B. The scaled Construction Documents shall show the location in the existing steam tunnels from the nearest steam pipe anchors to the new connection point of the existing steam piping to be installed by the Contractor. Any and all additional required piping, pipe anchor points, piping guides and expansion joints required shall be shown in plan and elevation drawings of the connecting tunnel. Design details of the building steam and condensate piping, piping supports, externally pressurized expansion joints, spacing of the pipe guides shall be shown on contract documents. All steel embeds and support steel shall be welded steel channel or equivalent section, designed by the project structural engineer. All piping with greater than 1/8" movement (based on anticipated thermal expansion between installation and operating temperatures) shall be designed and documented in plan and elevation drawings.
- C. Strut support systems are not acceptable.
- D. Condensate shall drain by gravity to/from steam traps. Alternative proposals must be approved by the WSU Project Manager and Engineering Services.
- E. Provide design details showing basis of design calculations for peak building steam loads, including specifics of steam consumed in preheat coils, water heaters and humidification.

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PART 2 - PRODUCTS

2.01 MEDIUM PRESSURE STEAM PIPE AND FITTINGS (GREATER THAN 15 PSIG)

- A. Pipe: ASTM A106 or ASTM A53 Grade B seamless carbon steel.
 - 1. 2" and smaller, threaded connections: Schedule 80
 - 2. 2½" to 12": Schedule 40
 - 3. 12" – 14": 0.375" wall
- B. Fittings and Joints (2" nominal and smaller):
 - 1. Class 125 threaded cast iron fittings and joints conforming to the requirements of ASME B16.4, or
 - 2. Schedule 80 butt weld fittings and joints conforming to the requirements of ASME B16.9.
 - 3. All elbows shall be long radius type.
- C. Fittings and Joints (2½ nominal):
 - 1. Class 125 cast iron threaded fittings and joints conforming to the requirements of ASME B16.4, or
 - 2. Buttweld fittings and joints conforming to the requirements of ASME B16.9; standard weight, seamless wrought carbon steel conforming to requirements of ASTM A234/A234M Grade WPB.
 - 3. All elbows shall be long radius type.
- D. Fittings and Joints (3" nominal and larger):
 - 1. 150 lb standard weight flanged carbon steel fittings and joints conforming to the requirements of ASME B16.5, or
 - 2. Standard weight carbon steel butt weld fittings and joints conforming to the requirements of ASME B16.9.
 - 3. All elbows shall be long radius type.

2.02 LOW PRESSURE STEAM PIPE AND FITTINGS (15 PSIG AND UNDER), SAFETY VALVE VENT, BLOWDOWN PIPING (100 PSIG AND UNDER), MISCELLANEOUS VENT PIPE, AND FITTINGS:

- A. Pipe: ASTM A106 or ASTM A53 Grade B seamless black steel. Pipe manufactured by electric fusion methods is not permitted.
 - 1. 2" and smaller, threaded connections: Schedule 80
 - 2. 2½" to 12": Schedule 40

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B. Fittings and Joints (2 1/2" nominal and smaller):

1. Class 125 cast iron threaded fittings and joints conforming to the requirements of ASME B16.4, or
2. Schedule 80 butt weld fittings and joints conforming to the requirements of ASME B16.9.
3. All elbows shall be long radius type.

C. Fittings and Joints (3" nominal and larger):

1. Class 150 weld neck or slip-on flange conforming to requirements of ASME B16.5; carbon steel forging conforming to requirements of ASTM A105/A105M. Flange neck thickness shall match pipe wall thickness.
2. Schedule 80 carbon steel butt weld fitting and butt weld joints.
3. All elbows shall be long radius type.

2.03 CONDENSATE RETURN, PUMPED CONDENSATE RETURN PIPE, AND FITTINGS (ALL PRESSURES)

A. Pipe: ASTM A106 or ASTM A53 Grade B seamless black steel. Pipe manufactured by electric fusion methods is not permitted.

1. 2½" and smaller, threaded connections: Schedule 80
2. 3" to 12": Schedule 40

B. Fittings and Joints (2½" nominal and smaller):

1. Class 125 cast iron threaded fittings and joints conforming to the requirements of ASME B16.4, or
2. Schedule 80 butt weld fittings and joints conforming to the requirements of ASME B16.9.
3. All elbows shall be long radius type.

C. Fittings and Joints (3" nominal and larger):

1. Class 125 cast iron threaded fittings and joints conforming to requirements of ASME B16.4, or
2. Class 150 weld neck or slip-on flange conforming to requirements of ASME B16.5; carbon steel forging conforming to requirements of ASTM A105/A105M. Flange neck thickness shall match pipe wall thickness.
3. Schedule 80 butt weld fittings and joints conforming to requirements of ASME B16.9; seamless wrought carbon steel conforming to requirements of ASTM A234/A234M, Grade WPB.

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2.04 PIPING SPECIALTIES

A. Large Steam Isolation Valves:

1. Building tie-in at campus distribution connections: Use cast steel gate valves.
 - i. Manufacturer: Velan Cast Steel Full Port Gate, Bolted Bonnet, 800 API 602 Pressure Rating, Flanged or Screwed Connection, Bolted Bonnet, TY Trim or approved equivalent.
2. Other steam isolation valves: Use cast iron valves suitable for pressures and temperatures anticipated.
 - i. Manufacturer: Nibco F-617-0 or T-617-0, meeting MSSSP-70 or approved equivalent.

B. Gaskets: Non-asbestos containing ring gaskets, Flexitallic type “C or CG” Grafoil/304SS or submitted equal, suitable for fluids and temperatures encountered. No sheet gasketing allowed.

C. Bolting: ASTM A193, Grade B7, for bolts and studs, and ASTM A194 Grade 2H for nuts. Anti-seize compound shall be used on all studs and bolts.

D. Sleeves: Sleeves for foundation wall penetrations shall be fabricated of 10 ga or 1/8” thick steel, with 2” wide collars welded in place, and the entire assembly hot-dip galvanized.

E. Wall penetration seals: High temperature elastomeric link type seals compressed with corrosion-protected bolts and compression plates; Thunderline Link-Seal Model “T”, no substitutions

F. Steam Strainers: All wye strainers used in steam and condensate service shall be cast steel. Install a 600# cast steel full port gate valve on the strainer drain without size reduction and discharge plug (Mueller 781 with 0.045” perforated screen). 4” long schedule 80 nipple on blow-down leg, and plugged blow-down valve.

G. Unions: Unions shall be forged steel 3000# class.

2.05 STEAM AND CONDENSATE PIPING INSULATION

A. Steam, condensate and hot water piping shall be installed with single-layer insulation compliant with current ASHRAE standards and the latest Washington State Energy Code, Table C403.2.8.

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- B. Pipe covering shall be sectional molded fiberglass with factory-applied waterproof jackets, installed per manufacturer's recommendations.
 - 1. Pre-Approved Manufacturer: Knauf Earthwool 1000° Pipe Insulation
 - 2. Protective metal shielding is required around insulation for sleeved penetrations and support hangers, to prevent damage due to relative motion.
 - 3. PVC pipe jackets over insulation are required in all Mechanical Rooms from floor-level to 8' AFF and in all high-traffic areas.
- C. Isolation valves (body bonnets and flanges), traps, expansion joints, steam meters, heat exchanger flanges shall be insulated with removable/reusable mesh/fiberglass insulation pads that extend 2 inches beyond flanges and secured with heat-resistant Velcro-type securing tabs. Piping and equipment subject to condensation shall be insulated and have support systems allowing full insulation thickness.

2.06 STEAM TRAPS

- A. Reference WSU Standard Detail 23 22 00 M1, Assemblies A and B.
- B. Float and Thermostatic Traps: Cast iron or ductile iron body, 125 psig working pressure with integral stainless steel air vent. Valve, seat, and float shall be made of brass, bronze or stainless steel; internal components to be easily removable without disconnecting piping. Minimum pipe connection size to be 0.75". Capacities (lbs/hour) shall be indicated on drawings and include the design Factor of Safety. Size traps at indicated lbs/hour at 0.5 psi differential (unless indicated otherwise). Size steam traps according to the system pressure range. TLV JX Series, Armstrong A series, or WSU Engineering Services approved equivalent.
- C. Bucket Traps: Cast iron, inverted bucket trap with side inlet and side outlet with 250 psig working pressure. Bucket and valve shall be easily removable without disconnecting piping. Minimum pipe connection size shall be 0.75". Indicate capacity (lbs/hour) on drawings and include the design Factor of Safety. Size traps at indicated lbs/hour at 0.5 psi differential (unless indicated otherwise). Size steam traps according to the system pressure range.
- D. Pre-Approved Manufacturers: Armstrong 800 series, Spirax/Sarco, Watson McDaniel
- E. Thermal Disc traps shall not be used.

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2.07 ACCESSORIES

- A. Safety Valves: ASME rated for 250 psig working pressure, equipped with test lever and 10% accumulation. Safety valves shall be insulated with removable jacket; manufacturer's data plate must remain visible. Consolidated 1900, or approved equivalent by Conbraco, Kunkle or Spence.
- B. Drip Pan Elbow: See WSU Standard Detail sheet 23 22 00 M1. For each safety valve, install cast iron type with inlet type and size to match safety valve discharge. Manufacturers: Grinnell 1538 and 1538F, Spirax/Sarco Model DPE, or approved equivalent.
- C. Expansion Joints:
 - 1. Expansion joints shall be 150# flanged ends, 150 psig saturated steam design, externally pressurized design, 10,000 cycle life, internal guide ring and end stop, with drain port and lifting lug. Flange bolts shall straddle the centerline.
 - i. Acceptable Expansion Joint Manufacturers: Hyspan 3500 series or Senior Flexonics Pathway X-Press or approved equivalent.
 - 2. Each expansion joint shall be provided with SS nameplates, indicating the date of manufacture, design rating of expansion joint and design travel.
 - 3. All surfaces of the expansion joint shall be thoroughly cleaned of dirt, grease, oil and all foreign matter.
 - 4. Shipping bars shall remain installed on the expansion joint to maintain the proper installation position and only removed after installation and approval by WSU Construction Manager, but before the system is energized.
 - 5. Install a 600# cast steel full port gate valve on the expansion joint drain without size reduction, using a 4" long Schedule 80 nipple.
 - 6. Expansion joint drains shall be piped full size to 6" from floor. Drain expansion joint into tunnel condensate piping.
- D. Vacuum Breakers: Provide vacuum breaker(s) on all air handling unit steam coils and steam converters:
 - 1. Spring loaded, ball type, brass body, stainless steel ball, with 300 psig, at 365° F.
 - 2. Preferred Manufacturers:
 - i. Hoffman #62
 - ii. Johnson Corporation series VB8 with threaded outlet

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3. Provide and install isolation valves upstream of vacuum breakers for accessible maintenance and replacement.
- E. Pipe Hangers: Saddle types with rollers for all steam and condensate pipe. 2" and under 15 psig steam piping may be split ring hangers.

2.08 PRESSURE REDUCING VALVES

- A. External pilot type, single seated, metal diaphragm actuated reducing valves rated for 250 psig steam working pressure.
- B. Bodies shall be of cast iron or ductile iron. Sizes 2 1/2" and larger shall have 150 psig flanged pipe connections.
- C. Seats, discs, stems, and diaphragms shall be constructed of stainless steel (bronze diaphragms acceptable). All internal working parts must be easily removable without disconnecting valve body from piping. PRV pilot shall be installed on the more accessible side of main body.
- D. Valve shall regulate accurately throughout range of pressure and flow conditions indicated and shall function quietly and shut tight on a dead end shut-off. Pressure Reducing Stations shall be designed for redundancy. Valves shall be installed in parallel, each sized for 80% of the maximum operating demand, so that a single PRV can be removed, repaired and replaced while maintaining most heating capacity during peak operating conditions.
- E. Pre-Approved Models:
 1. Fisher 92B
 2. Watson-McDaniel HDP series
 3. Armstrong GP 2000
 4. Proposed alternatives require approval from WSU Engineering Services.

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2.09 STEAM CONVERTER

- A. General: Shell and Tube (U-Tube) design, steam in shell, with water in tubes. Constructed of steel shell, 0.75" OD, .045" minimum wall copper tubes, and a cast iron or steel head. Tube bundle shall be readily accessible and removable for maintenance. Steam connections on head shall be 150 lb flanged. ASME rated for minimum of 125 psig on shell side and tube side with 300°F maximum working temperature. Submittal performance data shall be based on a waterside fouling factor of 0.0001.
- B. Pre-approved manufacturers:
 - 1. Bell & Gossett
 - 2. Armstrong
 - 3. Amtrol
 - 4. Taco
 - 5. Wheatley

2.10 SEMI-INSTANTANEOUS PACKAGED STEAM FIRED WATER HEATERS

- A. General Description: Provide an instantaneous steam-fired water heater. Heaters shall be complete with auxiliary equipment, fittings and contacts such that only required connections are cold water, hot water, steam, condensate and one power connection. Input pressure shall be 15 PSI saturated steam.
 - 1. Pre-Approved Manufacturer / Model: Aerco SW B+
 - 2. Proposed alternatives require approval from WSU Engineering Services.
- B. Factory Assembly: Heater shall be factory assembled and piped including incoming steam strainer, steam valve with electronic operated temperature regulator, main and auxiliary float and thermostatic steam traps or orifice, and condensate strainer. Heater shall be furnished with a water pressure gauge and an ASME pressure/temperature relief valve of sufficient size to relieve total BTU input of the coil.
- C. Controls: Unit shall be delivered only with a high limit safety, and fitted with a characterized Belimo ball valve with spring return actuator:
 - 1. Order unit with pneumatic controls; replace pneumatic steam valve with Belimo 1/4-turn characterized ball valve and actuator controlled by WSU Building Automation System (BAS).
 - 2. Piping: Metal piping shall be required for a minimum 2-foot run off water heaters before transition to PEX or other plastic piping.

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2.11 CONDENSATE PIPING:

- A. Schedule 80 black steel.

2.12 CONDENSATE RETURN RECEIVER AND PUMP

- A. Collect condensate by gravity drainage to a stainless steel (preferably floor level) condensate receiver with duplex pumping system, mechanically controlled. Design and install condensate piping so that it does not impede access to or removal of equipment in the Mechanical Room. The receiver and pumps shall be mounted in a manner that provides ease of adjustment, repair and ready removal and replacement of all equipment. Receiver shall include inlet, vent, drain, and overflow connections. Overflow connections shall discharge to sanitary sewer. Provide a separate vent line out of the condensate receiver through the roof; insulate vent piping up to 8 ft above roof level and where required for personnel protection.
- B. Pump Redundancy: The condensate return system shall be parallel pump equipped for redundancy. The pumps shall operate with lead/lag through the local float control system. Provide auxiliary contact on float control system for high-level alarm to the BAS. Programmable Logic Control (PLC) is not acceptable. Condensate pumps shall be connected to emergency power.
- C. Pump Selection: Consult with WSU Engineering Services regarding required pump sizes.
 - 1. Condensate pump rating shall be based on condensate at 180°F and 1,750 rpm operating conditions.
 - 2. Pump selection shall analyze system design flow rate, and receiver tank size shall provide a combination that does not cycle the pump start/stop more than 8 cycles per hour. The pump maximum design flow shall not exceed 90% of the design system size.
 - 3. Pumps shall be vertical shaft type with pump heads submerged, and motors located above the sump. Submersible pump-motor assemblies shall not be used. Pumps shall be coupled to open drip-proof NEMA motors. Provide a tubing vent line from each pump seal chamber to receiver. Pre-Approved Manufacturers:
 - i. Shipco Pumps
 - ii. Roth Pump Company

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- D. Controls: Duplex unit to be furnished with two NEMA 1 float switches and lead/lag alternator. Provide a UL or ETL approved NEMA 1 control panel, including two motor circuit breakers, fused control circuit with transformer and door interlock switch, two hand-off automatic switches, two magnetic starters with three leg overload protection, and heater and reset push-buttons that shall be provided factory prewired mounted receiver. Each pump discharge shall have 1/4" sampling test valve.
- E. Do not mix high, medium, and low pressure condensate systems.

2.13 STEAM HUMIDIFIERS

A. Steam Dispersion Panel:

1. The factory assembled steam dispersion panel shall include the following components:
 - i. Centrifugal water separator and steam drier designed to remove all water droplets and particulate larger than 3 microns.
 - ii. Distribution manifold providing uniform distribution across entire length, jacketed by steam to assure vapor discharged is free of condensate.
 - iii. Steam trap and steam trap safety temperature interlock which prevents cold startup and shuts down humidification if trap fails closed in operation. Condensate must be returned to the system.
2. Each dispersion tube shall be fitted with one or two rows of steam discharge tubelets inserted into the wall, centered on the diametric line.
3. Each tubelet shall extend through the wall of and into the dispersion tube and contain a steam orifice sized for its required steam capacity.
4. The humidifier shall provide absorption characteristics that preclude water accumulation on any in-duct surface within 15" of the humidifier tube panel while maintaining conditions of 80% maximum relative humidity at a minimum of 52° F in the duct airstream.
5. Air Pressure loss across the humidifier panel shall not exceed 0.2" of water column at a duct air velocity of 700 fpm.
6. All tubes and headers shall be 304 stainless steel and be Heli-arc welded
7. Casing assembly shall be 304 stainless steel.
8. Tubes and headers shall be welded 316 stainless steel.

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B. Pre-Approved Manufacturers:

1. Armstrong
2. Dri-Steem
3. Proposed alternatives require approval from WSU Engineering Services.

2.14 INTEGRAL FACE & BYPASS STEAM HEATING COILS

- A. Reference requirements for all coils (including Steam Heating Coils) in section 23 30 00 “HVAC Air Distribution”.
- B. Reference WSU Standard Detail drawing 23 22 00 M1, Assembly C.
- C. General: Integral Face and Bypass Steam Heating Coils shall consist of built-in series of finned heating elements and bypasses with interlocked dampers controlled by electric damper motor(s) and air stream thermostat. Dampers shall be arranged so as to completely enclose and isolate the heating coil when no temperature rise is required. Each coil shall be capable of maintaining a constant discharge air temperature regardless of variations in entering air temperatures with full steam pressure flow at all times. Proportioning of the air shall be such that the temperature at any point in a plane parallel to the face of the coil three feet downstream from the leaving side will not vary more than $\pm 5^{\circ}$ F from the average discharge air stream temperature.
- D. Coils shall have minimum 18 inches drop from outlet to trap inlet for proper drainage. AHU elevation and total mechanical room layout shall accommodate this requirement.
- E. Coils shall be installed in a manner that permits ready access to face on coil for cleaning.
- F. Dampers: Intake dampers shall be 16-gauge galvanized steel, outlet dampers shall be 18-gauge galvanized steel. The surfaces shall be cleaned and primed, then finished with air-dried enamel paint.
- G. Coil Elements: Finned heating elements shall be fabricated of seamless 5/8” O.D. copper tubes with 0.049” wall thickness and rectangular embossed aluminum fins of 0.010” thickness. Fins shall not be spaced closer than 12 fins per inch. Each tube shall be individually secured to the supply and return headers by a brazed joint with provision for individual tube expansion and contraction.
- H. Control Valve: Size control valve for minimum of 125% of coil design capacity at maximum of 1/2 of the available pressure drop.

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- I. Condensate Piping at Coils: Design shall follow manufacturer's piping recommendations with specific design attention paid to the available steam pressure at the coil inlet and pressure available at the steam trap inlet. Flexible condensate connection shall be twice the manufacturer's recommended length.
- J. Pre-Approved Manufacturers:
 - 1. LJ Wing
 - 2. Rosemex
 - 3. Proposed alternatives require approval from WSU Engineering Services.

2.15 STEAM UNIT HEATERS

- A. General: Provide horizontal unit heater. All ratings shall be based on tests made in accordance with standard adopted by the Air Moving and Conditioning Association (AMCA).
- B. Casing and Cabinet: Cabinet shall be fabricated or steel with electrostatically applied baked paint.
- C. Coil: Coils shall have aluminum fins mechanically expanded for a permanent bond to copper tubes. Minimum coil thickness shall be 0.049". Coils shall be of parallel tube design with copper headers. Coil connections shall be steel with standard pipe threads. Copper tube coils shall be rated at a minimum of 250 psig and 366° F.
- D. Fan: Fan shall be propeller type with steel blades and steel hubs.
- E. Motor: Motor shall be totally enclosed, specifically designed for unit heater service with automatic reset inherent overload protection. Motor and fan assembly shall be resiliently mounted.
- F. Louvers: Unit shall have double deflection discharge louvers.
- G. Pre-Approved Manufacturers: McQuay, Modine, Armstrong, and Trane.

2.16 STEAM-POWERED CONDENSATE PUMP

- A. General: Use of steam-powered pumps for condensate is a means of last resort, and requires specific approval by WSU Engineering Services.

2.17 WARM-UP PIPING:

- A. When warm up bypass piping and valves are installed, piping shall be no larger than 1" nominal size.

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2.18 STEAM AND CONDENSATE INSTRUMENTATION

A. Thermometers:

1. Provide thermometers where equipment causes fluid temperature changes (except for finned radiation and convectors).
2. Thermometers shall be installed in wells so that they can also be removed from the system and replaced without shutting the system down.

B. Pressure Gauges:

1. Provide pressure gauges for all heat exchangers and both sides of steam pressure reducing stations.
2. For all pumps (suction and discharge) install a single water-filled pressure gauge across both supply and return lines to compare pressure.
3. Gauge selection shall typically center on design operating pressure and cover safe system operating range without damage.
4. Provide a throttle valve for each gauge to allow snubbing and isolation function.

C. All gauges shall be installed where easily accessible and legible for Maintenance and Utilities personnel.

2.19 STEAM AND CONDENSATE METERING AND MONITORING

A. Steam BTU Meter: Sierra InnovaMass 240S/241S or approved equivalent. Obtain approval through WSU Engineering Services.

B. Pressure shall be measured at the building entrance and all pressure reducing stations, using a tee, isolation valve, pipe syphon, tee, and pressure transmitter connected to the WSU Energy Management System (EMS) and local pressure gauge.

C. Condensate flow shall be measured with the meter fully trapped, installed with a 3-valve bypass for maintenance.

1. Pre-Approved Meter Manufacturers/Models:

- i. ONICON F-3100 series electromagnetic in-line flowmeter

D. Condensate conductivity meter shall be installed per manufacturer's recommendations. Meter shall alarm to the BAS when condensate conductivity exceeds 50 μ S/cm (micro-Siemens per centimeter).

1. Pre-Approved Manufacturer: Rosemount Analytical Model 0402-13

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PART 3 - EXECUTION

3.01 PIPING

- A. Requirements: 2-1/2", 3-1/2", 5" pipe sizes shall not be used. These sizes are not readily available.
- B. Slope mains down in direction of flow not less than 1.00" in 40.00 feet, and small branches not less than 1.00" in 10.00 feet. Connect multiple branches to top of main. Install eccentric reducers "with flat on bottom" approximately 3 feet beyond last branch where main changes size. Install drip leg assemblies at all low points of steam piping system and on uphill side of all isolation valves. Provide means to drain all low points, including adjacent to closed valves for start-up purposes.
- C. Minimum pipe size: Unless specifically approved by WSU Engineering Services, minimum pipe size shall be 0.75". Where piping is required to be reduced to accommodate a particular item (e.g. a control valve), install eccentric reducers on both sides as close as practical. Where straight runs of piping are required to accommodate uniform flow (entering and leaving), installation shall be as recommended by manufacturer of item. In all cases, pipe size shall be 0.75" minimum size (entering and leaving), as soon as recommended conditions are met. All other valves, fittings, and accessories associated with system installations, shall be 0.75" minimum, unless otherwise approved.
- D. Drip Leg Requirements: Drip legs, as a minimum, shall be same size as steam line they serve (maximum 2.00" pipe size, unless approved otherwise). Provide trap assembly, as detailed, utilizing extra heavy nipples.

3.02 SAFETY VALVES:

- A. Reference WSU Standard Detail drawing 23 22 00 M1.
- B. Pipe vent from safety valve through drip pan elbow up through roof to a terminus 8 feet above finished roof surface. Special care shall be taken in the design so that no piping reactions are withstood by the safety valve. Vent piping exposed to weather shall be primed and painted with high heat exterior grade paint. Where safety valve vent piping is required to run horizontally, it shall be sloped down toward drip pan elbow such that there shall be no low points for water to collect.

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3.03 EXPANSION PROVISIONS

- A. Expansion Joints: Install with alignment and roller guides as recommended by manufacturer.
- B. Anchors: Provide heavy steel collars with lugs and bolts for clamping pipe and attaching anchor braces or, at Contractor's option (or as indicated), provide weld-on type anchors. Anchors shall be installed so that attachment to structure does not injure the structure either in the installation, by weight, or due to thermal expansion forces of piping system that is being anchored.

3.04 PRESSURE GAUGES: Install with ball type isolation valve and pigtail siphon. Install as shown on drawings or as required to monitor system operation upstream and downstream of isolation and control valves.

3.05 DRAIN VALVES FOR WARM UP: Drain valves shall be provided adjacent to all sides of valves where condensate may collect, drain valves shall be located outside of insulation on schedule 80 nipples.

3.06 PRESSURE TESTING: Hydrostatically test piping, accessories, and equipment at 150% of operating pressure, 125 psig minimum, with no perceptible drop in pressure, for a period not less than 2 hours. Inform Consultant, Commissioning Agent, and WSU Construction Manager at least two days in advance, so they may witness testing. Testing with compressed air is not allowed. Provide written test description and results to WSU Construction Manager, listing personnel involved.

3.07 CLEANING: Thoroughly clean system to remove dirt, steel shavings and chips, and oil. Blow down strainers. Drain water and blow steam through system back to receiver until condensate is free of oil; run condensate to sanitary sewer drain and vent steam from receiver to outside. Open and clean entire interior of receiver before operating condensate pumps or pumping condensate back to existing WSU condensate lines. Upon completion of system cleaning, contractor shall furnish the WSU Construction Manager with written documentation of cleaning prior to pumping condensate back to campus system.

3.08 LARGE FLANGE ASSEMBLY TIGHTENING: For tightening studs on 10" and larger flanges, in campus distribution pressure piping, a written bolt tightening plan shall be submitted and reviewed by the WSU Construction Manager one month prior to scheduled work. The plan shall describe the means and methods to be utilized to determine and achieve bolt or stud tension and the means and methods used for checking bolt or stud tensions. Slug wrenches and hammers shall not be accepted.

END OF SECTION