SECTION 23 50 11

BOILER PLANT MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Condensate receiver, feedwater deaerator, pumps and other equipment that supports the operation of the boilers.

1.02 DEFINITIONS

A. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.

B. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.03 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
1. MP Steam Piping: 125 psig.
2. LP Steam Piping: 25 psig.
3. Condensate Piping: 100 psig at 250°F.
4. Makeup-Water Piping: 120 psig at 100°F.
5. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.04 ACTION SUBMITTALS

A. Condensate Receiver/Feedwater Deaerator with Storage Tank and Accessories:
1. Drawings showing arrangement and overall dimensions of assembled unit including storage tank. Show locations unit mounted piping and devices Show locations and sizes of pipe connections and access openings. Show design of all shell, head and nozzle welds.
2. Weight of entire assembly empty and flooded.
3. Catalog data, drawings and specification sheets showing design and construction of unit mounted devices including feedwater deaerator, storage tanks, safety valves, overflow control valve, water level and overflow control systems, orifices, vacuum breaker, alarm switches and all accessories.
4. Catalog data and specification sheets on design and construction of pumps, motor controllers, and couplings.
5. Performance data:
   a. Pressure and temperature limitations of feedwater deaerator, pumps, safety valve, overflow control valve, vacuum breaker, alarm switches and all accessories.
   b. Performance curves showing discharge head, required flow plus recirculation, net positive suction head required, efficiency, driver power, impeller diameter to be furnished.
   c. Size and capacity of vent and recirculation orifices.
6. Oxygen sample and chemical feed probe design. Deaerator inlet pressure requirements - steam and water.
7. Seismic design of support framework for packaged system, including reaction forces at each anchor point.

1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For all maintainable components.

1.07 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify processes and operators according to the following:
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 COMBINATION CONDENSATE RECIEVER / FEEDWATER DEAERATOR

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cleaver Brooks
2. Industrial Steam
3. Lockwood Products

B. Unit Assembly
1. General: Combined condensate receiver / deaerator unit consisting of tanks, structural base pumps, factory mounted piping, accessories, and controls.
2. Tank Support Base: Tanks shall be supported by steel saddles and structural base frame, supplied by the tank manufacturer, welded to tank and anchored to the concrete floor. Design saddles to support tank (full of water), accessories, and portions of connecting piping to first hanger. Coordinate location with structural drawings.
3. Overall dimensions: Comply with overall dimensions and arrangement of the tank and accessories shown on contract drawings.
   a. Overall Tank Length: 206 inches
   b. Overall Tank Width: 60 inches
   c. Base Length: 168 inches
   d. Base Width: 66 inches

C. Condensate Receiver Section
1. General: Horizontal cylindrical welded steel tank, including accessory equipment, suitable for rigging into the available space. Accessories include, thermometer, water level gauge, and other devices as specified.
2. Performance and Operating Characteristics:
   a. Service: Receiving and storing steam condensate and make-up water.
   b. Condensate Input Temperature: Contents of tank may vary in temperature from 40 to 212 degrees F.
3. Condensate Storage Capacity to the Overflow Line: 900 gallons. Overflow line (elevation) shall be set by unit manufacturer.
4. Construction:
   a. Construct tank and appurtenances in accordance with ASME BPVC Section VIII. Tank shall have cylindrical shell and dished heads.

b. Material of construction shall be stainless steel ASTM A240/A240M.
c. Design tank for 25 psig working pressure with a minimum material thickness of 1/4 inch. Thickness of head material at any point shall not vary more than 10 percent from the nominal thickness.
d. Tank joints shall be double-vee full penetration weld, double-welded butt joints or single-welded butt joints with backing strips.
e. Provide 12 inches by 16 inches elliptical manway. Provide access openings in condensate receiver section to allow inspection and replacement of internal components.
f. Provide overflow pipe inside tank with siphon breaker.
g. Provide nozzles for piping connections located as shown.
   1) Threaded for sizes 2 inches and under.
   2) Flanged, 150 psi ASME, for sizes above 2 inches.
   3) Tank opening for pump suction pipes shall include vortex spoilers.
h. Passivate stainless steel tank in accordance with ASTM 380 (Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems).
i. Furnish completed ASME Form U-1 or U-1A MANUFACTURERS' DATA REPORT FOR PRESSURE VESSELS. Hydrostatically test tank at 1-1/2 times the design pressure.
j. Nameplate: Affix to bracket that projects beyond the field-applied tank insulation. Nameplate shall include ASME stamp and data to show compliance with design, construction and inspection requirements of the Code, and tank manufacturer information.

D. Deaerator Section
1. General: Pressurized 6 psi unit designed to heat and deaerate boiler feedwater by direct contact with low pressure steam. Spray type deaerating section. Horizontal feedwater storage tank. Provide accessories including vacuum breaker, safety valve, water inlet and overflow controls and control valves, water level indicators and alarms and other devices as specified and shown.
2. Performance and Operating Characteristics:
   a. Oxygen Content of Feedwater Output: 7 parts per billion maximum over turndown range with minimum and normal feedwater input temperatures as listed.
   b. Turndown: 10/1.
   c. Required Maximum Feedwater Flow Output: 20,000 lb/hr.
   d. No carbon dioxide in feedwater output; maximum steam vent loss 1/2 percent of input steam at maximum load.
   e. Feedwater Input Temperature: Minimum temperature is 60 °F and normal range is 140 – 180 °F.
   f. Water Pressure Loss Through Spray Valves: 7 psi maximum.
   g. Steam Pressure Loss in Unit: 1 psi maximum.
3. Feedwater Storage Capacity to the Overflow Line: 800 gallons. Overflow line (elevation) shall be set by feedwater deaerator manufacturer so that there is no water hammer when water is at this level.
4. Construction:
   a. Storage Tank and Deaerator Pressure Vessels:
      1) Conform to ASME Boiler and Pressure Vessel Code, Section VIII. Design for saturated steam at 50 psi.
      2) Carbon steel, ASTM A285 Grade C or ASTM A516 Grade 70. Weld metal strength shall approximate the strength of the base metal. All welds shall be double-vee type. No single vee welds allowed. Weld undercut not allowed. All welding must be constructed to allow future internal weld inspections, utilizing non-destructive-testing methods.
      3) Post Weld Heat Treatment (PWHT) to stress-relieve pressure vessel to 1150 °F not to exceed ASME hold-time or temperature.
      4) Provide 100 percent radiography of all longitudinal and circumferential welded seams. Test nozzle-to-shell welds by wet magnetic-particle method. Hydrostatically test final assembly at 1.3 times design pressure.
      5) Furnish completed applicable ASME Forms U-1, U-1A or U-2.

b. Spray Valve Assemblies: Spring-loaded, guided stem, stainless steel and Monel, removable.
c. All other parts in deaerator section exposed to un-deaerated liquids or gases must be constructed of stainless steel, cupro-nickel or equivalent.
d. Provide two 12 inches x 16 inches elliptical manways in storage tank, located below the normal water level, but near the tank centerline, and away from the deaeration section or internal piping. Manway locations must allow unrestricted access to tank interior with no interference from internal equipment and piping and with easy access from outside the tank. Second manway is to facilitate the annual internal inspections.
e. Provide access openings in deaeration section to allow inspection and replacement of spray valve assemblies.
f. Support: Steel saddles or legs welded to storage tank. Coordinate location with structural design of building.
g. Nameplates: Attach to bracket projecting beyond field-applied insulation. Provide all ASME pressure vessel nameplate information as required by the Code along with information identifying the designer and manufacturer of the storage tank and the deaeration section.
h. Pipe Connections: As shown on drawings.
    1) Threaded for sizes 2 inches and under.
    2) Flanged, 150 psi ASME, for sizes above 2 inches.
    3) Overflow Pipe:
        a) Overflow pipe inside tank terminating 6 inches below low level alarm set point. Operation of overflow control system must not allow water level to fall to the level of the overflow pipe inlet.
        b) Overflow pipe sizing, based on required maximum feedwater flow output of feedwater deaerator.
i. Sentinel Steam Safety Valve: Mount on feedwater deaerator pressure vessel. Set pressure 15 psi. Minimum capacity 900 lb/hr. Refer to “Accessories, Steam Safety Valves.”
j. Oxygen and Non-Condensable Gas Venting: Straight vertical pipe extending through roof from deaeration section. Provide gate valve in vent pipe and orifice. Orifice hole size selected by feedwater deaerator manufacturer for normal venting.
k. Vacuum Breaker: Sized by deaerator manufacturer to protect unit. Bronze swing check valve, rated for 150 psi, PTFE seat, stainless steel hinge pin.
l. Water Sample and Chemical Feed Probes: Type 304 or 316 stainless steel, multi-ported, minimum length 1 foot, accessible for removal from exterior of tank.

5. Overflow Trap:
a. Type: Float type steam trap specifically designed to relieve excess condensate from deaerator storage tank.
b. Chamber
    1) 4-inch and below: Cast iron.
    2) 6-inch and above: Steel.
c. Internal Valve: brass/bronze
d. Float Ball: 316 stainless steel
e. Connections:
    1) Threaded for sizes 2 inches and under.
    2) Flanged, 150 psi ASME, for sizes above 2 inches.
f. End Cover: Large end cover provides easy access to internal valve assembly.
g. Performance:
    1) Maximum Operating Pressure: 50 psig.
    2) Maximum Pressure Drop: 15 psi.
    3) Maximum Operating Temperature: 250 degree F
    4) Nominal Leakage Rate: 0.1% of rated capacity.

E. Condensate Transfer and Feedwater Pumps
1. Type: Two or more stages, centrifugal diffuser type, direct-coupled, vertical shaft, in-line, base-mounted, motor-driven with integral VFD controller and sensor, arranged as shown. Similar to Grundfos CRE series.

2. Service: Design pumps and accessories for continuous service, 248 degrees F water, with flow rates ranging from maximum scheduled on the drawings (plus manufacturer's recommended recirculation) to 10 percent of maximum (plus manufacturer's recommended recirculation). Pumps shall be suitable for parallel operation without surging or hunting.
3. Performance: Refer to schedules on drawings. Pump head-flow performance curve shall slope continuously upward to shut-off.
4. Construction:
    a. Mechanical seals shall have sealing face materials of carbon and tungsten or silicon carbide.
    b. Design bearings for two-year minimum life with continuous operation at maximum pump operating load. Bearings and shaft seals shall be water-cooled if recommended by pump manufacturer for the service.
    c. Materials of Construction:
        1) Chambers: Stainless steel
        2) Impellers: Stainless steel
        3) Diffusers: Stainless steel
        4) Shaft: Stainless steel
        5) Suction-Discharge Chamber: Cast iron or stainless steel
    d. Recirculation Orifice: Provide stainless steel recirculation orifice selected by pump manufacturer to protect pump from overheating at shut-off and designed for low noise under the service conditions. Orifices must not exceed sound level of 85 dba at a distance of 5 feet.
    e. Shaft Couplings: Pump manufacturer’s standard. Provide coupling guard.
    f. Integrated Variable Frequency Drive Motor:
        1) Each motor shall be of the integrated Variable Frequency Drive design consisting of a motor and a Variable Frequency Drive (VFD) with a built-in pump system controller. The complete VFD/motor assembly shall be built and tested as one unit by the same manufacturer.
        2) The VFD/motor shall have an IP55 (TEFC) enclosure rating as a complete assembly. The motor shall have a standard NEMA C-Face, Class F insulation with a Class B temperature rise.
        3) The VFD shall be of the PWM (Pulse Width Modulation) design using up to date IGBT (Insulated Gate Bipolar Transistor) technology.
        4) The VFD shall convert incoming fixed frequency three phase AC power into a variable frequency and voltage for controlling the speed of the motor. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump control and to eliminate the need for motor de-rating.
        5) The VFD shall have, as a standard component, an RFI filter (Radio Frequency Interference) to minimize electrical noise disturbances between the power electronics and the power supply. The VFD/motor shall meet all requirements of the EMC directive concerning residential and light industry equipment (EN 61800-3).
        6) The VFD shall have internal solid-state overload protection designed to trip within the range of 125-150% of rated current.
        7) The VFD/motor shall include protection against input transients, loss of AC line phase, over-voltage, under-voltage, VFD over-temperature, and motor over-temperature. The VFD/Motor shall include an Automatic De-Rate Function that shall reduce speed during periods of overload allowing for reduced capacity pump operation without complete shut-down of the system.
        8) The VFD/motor shall have, as a minimum, the following input/output capabilities:
            a) Speed Reference Signal 0-10 VDC, 4-20 mA
            b) Digital remote on/off
            c) Fault Signal Relay (NC or NO)
            d) Network communications with BACnet MS/TP or BAS compatible Ethernet communications protocol.

9) Motor drive end bearings shall be adequately sized so that the minimum L10 bearing life is 17,500 hours at the minimum allowable continuous flow rate for the pump at full rated speed.

F. Cleaning and Painting: Remove all foreign material to bare metal. Coat exterior of pressure vessel with rust-preventative primer and manufacturers standard finish coat. Do not coat interior of pressure vessel.

G. Pipe and Fitting: Conform to 23 22 13 - Steam and Condensate Heating Piping

H. Insulation: Field-applied. Conform to 23 07 16 - HVAC Equipment Insulation and 23 07 19 - HVAC Piping Insulation.

I. Accessories
1. Steam Safety Valves
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Armstrong International, Inc.
      2) Kunkle Valve.
      3) Spirax Sarco, Inc.
   b. Bronze or Brass Steam Safety Valves: ASME labeled.
      1) Disc Material: Forged copper alloy.
      2) End Connections: Threaded inlet and outlet.
      3) Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
      4) Pressure Class: 250.
      5) Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
      6) Valves in "Cast-Iron Safety Valves" Paragraph below are available in NPS 1-1/2 through NPS 6 (DN 40 through DN 150).
   c. Cast-Iron Steam Safety Valves: ASME labeled.
      1) Disc Material: Forged copper alloy with bronze nozzle.
      2) End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
      3) Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
      4) Pressure Class: 250.
      5) Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
      6) Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
   d. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.
2. Pressure Reducing Valves
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Armstrong International, Inc.
      2) Spence Engineering Company, Inc.
      3) Spirax Sarco, Inc.
   b. Pilot-actuated Pressure-reducing Valve
      1) Basis of Design: Spence ED/E2D Series.
      2) Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.
      3) Description: Pilot-actuated, metal diaphragm type, normally closed, with adjustable pressure range and positive shutoff. ASME labeled.
      4) Body: Cast iron.
      5) End Connections:
         a) NPS 2 and smaller: Class 250 MPT threaded connections.
         b) NPS 2-1/2 and larger: Class 125 flanged connections.
      6) Trim: Hardened stainless steel.

7) Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.
8) Gaskets: Non-asbestos materials.
9) Performance:
   a) 20:1 turndown, control accuracy:
   b) Outlet pressure 25 psig and below: +/- ½ psi.
   c) Capacities and Characteristics: As scheduled on drawings:
10) Accessories:
11) Acoustic Blanket Insulation:
   a) Basis of Design: Spence, Insulcap Series.
   b) Type: Removeable insulation jacket, integral fasteners
   c) Core Filler: ASTM C 1086
   d) Jacketing: PTFE Coated Fiberglass composite
   e) Sound Reflector: ASTM E90.
   f) Sound Reduction: 6dBa.

J. Control and Instrumentation
1. Control Panels: Provide independent unit control panels condensate receiver and feedwater deaerator.
   a. Factory wired between pumps and control panel, for single external electrical connection.
   b. Provide fused, control-power transformer if voltage exceeds 230 V ac.
   c. NEMA 250, Type 12 enclosure with hinged door and grounding lug, mounted on pump.
   d. Motor controller for each pump with HOA switch.
   e. Numbered terminal strip.
   f. Disconnect switch.
   g. Low voltage separation with numbered terminal strip.
2. Thermometers and Pressure Gages: Provide thermometers on deaeration section and on storage tank. Provide compound gage with shut-off valve and siphon on deaerator. Conform to 23 05 19 - Meters and Gages for HVAC Piping.
3. Water Level Indicators:
   a. Gage Glasses: Red line type, overlapping glasses if multiple glasses are utilized. Provide automatic offset-type gage valves that stop the flow if a glass is broken. Drain cock on lower gage valve. Gage glass protecting rods.
   b. Minimum rating: 250 degrees F, 50 psi.
4. Low Level Alarm Switch: Provide alarm switch for condensate receiver tank and feedwater deaerator tank.
   a. Float type unit with hermetically sealed mercury switch.
   b. Minimum rating 250 degrees F, 50 psi.
   c. Locate external to tank on a vertical header with valved tank connections and valved drain. Switch elevation shall be at the tank centerline.
   d. BAS Interface: Digital output signal digital input to Building Automation System. Provide factory wiring between switch and control panel terminal strip.
5. Tank Water Level Transmitter: Provide piping connections for water level transmitter for condensate receiver tank and feedwater deaerator tank.
   a. Level transmitter provided by BAS. See 23 09 23 - Building Automation Systems for HVAC.
   b. Locate piping external to tank with valved tank connections and valved drain. Transmitter piping connections located near bottom elevation of tank.
6. Make-up water, Condensate Transfer Pump and Feedwater Pump Control: Provided by Building Automation System See 23 09 23 - Building Automation Systems for HVAC.
   a. Make-up Water Control Valve: Provided by Building Automation System See 23 09 23 - Building Automation Systems for HVAC.
   b. Pump Control Interface:
      1) Digital Start/stop: Digital output from BAS.
      2) Analog Speed Control: 4-20mA or 0-10 analog output from BAS.
      3) Motor Fault Alarm: Digital input to BAS.
      4) Digital output signal digital input to Building Automation System.
      5) Provide factory wiring between switch and control panel terminal strip.

2.02 DEAERATOR WATER SAMPLE COOLER

A. Type: Factory built shell and coiled tube heat exchanger with sample in tube, cooling water in shell, designed for wall mounting, similar to Forbes Marshall DHx series.

B. Construction:
1. Shell and Head: Stainless steel shell, bolted or threaded into head. Head shall have wall mounting brackets and piping connections for sample in and out and cooling water out. Minimum design pressure for shell and head, 150 psi. Shell removable without disturbing piping connections.
2. Sample Coil: Shall be 1/4-inch outside diameter stainless steel tubing, 1.2 square feet minimum heat exchange surface. Minimum design for 150 psi, 370 °F. Design coil to relieve stresses due to thermal expansion.
3. Arrangement: Shall be as shown on the drawings.

2.03 OVERFLOW DRAIN LINE COOLER

A. Type: Self-contained, reverse-acting thermal bulb-operated water control valve with factory mixing pipe assembly.

B. Performance: Control valve shall operate automatically to control blowoff tank water outlet temperature to 140°F maximum by regulating the flow of cold water which mixes with the overflow water and reduces the temperature overflow water. Provide valve designed for modulating and tight shut off service. Temperature control range shall be adjustable, 100 to 170°F minimum.

C. Service: Provide valve designed to control the flow of city water with temperature 40 to 80°F, and pressure up to 100 psi. Thermal bulb will be inserted in overflow outlet pipe and will be subjected to water temperatures up to 230°F.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install piping connections and accessories to provide access for periodic maintenance and removal.

B. Equipment Mounting:
1. Coordinate location with structural requirements of the building.
2. Install unit on concrete equipment base as specified and as detailed on drawings.
3. Bolt to building structure as recommended by manufacturer or as shown. Comply with seismic requirements.
4. Arrange anchorage to allow thermal expansion of unit.

C. Condensate Receiver / Feedwater Deaerator with Storage Tank and Accessories.
1. Location shall permit access to and removal of all internal and external features without removing other items of equipment or piping.
2. Clean interior of equipment before placing in service.

3. Deaerator vent pipes must extend vertically through roof. Horizontal runs not permitted.

D. Boiler Feed and Condensate Transfer Pumps:
1. Check pump alignment when both pump and driver are at normal operating temperature.

3.03 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Install full-size vent piping to outdoors.

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Clean strainers.
3. Perform the following preventive maintenance operations and checks before starting:
a. Check motors for proper rotation.
b. Test pump controls and demonstrate compliance with requirements.
c. Replace damaged or malfunctioning pump controls and equipment.
d. Verify that pump controls are correct for required application.
4. Start pumps according to manufacturer's written startup instructions.
5. Check deaerator steam vent and adjust orifice size as required.

B. Provide start-up and test report.

3.05 DEMONSTRATION

A. Provide a factory-authorized service representative for 4 hours to train Owner's maintenance personnel to adjust, operate, and maintain tanks, components, pumps and accessories.

END OF SECTION