

SECTION 23 52 00 - HEAT BOILERS

PART 1 - GENERAL

1.1 SYSTEM DESIGN REQUIREMENTS

- A. Boilers included in this Section are intended for structures constructed outside the practical limits of the campus central steam distribution system and have access to natural gas.
- B. Design these systems as simple heating water hydronic systems to meet building heating and ventilating requirements.

1.2 QUALITY ASSURANCE

- A. Electrical components shall comply with NFPA 70-96 and be UL listed.
- B. Boilers shall comply with ASME Boiler and Pressure Vessel Code, Section IV-95.
- C. Boilers tested and rated according to the Hydronics Institute's "Testing and Rating Standard for Heating Boilers" with I=B=R emblem on a nameplate.

1.3 WARRANTY

- A. Boilers warranties shall be provided in accordance with Section 23 00 00, including the manufacturer's standard warranty of not less than 10 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Inclined Water Tube Boiler:
 - a. Anax
 - b. Rite
 - 2. Cast-Iron Boilers:
 - a. Burnham
 - b. Peerless
 - c. Weil-McLain
 - 3. High-Efficiency Compact Boiler:
 - a. Lochnnar
 - b. Patterson-Kelly
 - 4. Scotch Marine Boiler:
 - a. Burnham
 - b. Kewaner
 - c. Superior
 - 5. Condensing Boiler:
 - a. AERCO
 - b. Buderus
 - c. Viessman

2.2 MATERIALS, GENERAL

- A. Inclined Water Tube Boiler:

1. Type: Factory assembled, packaged, and tested forced draft inclined water tube boiler. Non-condensing design to operate at 80 percent efficiency.
 2. Construction:
 - a. Free-floating tube bundle assembly consisting of steel tubes, 2-inch diameter supported by steel frame with expansion joint at each corner.
 - b. Tubes sloped upward from rear to front to eliminate air bubbles.
 - c. Full-face reinforced neoprene head gasket.
 - d. 18 gauge galvanized or painted steel jacket.
 3. Pressure Rating: 125 psi working pressure, ASME stamped.
 4. Burner:
 - a. UL listed forced draft burner for operation with pressurized vent stack without barometric damper or induced draft fan.
 - b. Fuel: Natural gas.
 - c. Electronic supervised spark ignition.
 - d. Burner Safety Controls:
 - 1) Scanner or ultraviolet flame detector.
 - 2) Airflow switch.
 - e. Positive pressure at flue collar.
 5. Boiler Controls and Trim:
 - a. Operating control.
 - b. High limit control
 - c. Low water cutoff.
 - d. ASME pressure relief valve set at proper psi for operating conditions.
 - e. Combination temperature/pressure gauge.
 - f. Built-in air elimination.
 - g. Control panel with indicating lights.
 6. Gas Train:
 - a. UL and FM listed gas train, factory assembled.
 - b. Main gas pressure regulator.
 - c. Main gas valve.
 - d. Main and pilot gas shut-off valves.
 - e. Auxiliary gas valve.
 - f. Dual safety gas valves.
 - g. Low and high gas pressure gas switches above 2500 MBH.
- B. Cast-Iron Boilers:
1. Factory assembled and packaged, with cast-iron sections set on an insulated steel base, sealed with high-temperature sealant, held together with tie rods, and with insulated extended jacket and vent connection.
 2. Gas Burner:
 - a. Atmospheric or forced draft type.
 - b. Modulation firing.
 - c. Prepurge.
 - d. Low fire start.
 - e. Modulating position air control.
 - f. Pressure regulator.
 - g. Gas valves, manual shutoff, intermittent spark or glow coil ignition, flame-sensing device, and automatic 100 percent shutoff.
 3. Pressure Rating: 30 psig.
 4. Fuel: Natural gas.
 5. Trim and Accessories:
 - a. Safety Relief Valve: ASME rated, factory set at boiler pressure rating.
 - b. Gauge: Combination water pressure and temperature. Pressure range to be 0 - 50 psig and temperature range to be 40 to 240 degrees F.
 - c. Low Water Cutoff: Prevent burner operation on low water level.

- d. High Limits: Two temperature controls to limit boiler water temperature. One with automatic reset, the other with manual reset.
 - e. Operating Controls: Prewired, factory assembled electric control including pilot safety and thermocouple transformer, 24-volt gas valve, manual main and pilot valves.
 - f. High pressure gas switches
 - g. Electronic pilot ignition.
 - h. Safety pilot switches: 100% shut-off.
 - i. Gas pressure regulator.
 - j. Safety Controls: Energize ignition, limit time for establishing flame, prevent opening of gas valve until pilot flame is proven, and stop gas flow on ignition failure.
- C. High-Efficiency Compact Boiler:
- 1. Radial fired, vertical hot water boiler with gas fired power burner. Non-condensing design to operate at AGA certified efficiency of 85 percent.
 - 2. Construction:
 - a. Combustion Chamber: 16 gauge corrosion resistant aluminized steel or cast iron.
 - b. Heating Surface: Finned copper tubes.
 - c. Outer Cabinet: Minimum 16 gauge steel, air tight, with an insulating air space between the combustion chamber and outer cabinet.
 - d. Cabinet Finish: Baked epoxy coating finished inside and out.
 - e. Factory assembled and fire tested.
 - 3. Pressure Rating: 160 psi working pressure.
 - 4. Burner:
 - a. Gas power burner, radial fired.
 - b. Fuel-air mixture controlled by multiple brass orifices and venturi core equipped to measure air flow rate to the burner.
 - 5. Burner Controls:
 - a. Electric spark ignition with interrupted type pilot.
 - b. Flame rod pilot and main flame control.
 - c. AGA approved electronic flame safeguard programmer with pilot failure and lock-out with manual reset.
 - 6. Gas Manifold:
 - a. AGA lubricated plug cock.
 - b. Pressure regulator.
 - c. Low gas pressure switch.
 - d. Two solenoid-operated diaphragm valves.
 - e. Pilot gas manifold with cock, pressure regulator, gas filter and solenoid valve.
 - f. Both gas manifolds, main and pilot, to be accessible without removing cabinet.
 - 7. Smoke Venting:
 - a. Boiler AGA certified as "Category 1" for venting, requiring either a double wall or an insulated type "B" vent pipe.
 - 8. Trim and Accessories:
 - a. Safety Relief Valve: ASME rated, factory set at boiler pressure rating.
 - b. Gauge: Combination water pressure and temperature. Pressure range to be 0 to 50 psig and temperature range to be 40 to 240 degrees F.
 - c. Low Water Cutoff: Prevent burner operation on low water level.
 - d. High Limits: Two temperature controls to limit boiler water temperature. One with automatic reset, the other with manual reset.
 - 9. Fuel: Natural gas.
- D. Scotch Marine:
- 1. Multi-pass, horizontal fire-tube boiler factory-mounted on heavy steel base frame. Boiler to provide 80 percent efficiency.
 - 2. Construction:
 - a. Insulated metal jacket.
 - b. Insulated front flue doors.

- c. Refractory filled rear access with observation port.
 - d. Bottom blowdown connection.
 - e. Heating Surface: 5 square feet of heating surface per rated BHP.
 - f. Cabinet Finish: Baked epoxy coating finished inside and out.
 - g. Factory assembled and fire tested.
 - 3. Burner:
 - a. UL/FM approved forced-draft burner, rated to produce full output at 5200-foot elevation.
 - b. Radial port flame retention type burner head and diffusers.
 - 4. Burner Controls:
 - a. Direct spark ignition electrode.
 - b. Ultraviolet flame detector.
 - c. Airflow safety switch.
 - d. Modulating control motor with linkage to control modulating gas valve and air inlet damper for proper fuel air mixtures.
 - 5. Gas Train:
 - a. AGA lubricated plug cock.
 - b. Gas regulator.
 - c. Motorized gas valve with proof of closure switch.
 - d. Safety gas valve.
 - e. Pressure regulator.
 - f. High and low gas pressure switch.
 - g. Pilot solenoid valve.
 - h. Pilot gas manifold with cock, and pressure regulator.
 - i. Both gas manifolds, main and pilot, to be accessible without removing cabinet.
 - 6. Smoke Venting:
 - a. Boiler AGA certified as "Category 1" for venting, requiring either a double wall or an insulated type "B" vent pipe.
 - b. Type B Gas Vent: Double wall gas vent complying with NFPA 211-96, inner pipe of sheet aluminum, outer pipe of galvanized steel sheet. Provide tees, elbows, increasers, draft hood connectors, metal cap with bird barrier, adjustable roof flashing, storm collar, support assembly, thimbles, fire-stop spacers, and fasteners.
 - 7. Trim and Accessories:
 - a. Safety Relief Valve: ASME rated, factory set at boiler pressure rating.
 - b. Gauge: Combination water pressure and temperature. Pressure range to be 0 to 50-psig and temperature range to be 40 to 240 degrees F.
 - c. Low Water Cutoff: Prevent burner operation on low water level.
 - d. High Limits: Two temperature controls to limit boiler water temperature. One with automatic reset, the other with manual reset.
 - 8. Fuel: Natural gas.
- E. Condensing Boiler:
- 1. Boilers shall be natural gas fired, condensing fire-tube design with a modulating forced draft power burner and positive pressure vent discharge.
 - a. Modulating Air/Fuel Valve and Burner
 - b. The boiler burner shall be capable of a 10 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves.
 - c. The burner shall produce <30 ppm of NOx corrected to 3% excess oxygen.
 - d. All burner material exposed to the combustion zone shall be of stainless steel construction. Dual heat exchangers utilizing stainless steel or aluminum alloy in only one of the heat exchangers are not permitted.
 - e. A variable speed cast aluminum pre-mix blower shall be utilized to ensure the optimum mixing of air & fuel between the air/fuel valve and the burner.
 - 2. Pressure Vessel/Heat Exchanger
 - a. Boiler shall be capable of handling return water temperatures down to 40 F without any failure or corrosion for the life of the boiler.

- b. Heat exchangers shall be constructed of 316L stainless steel fire tubes and tube sheets with a one-pass combustion gas flow design. The fire tubes shall be 5/8" OD with no less than 0.065" wall thickness. Upper and lower stainless steel tube sheets shall be no less than 0.313" thick. Access to the tube sheets and heat exchangers are available by burner and exhaust manifold removal.
 - 3. Exhaust Manifold
 - a. Provide materials and routing per manufacturer and code requirements. Provide drain in flue vent where recommended by manufacturer.
 - 4. Controls:
 - a. The controller shall have the ability to vary the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant.
 - b. The system shall control the boiler outlet header temperature within +2°F. The controller shall be a PID type controller and uses Ramp Up/Ramp Down control algorithm for accurate temperature control with excellent variable load response. The system controller shall provide contact closure for auxiliary equipment such as system pumps and combustion air inlet dampers based upon outdoor air temperature.
 - c. Acid neutralization: Provide acid neutralizers as needed.
- F. Controls:
 - 1. UL listed, electronic boiler control with adjustable reset ratios, adjustable offset to raise or lower reset curve, adjustable outdoor cutoff, night set back, minimum boiler water temperature adjustment, setback clock and adjustable morning warm up, manual override, LED indication of Setback, Bypass and On.
 - 2. Provide standalone controls by manufacturer. Controllers shall have software interface with BAS to reset temperatures and schedules. Provide communication gateway if required

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install boilers level and plumb, according to manufacturer's recommendations.
- B. Install boilers on 4-inch thick concrete base, 4 inches larger on each side than base of unit.
- C. Install natural gas-fired boilers according to NFPA 54-96. Connect gas piping full size to boiler gas train inlet. Install with a union and dirt leg.
- D. Connect heating water piping to boiler with shutoff valve and union or flange at each connection.
- E. Install piping from safety relief valve to nearest floor drain.
- F. Controls:
 - 1. Wire boiler burner so it cannot fire unless heating water-circulating pump is running.
 - 2. Boiler shall be started and stopped automatically through the boiler control panel. Outdoor temperature sensor shall enable reset of heating water temperature in accordance with the following schedule:

Outdoor Air Temperature	Heating Water Temperature
70 degrees F	140 degrees F
0 degrees F	190 degrees F
 - 3. Wire boiler burner through flow switch in heating water loop to prevent boiler operation until positive flow is proven.
 - 4. Low water cutoff switch shall shut down boiler operation when water level drops below limit.

5. Automatic high limit shall shut down boiler operation when water temperature exceeds 200 degrees F (adjustable). Manual reset high limit shall shut down boiler operation when water temperature exceeds 205 degrees F (adjustable).
6. Install emergency shutdown switch near boiler room exit door. Wire switch through the burner controls.
7. Boiler shall have the capability for external hot water reset and enable via the BMS.

3.2 TESTING, CLEANING AND CERTIFICATION

- A. Test boiler performance and adjust boiler combustion efficiency to meet manufacturer's recommendations.
 1. Measure and record the following:
 - a. Gas pressure on manifold.
 - b. Combustion air temperature at inlet to burner.
 - c. Flue gas temperature at boiler discharge.
 - d. Flue gas carbon dioxide and oxygen concentration
 - e. Natural flue draft.
- B. Flush and clean boilers according to manufacturer's instructions.

3.3 COMMISSIONING (DEMONSTRATION)

- A. Provide 2 hours of instruction to university's representative. Include operation of boiler including accessories and controls, procedures for startup and shutdown, troubleshooting, servicing, and preventive maintenance. Review data in the maintenance manuals.

END OF SECTION 23 52 00