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INDUSTRIAL BOILERS

(PROJECT STANDARDS AND SPECIFICATIONS)

TABLE OF CONTENT

SCOPE

This Project Standard and Specification covers requirements governing the design, fabrication, and inspection of gas and oil fired water tube boilers having steam outlet conditions not exceeding 750 psig and 800^{o}F.

REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

1. Air Moving and Conditioning Association Standard (AMCA)

   210 Test Code for Air Moving Devices

2. ASME Codes

   Section 1 – Power Boilers
   Section VIII – Pressure Vessels, Division 1
   Code Case Interpretation 1355 – Electroslag Welding
   Power Test Code 19.11 – Quality and Purity of Steam

3. ASTM Standards

   C 64 Fireclay Brick Refractories for Heavy Duty Stationary Boiler Service
   C 153 Fireclay Brick Refractories for Moderate Duty Stationary Boiler Service
   C 155 Insulating Fire Brick
   C 176 Fireclay Plastic Refractories for Boiler and Incinerator Services
   C 213 Aluminum Silica-Base Castable Refractories for Boiler Service

4. ANSI Standard

   B16.11 Forged Steel Fittings, Socket Welding and Threaded

5. ISO-International Standard Organization

   R – 831 Rules for Construction of Stationary Boilers

DEFINITIONS AND TERMINOLOGY

Effective projected radiant surface (in the furnace) – it shall be calculated as the flat projected area of exposed tubes and exposed extended surface integral with tubes. Refractory covered surfaces shall not be included. Calculation of furnace heat absorption is to be based on this definition.

Fuel cutoff time - the interval between loss of flame and stopping the fuel flow to the burner, and consists of the response time of the flame scanner system plus the valve closure time.

Furnace limits - limits not extending beyond the first plane of entry into or between tubes. Screen tubes, when used, shall be considered as the first plane of entry.

Furnace volume - the cubic contents of the space provided for combustion of the fuel.

Heat transfer surface (in the boiler bank) – it shall be calculated as exposed tube surface beyond furnace limits excluding superheater surface. No covered tubes, or covered or exposed drums shall be counted.

Pilot burns:
- An interrupted pilot burns during light off and is shut off during normal operation of the main burner.
- An intermittent pilot burns during light off and while the main burner is firing, and is shut off with the main burner.
- A continuous pilot burns throughout the entire period the unit is in service whether or not the main burner is firing.

Radiant heating surface in the furnace - the flat projected area of all surfaces enclosing the furnace volume exclusive of superheater cavity opening. Calculation of furnace heat release is to be based on this definition.

Response time - the period from flameout to de-energization of the fuel cutoff valve solenoid.

Test block conditions - shall be determined for the fan and ducting arrangement in accordance with the applicable test procedure in the AMCA Test Code for Air Moving Devices.

ADDITIONAL REQUIREMENTS

The design and construction of boilers shall be per ASME Code Section 1 and the requirements given herein.

Proposals to use other codes shall be submitted to purchaser for approval by Owner's Engineer. To be considered for acceptance, all of the following criteria must be met:

- The code must be acceptable to the inspecting authority of the country in which the boiler will be installed.
- All provisions of ISO R-831 are met.
- For purposes of establishing allowable design stresses for all materials, the yield strength shall be taken to be no greater than 80% of minimum tensile strength specified for the material.

The vendor shall comply with any local rules or regulations specified by the purchaser.

Enclosures for motors and electrical equipment shall be appropriate for the specified area classification and environment.

DOCUMENTATION

Proposal information. A technical description, including the following information for the boiler and auxiliaries, shall be supplied:

a. An itemized descriptive list of valves, instruments, controls, piping, and other boiler accessories included in the scope of supply.
b. The system resistance curve shall be overplotted on the fan characteristic curves.
c. The time required to increase the steam rate of the boiler from 20% to 100% MCR.
d. A functional logic diagram showing the light-off and shut-down sequence for the burners.
e. Heat transfer surface in the furnace and boiler bank reported in accordance with the definitions given in this Project Standard and Specification.
f. The applicable performance data shown in Table 1 for the maximum continuous rating and other specified operating points.
g. A dimensional drawing or drawings showing drum internals, drum and header material, outside diameter, plate thickness; water and steam circuit arrangement, furnace configuration, burner locations, flue and duct

arrangements, and dimensions and material of expansion joints, sizes and locations of vents and drains.

h. Materials of construction.
i. Extent of platforming, ladders, and stairways to be supplied.
j. A list of exceptions to this Project Standard and Specification or, if there are no exceptions, a statement to this effect in the proposal.
k. Maximum boiler turndown with all burners in operation and minimum recommended excess air for the specified design fuel and fuel pressure. The maximum capacity of liquid fuel guns shall be stated in pounds per hour.
l. A curve showing the variation of superheater outlet temperature with boiler load over the range of operation of the boiler.
m. Recommended spare parts based on one-year continuous operation.
n. A drawing showing superheater tube metal thermocouple locations and method of attachment to the tubes.

Operating manuals shall be furnished written specifically for the unit being supplied. The manuals shall include all details necessary for commissioning, start up, and operation without the need for vendor's assistance.

MATERIALS

1. Steam generating tubes and economizer tubes shall be carbon steel, seamless, or electric resistance welded.
2. Superheater tubes shall be carbon steel or alloy seamless steel. Carbon Molybdenum tubes are not acceptable.

3. Refractory material for surfaces other than the top of furnace floor tubes shall be per the following:

Vanadium Content In Fuel	Maximum Hot Face Refractory Operation Temperature	Type Refractory Required
>75 ppm	>1700^{o}F	Synthetic mullite or 70% alumina refractory.
>75 ppm	<1700^{o}F	Brick-equal to ASTM C 64 regular high duty or castableequal to ASTM C 213 Class D having a minimum 50% alumina content and 600 psi modulus of rupture after air drying.
<75 ppm	<2000^{o}F	Brick-equal to ASTM C 153 medium duty. Castable-equal to ASTM C 213 Class B. Plastic equal to ASTM C 176 high duty. Insulating brick-equal to ASTM C 155 group 26.
<75 ppm	>2000^{o}F	Synthetic mullite or 70% alumina refractory.

4. Quality of refractory material covering furnace floor tubes shall be at least high duty brick.
5. Flue gas and air ducts shall be carbon steel.
6. Lagging shall be covered by either galvanized steel or aluminum.
7. Drums, headers and tubes. Material with a maximum tensile strength in excess of 112,500 psi is not acceptable. Proposals to use proprietary alloy material shall be submitted to purchaser for approval by Owner's Engineer.
8. The lowest-metal-temperature shall be the hydrostatic test temperature option.
9. Burner piping shall be carbon steel.

LAYOUT AND ARRANGEMENT

1. The furnace dimensions and design shall be such that complete combustion of the fuel takes place within the furnace with no flame impingement on sidewalls, roof or target wall.

2. Based on design of fuel higher heating value, the maximum heat release at Maximum Continuous Rating (MCR) in the furnace shall not exceed the following limits:

FUEL FIRED	HEAT RELEASE	
	BTU/Hr. cu. ft. of Furnace Volume	BTU/Hr. sq. ft. of Radiant Heating Surface In The Furnace
Gaseous fuels and liquid fuels lighter than 15° API	80,000	150,000
Liquid fuels 15° API and heavier	60,000	150,000

3. When firing fuels 15° API and heavier, minimum distance between the burner gun tip and nearest furnace surface along the burner throw shall be 0.35 feet/MMBTU/Hr./burner gun, based on the design fuel higher heating value.
4. When firing fuels 15° API and heavier and ash greater than 0.5 wt. % convective and superheater tubes in regions where flue gas temperature exceeds 1200°F shall be spaced on a minimum of 3 x OD centers in the plane normal to flue gas flow.
5. Downcomers and drum internals shall be designed to insure positive circulation under all load fluctuations.

DRUMS AND HEADERS

1. Maximum allowable working pressure, per ASME Code Section I, PG-21, shall be at 4% or 15 psi, whichever is greater, above the maximum operating drum pressure.
2. The boiler and auxiliary equipment with the exception of the forced draft fans and drivers, shall be designed for a minimum of 10% excess air for firing gas fuel and 15% excess air for firing oil fuel or combination gas and oil fuel.
3. Steam drum internal are to include the steam collecting system and all necessary internal piping such as chemical feed, continuous blowdown, and feedwater distribution.
4. Steam and lower drums shall be equipped with a manhole and hinged cover at each end. Minimum clear opening dimensions shall be 12 x 16 in. or 16 in. diameter. The interior of the upper and lower drums shall be cleaned by sand- or grit-blasting.
5. The size of blowdown nozzles shall be determined based on the blowdown rate and back pressure specified.
6. For boilers operating over 500 psi, steam drum internals shall include centrifugal type primary separators.

Proposals to use other types of primary separators shall be submitted to purchaser for approval by the Owner's Engineer. To be considered for approval the vendor must substantiate with test data from a commercial unit that the solids content of steam entering the superheater will not exceed 1 ppm when operating with normal water level and with boiler water concentration defined below.

7. The lower drum or drums shall be fitted with blowdown nozzles and internal piping for removal of sediment.
8. Piping and tubes shall be attached to drums and headers with full penetration welds (tube connections per Figures PW-16 (y) or (z) of ASME Code Section 1 are permissible for up to one-half inch tube wall thickness). Rolled connections may be used for steam generating tube banks where closely spaced tubes make strength welding impractical.
9. Drums with wall thickness greater than 2 inches shall have welded connections as follows:
   - Connections greater than 4 inches NPS shall be per Figures PW-16 (q-1), (q-2), (q-3) or (q-4) of ASME Code Section 1.
   - Connections 4 inches NPS and less shall be as above or per Figures PW-16 (a), (b), (c), (g), (h). Figures PW-16 (y) or (z) may also be used for tube connections 4 inches NPS and less when the tube wall thickness is less than one-half inch.
10. Drums and headers, where both the wrapper plate and tubesheet exceed 2 inches in thickness.

SUPERHEATER

The superheater shall be arranged such that the inlet tubes are not located in the region of highest flue gas temperature.
When the superheater is located within direct view of the burners, a minimum of two rows of staggered screen tubes shall be provided between it and the furnace.
Superheater headers and tubes shall be designed to assure balanced flow between passes and superheater pressure drop at MCR shall not be less than 15 psi.
Superheaters may be drainable or non-drainable.
Proposals to use non-drainable superheaters shall be submitted to purchaser for approval by the Owner's Engineer. To be considered for approval the vendor must substantiate by commercial experience at a similar installation that a non-drainable superheater will be free of water before furnace exit gas temperatures reach allowable superheater tube metal temperatures when starting up the boiler using the manufacturer's recommended heat-up curve.