GENERAL STANDARD

FOR

FIRETUBE AND PACKAGED BOILERS

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1. SCOPE

1.1 This Standard covers the minimum requirements for materials, design, fabrication, inspection, testing, preparation for shipment and guarantees of firetube and packaged boilers.

1.2 This Standard includes supplementary requirements to BS 2790 (1992) specification for design and manufacture of shell boilers of welded construction. All provisions of ISO R-831 are met.

1.3 The following standard shall also be used when applicable.

ASME "Boiler & Pressure Vessel Code" Section I.

1.4 In the case of packaged type, unit shall meet the following requirements.

1.4.1 The unit supplied shall be completely fabricated, assembled, tested and dismantled only to the extent necessary for inspection and practical shipping.

1.4.2 The unit shall be supplied piped, wired, and ready for operation with a minimum of field tie-ins.

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor:

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

B 16.5	"Steel Pipe Flanges and Flanged Fittings"
B 31.3	"Chemical Plant and Petroleum Refinery Piping"
B 31.1	"Power Piping"

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

Sec. 1	"Rules for Construction of Power Boilers"

BSI (BRITISH STANDARD INSTITUTION)

BS 799	"Oil Burning Equipment", Parts 3 and 4
BS 1560	"Steel Pipe Flanges and Flanged Fittings for the Petroleum Industry"
BS 2790	"Design and Manufacture of Shell Boilers of Welded Construction"
BS 3059	"Specification for Steel Boiler and Superheater Tubes"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-M-PM-115	"Centrifugal Pumps for General Services"
IPS-G-SF-900	"Noise Control"
IPS-M-PI-110	"Ball Valves" Volume 2, Part II

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

831	"Rules for Construction of Stationary Boilers"

3. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

4. DOCUMENTATION

4.1 The Contractor shall provide the following documentation for approval by the Company:

4.1.1 With the proposal

a) General specification.

b) Statement of design code compliance.

c) Outline arrangement and cross-sectional drawings of boiler, ducting and stack, showing burner and platform location.

d) Specification of burner type, layout, model, size and manufacturer.

e) Soot blower type, location, manufacturer and arrangement.

f) Guarantees as required by Clause 16 of this Standard.

g) Noise information as required by IPS-G-SF-900 "Noise Control".

h) Statement of maximum permissible boiler water TDS.

i) Statement of furnace positive and negative pressures.

j) Furnace maximum and average heat flux density.

k) Heat flux to cause "Departure from Nucleate Boiling" (DNB).

l) Furnace flue gas exit temperature.

m) Method of fuel consumption and thermal efficiency tests, with correction formula, curves, etc. used in the calculations.

n) Statement of percentage radiation loss for the whole boiler.

o) Over capacity rating, indicate maximum time allowed to run.

p) Heat release mj/m³ firebox volume.

q) Efficiency at full, 75%, 50%, 25% load. Include excess air and ambient temperature used in calculating these efficiencies.

4.1.2 Prior to order

a) Individual specification data sheets for fans and other ancillary equipment.
b) Recommended spares list for 12 months operation.
c) Specifications for instrument piping and cable.
d) Design and construction of flue gas dampers.
e) Burner fuel gas flow rate and automatic control.
f) Breakdown of total feedwater pressure requirement.
g) Capacity capability using natural draft when draft fans fail, if exist.

Note:

Items (b) and (d) may be deferred by agreement with the Company.

4.1.3 During design and prior to manufacture

a) Valve data sheets for HP steam, feedwater, safety relief and pressure-reducing over 14 bar .

b) Details of connections and conditions at supply limits.

c) Specifications, individually completed data sheets (including process performance, constructional and test data) and cross-sectional drawings, for all machinery.

d) Local control panel layout and location.

e) List of instrument makes and models.

f) Schematic and hook-up drawings of emergency shutdown systems and automatic trip systems, burner management and controls, accompanied by a detailed description of operation.

g) Foundation general arrangement and details.

h) Cable trench layout and details.

i) Structure loading under various design conditions, together with design stresses.

j) Piping specifications.

k) Welding procedures.

l) Design details and mode of operation for isolating plates in common ducting or stack.

m) Burner flame detection equipment.

n) Lighting levels at burner and access platforms and stairways.

o) Design of stack duct entries.

p) Winterization proposals for plant protection.

q) Any special type screwed pipework fittings.

r) Flue gas ducting internal lining.

s) Stack height, diameter and wall thickness.

t) Overall dimensions for layout purpose, showing ladders, stairways and platforms supplied.

4.1.4 Prior to operation

The Company when placing an order, will specify the date of providing plant operating manual.

5. DEFINITIONS AND TERMINOLOGY

Boiler

A closed pressure vessel in which a liquid, usually water, is vaporized by the applications of heat.

Firetube Boiler

A boiler with straight tubes which are surrounded by water and steam and through which the products of combustion pass.

L.H.V Low Heating Value.

M.C.R The Maximum Continuous Rating; i.e. steam flow rate, which a boiler will deliver at its stop valve.

T.D.S Total Dissolved Solids.

6. MATERIALS

6.1 The materials used in the manufacture of pressure parts and also the materials for plates, tubes, bars, and forgings, shall comply with BS 2790: Section 2.

6.2 For installations operating in sour environment, materials of construction selected shall be least affected when subjected to atmospheric corrosion attack.

6.3 Under no circumstances shall valves, regulators, etc., contain any copper or brass components.

6.4 Superheater tubes shall be carbon steel or alloy steel.

6.5 Quality of refractory material covering furnace floor tubes shall be at least High-Duty brick.

6.6 Flue gas and air ducts shall be carbon steel.

6.7 All insulation shall be covered with metal jackets, either: zinc coated (galvanized) steel, aluminum-coated steel, or aluminum.

6.8 Burner piping shall be carbon steel.

7. DESIGN

7.1 General

7.1.1 Wetback units shall normally be used. A dryback design may be considered when a superheater is required, provided that the refractory does not present a potentially severe maintenance problem.

7.1.2 The flow of steam through the superheater shall create such a pressure drop over the entire operating range as will ensure an adequate distribution of steam through all tubes, and thereby prevent overheating of any element. The boiler designer shall state the pressure drop across the superheater at 40%, 70%, 100% and 110% of MCR.

7.1.3 Facilities shall be provided to enable inspection of internal surfaces without recourse to cutting and rewelding.

7.1.4 The manufacturer shall show by calculation that the attachment of tubes to tube sheets is satisfactory in relation to the pressure and heat transfer rates envisaged for the conditions stated.

7.1.5 Superheater tubes shall be to BS 3059 or equivalent standard.

7.1.6 Internal pipework which is the responsibility of the boiler supplier, shall be based generally on ANSI B 31.3 for fuel piping, ANSI 31.1 for steam piping, or other equivalent standards. Exceptions may be made where necessary to meet special requirements and any such exceptions shall be stated.

7.1.7 Terminal flange connecting to external pipework shall be of raised face type complying with ANSI B 16.5 or BS 1560, adopting the pressure/temperature ratings of ANSI B 16.5 latest issue.

7.1.8 In the case of package type, unit shall meet the following requirements.

7.1.8.1 All necessary equipment such as ladders and platforms, guards for moving parts, etc., shall be supplied as part of the package.

7.1.8.2 All boilers heaters shall be installed inside the buildings.

7.1.8.3 Indoor equipment shall be suitably protected against damage by infiltration of moisture and dust during plant operation, shutdown, washdown, and the use of fire protection equipment.

7.1.8.4 Outdoor equipment shall be similarly protected, and in addition, it shall be suitable for continuous operation when exposed to rain, snow or frost, high winds, humidity, dust, temperature extremes, and other severe weather conditions.

7.1.8.5 The unit shall be laid out such as to make all equipment readily accessible for cleaning, removal of burner, replacement of filters, controls and other working parts, and for adjustment and lubrication of parts requiring such attention. For similar reasons, the boiler front and rear doors shall be hinged or davitted.

The boiler shall be installed with the following minimum clearances:

Vertical	1200 mm
Sides and Rear	1200 mm
Front	1200 mm

Clearances shall be increased to take into account for swinging open the front and/or the rear enclosures and for the tube removal.

7.2 Design of Welded Joints

7.2.1 Longitudinal, circumferential and other joints, uniting the material used for channels, shells, or other pressure parts shall be butt welded with full penetration.

7.2.2 Welding grooves

In accordance with ASME PW-9.2.

7.2.3 Joints between materials of unequal thickness

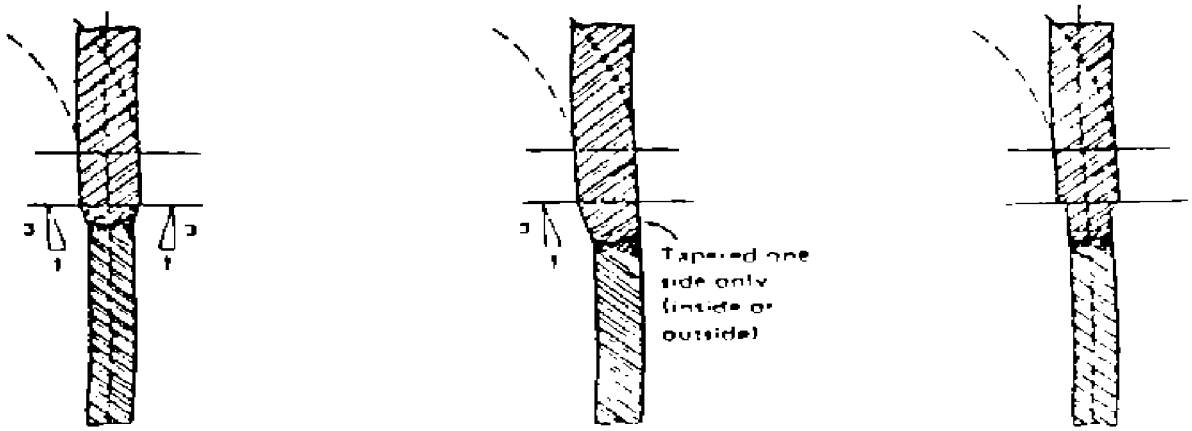
A tapered transition section having a length not less than three times the offset between the adjoining surfaces, as shown in Fig. 1, shall be provided at joints between materials.

The transition section may be formed by any process that will provide a uniform taper. The weld may be partly or entirely in the tapered section or adjacent to it as indicated in Fig. 1.

This paragraph is not intended to apply to joint design specifically provided for elsewhere in this Standard or to joints between tubes, between tubes and headers, and between tubes and tubesheets.

7.2.4 Welded joints subject to bending stress

The design of welded shells and heads shall be such that bending stresses are not brought directly on the welded joint. No single-welded butt joint or fillet weld shall be used where a concentrated bending stress will occur at the root of the weld due to bending of the parts joined, as in the corner weld shown in Fig. 2, unless the parts are properly supported independently of the welds.

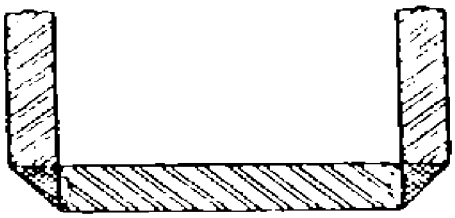


(a)
Preferred Method
(Center lines Coincide)

(b)
Permissible
(Circumferential Joints Only)

(c)
Not
Permissible

BUTT WELDING OF PLATES OF UNEQUAL THICKNESS
Fig. 1



EXAMPLE OF CORNER WELD SUBJECT TO BENDING STRESS
Fig. 2

7.3 Head to Flange Requirements

In accordance with ASME PW-13.

7.4 Thickness Requirements

7.4.1 Shell and dome

The minimum thickness of shell plates and domeplates, after forming shall be as follows:

I.D of Shell or Dome	Minimum Thickness, in (mm)
900 mm or under	6
Over 900 mm to 1370 mm	8
Over 1370 mm to 1800 mm	10
Over 1800 mm	13

7.4.2 Tubesheet

The minimum thickness of tubesheets of firetube boilers shall be as follows, but it shall not be less than 0.75 times the thickness of the shell to which it is attached:

Diameter of tubesheet	Minimum Thickness, in (mm)
1060 mm or under	10
Over 1060 mm to 1370 mm	11
Over 1370 mm to 1800 mm	13
Over 1800 mm	14

7.5 Attachment of Heads and Tubesheets

In accordance with ASME PFT-11.

7.6 Attachment of Tubes

In accordance with ASME PFT-12.2.

7.7 Attachment of Furnaces

In accordance with ASME PFT-20.

7.8 Access and Firing Door Openings

In accordance with ASME PFT-42.

7.9 Requirements for Inspection Openings

7.9.1 All openings shall meet the requirements of BS 2790: Section 3.6. Manholes may be substituted for handholes. Where washout plugs are used the minimum size shall be 38 mm.

7.9.2 Horizontal-return tubular boiler

In accordance with ASME PFT-43.2.

7.9.3 Traction, stationary, or portable return tube firetube boilers

In accordance with ASME PFT-43.3.

7.9.4 Scotch boilers

In accordance with ASME PFT-43.4.

7.9.5 Vertical boiler

In accordance with ASME PFT-43.5.

7.9.6 Opening between boiler and safety valve

The opening or connection between the boiler and the safety valve shall have at least the area of the valve inlet.

After the boiler manufacturer provides for the opening required by the Code, a bushing may be inserted in the opening in the shell to suit a safety valve that will have the capacity to relieve all the steam that can be generated in the boiler and which will meet the Code requirements.

No valve of any description shall be placed between the required safety valve or safety relief valve or valves and the boiler, or on the discharge pipe between the safety valve or safety relief valve and the atmosphere. When a discharge pipe is used, the cross-sectional area shall be not less than the full area of the valve outlet or of the total of the areas of the valve outlets discharging thereinto and shall be as short and straight as possible and so arranged as to avoid undue stresses on the valve or valves.

8. PIPING, FITTINGS, VALVES AND APPLIANCES WATER GLASSES

8.1 Water Glasses

In accordance with ASME PFT-47.

8.2 Feed Piping

8.2.1 When a horizontal-return tubular boiler exceeds 1000 mm in diameter, the feedwater shall discharge at about three-fifths the length from the end of the boiler which is subjected to the hottest gases of the furnace (except a horizontal-return tubular boiler equipped with an auxiliary feedwater heating and circulating device), above the central rows of tubes. The feed pipe shall be carried through the head or shell farthest from the point of discharge of the feed-water and be securely fastened inside the shell above the tubes.

8.2.2 In accordance with ASME PFT-48.2.

8.3 Blowoff Piping

In accordance with ASME PFT-49.

8.4 Auxiliary Piping Component-Connections

8.4.1 Minimum size of piping shall be DN 15 unless otherwise specified.

8.4.2 Minimum bore of piping shall be 6.35 mm.

8.4.3 Draft gage connections shall be provided and located: one in the burner windbox, one in the furnace zone, and one at the boiler outlet.

8.4.4 A flue gas sampling connection, DN 25 shall be provided at the boiler outlet. Its location shall be such that a representative sample is obtained.

8.4.5 Boiler drain, level gage and sample connections shall be piped to grade.

8.4.6 Pressure Relief (PR) valves discharging materials such as hot water, steam, air or inert gas to atmosphere, shall be furnished with outlet piping to direct the flow away from areas where personnel may be present.

8.5 Valves

8.5.1 For steam and feed water shut-off duties, parallel slide valves shall be used. All valves shall be of steel construction suitable for the pressure and temperature concerned and cast iron shall not be used for any valve or fitting. The main steam stop valve may be an angle screw-down type mounted directly on the outlet nozzle of the boiler.

8.5.2 Boiler isolation from the range shall be to double-isolation standard. As a minimum, a block valve and screw-down non-return valve and a drain shall be provided.

8.5.3 All gate type and screwdown valves shall have rising spindles with handwheels rotating clockwise to close, and marked accordingly. Stainless steel or alloy nameplates shall be fitted to each valve to indicate valve duties and item number.

8.5.4 Two blowdown valves, of a size depending upon the size of the boiler, shall be fitted at the bottom of the boiler water space.

8.5.5 An air cock shall be fitted to the top of the boiler shell.

8.5.6 An anti-syphon valve shall be provided to prevent the boiler filling with water as the internal pressure falls during shutdown operations.

8.5.7 Soft sealed type valves shall not be used.

8.5.8 All valves shall be suitable for the line service classification. Single or double valves at a classification change shall be suitable for the more severe line classification on either side of the valve(s) location.

8.5.9 Materials for the first block and check valve and the connective piping through the first check valve shall be suitable for the more corrosive condition of the process or utility service for maximum metal temperature of the connective piping.

8.5.10 Material used for valve packing and seals preferably asbestos free shall be suitable for the maximum and minimum fluid design temperatures to which these components will be exposed.

9. BURNERS

9.1 Fuels to be used and conditions of supply will be specified by the Company. Heating for fuel oil shall be provided as necessary so that the viscosity required at the burners can be achieved at all times.

9.2 Liquid fuels shall be filtered through mesh of nominal 0.25 mm aperture for heavy fuel oils and 0.18 mm for light fuel oils, or as specified by the burner manufacturer. Duplex type filters or two filters in parallel shall be provided, allowing change-over to take place without interruption of flow. A differential pressure gage shall be provided across the filters.

9.3 Steam-atomized, pressure-jet or rotary-cup type burners may be used, provided that they are fully proven for use with the particular furnace and fuels to be burnt. Works tests shall be carried out, using samples of the fuels concerned, on a boiler similar to that under consideration. If steam-atomized burners are used, the boiler designer shall justify any steam consumption greater than 0.5% of boiler MCR.

9.4 During the works tests the opportunity shall be taken to measure the noise levels of the combustion equipment, etc.

9.5 Each main burner assembly shall be equipped with a fixed gas fired pilot burner suitable for a gas supply pressure of 0.2 to 0.35 bar, for which the gas supply shall be from a source independent of the main fuel.

Each pilot burner shall incorporate an electric ingniter as part of its assembly and must be suitable to ensure safe and efficient ignition of all fuels specified. They shall also be permanently lit when their respective main burners are in use but shall be removable for maintenance while the boiler is in operation.

9.6 Both main and pilot burner shall have proven flame detection equipment responsible for controlling fuel admission and cut-off to their respective burners.

9.7 Fuel gas burners shall be of the multi-spud or gun type.

9.8 When both liquid and gaseous fuels are specified, all burners shall be capable of burning satisfactorily any of the fuels separately or simultaneously.

9.9 Where waste fuels are to be burned, they shall be considered as intermittent supplies and the reliable operation of the boiler should not depend on their use.

9.10 Burner minimum turndown shall be 3:1 for liquid fuels and 10:1 for fuel gas. O_2 percentage in the flue gas shall be in the range of 1½ - 2% for liquid fuels and 3 - 3½% for gaseous fuels, over the turndown range of 50 - 100% MCR.

9.11 For boilers above 4.5 tonne/h capacity, the burner turndown shall not be less than 4:1 for liquid fuels provided that where steam superheaters are fitted, the steam flow shall always be adequate to prevent overheating of any element.

9.12 Unburnt carbon in the flue gas shall not be greater than 0.05% wt. of the fuel.

9.13 Carbon monoxide in the flue gas shall not be greater than 0.01% by volume at specified O_2 content in flue gases.

9.14 The pilot flame shall be visible through the burner peephole, at least prior to the ignition of the main flame, and shall be monitored by a reliable flame detector, preferably of the ionization probe type, at all times. The pilot burner shall be proven capable of igniting the main fuels efficiently and of remaining lit under all windbox and furnace conditions likely to be experienced.

9.15 Separate combustion air to pilots must be arranged if the main windbox supply, under all pressure changes normally experienced, cannot be relied upon to maintain the flame in a satisfactory condition.

9.16 Duplex type filters, or two filters in parallel, of 125 microns mesh in monel, shall be provided in the gas supply for each convenient group of pilot burners. The pipework from the strainers to the pilot burners shall be in stainless steel.

9.17 Burner viewing ports shall be fitted to each burner assembly front plate in such a position as to afford an adequate visual examination of the burner stabilizer and the root of the flame.

9.18 Provision shall be made for the automatic steam purging of burner guns to remove all liquid fuels. It shall not be possible to withdraw a gun from the burner assembly unless the fuel is shut off, the purging carried out and steam shut off. It shall also not be possible to turn on fuels or steam with the gun withdrawn. This mechanism must only be capable of being overridden by a locked 'defeat' switch with a removable key. When a burner trips out on default of flame, or any other essential condition, the burners shall not be automatically purged. Indication of the unpurged condition shall be visible from the firing floor and boiler control panel. The purging sequence shall be initiated by local push-button control by the operator when he is satisfied that it is safe to so purge the fuel from the guns into the furnace. Under these conditions, the pilots must be in operation.

9.19 Where automatic valves are proposed for the "on" and "off" control of the fuels and steam to individual burners, separate manually-operated valves shall also be provided at the boiler front. All these valves, both automatic and manual, shall be specifically selected to give reliable operation, tight shout-off and no external leakage over the full operation period between boiler overhauls which shall be taken as 36 months. Valves shall preferably be of the ball valve type to IPS-M-PI-110, Volume 2, Par II or equivalent, subject to the operating temperature and pressure being within the rating of the valve seat, etc. Overtravel on automatic valves shall be sufficient to operate limit switches satisfactorily.

9.20 After purging, the sequence of events of start-up shall embody the following principles:

- **a)** Ensure all interlocks are in the correct condition to proceed.
- **b)** Prove fuel valves closed and correct the air flow rate.
- **c)** Prove the required number of air registers open to ensure the minimum boiler air flow.
- **d)** Start pilot igniter.
- **e)** Open pilot gas valves and closed bleed valve.

9.21 The start-up and shut-down sequence shall be automatic with push-buttons to start and stop the sequence for each burner. As specified by the Company, colored lamps on the panels shall indicate the status of burners.

9.22 Interlocks shall be provided to prevent burner start-up if the furnace conditions are not satisfactory. These shall initiate shut-off of the main fuel trip valve to the boiler at any time during operation, if they are not continuously satisfied. Conditions producing lock-out or trip shall include the following:

- **a)** Extra-low water level.

b) Low pilot fuel gas supply pressure (shut off pilot gas at start-up only).

c) Low supply pressure for the relevant fuel.

d) Loss of forced drought.

e) Loss of induced drought.

f) Loss of main burner flames (individual burner fuel cut off).

g) Loss of atomizing steam pressure (on liquid fuel firing).

h) Low pressure of control air/instrument air (start up conditions only; "fail-locked" would operate when on load). See Clause 10.

i) Loss of electric power supply (start-up conditions only; "fail-locked" would operate when on load see Clause 10).

9.23 Fuel pipework shall have blanked-off connections to which temporary steam lines may be attached for purging before maintenance. They shall be located close to, and downstream of, the shot-off valves.

9.24 Fuel oil and fuel gas pipework shall have tracing, thermostatically controlled.

9.25 Atomizing steam lines shall be lagged separately from fuel lines.

9.26 The atomizing steam pressure shall be controlled to give a constant value, or constant differential pressure from that of the fuel, as the particular type of burners may require.

9.27 The manufacturer shall specify a purging procedure in the boiler manual. This shall include at least 5 volume air change of the furnace before the first burner is started up.

10. INSTRUMENTS, CONTROLS AND SAFETY EQUIPMENT

10.1 Where 'fail-locked' control circuits are specified, digital signals shall be used. Provision shall also be made for local tripping of critical equipment.

10.2 Unless otherwise specified, automatic control of the following functions shall be provided:

1) Fuel supply to burners.
2) Combustion conditions.
3) Boiler water level.
4) Feed water supply.
5) Burner management.
6) Furnace purge before first burner light-off.

10.3 Controls may be pneumatic or electronic, or a combination of both, as the Company, may specify.

10.4 Solid state burner management equipment shall be used unless the Company specifies or agrees otherwise.

10.5 The boiler manufacturer shall be responsible for the satisfactory design and operating capability of the instruments, controls and safety equipment associated with the boiler, and he shall submit details to the Company for approval before placing purchase orders.

10.6 The flow rate of fuels to the burners shall be controlled by the pressure of the steam in the boiler or discharge header common to other boilers, unless specified otherwise .

10.7 For boilers of up to 4.5 tonne/h capacity the fuel may be controlled at two firing rates, one high and one low, related to boiler steam pressures, the low firing rate also being used for the warming up of the boiler. The steam pressure band over which the burner is controlled shall normally be no more than 5% of the operating pressure, unless otherwise agreed with the Company.

10.8 Above 4.5 tonne/h capacity, modulating control of the fuel flow rate shall be employed, with the flow inversely proportional to steam pressure existing at the boiler or common steam header. An override shall be incorporated each boiler control system to shut down the burners of a boiler whose steam pressure is about to lift the safety relief valve. The setting of the override shall be adjustable between normal operating pressure and the safety relief valve set pressure.

10.9 All automatic burners shall be provided with management equipment to control the sequences of operation during start-up and shut-down and to monitor the conditions of the burner flame at all times, in accordance with the technical requirements of BS 799: Parts 3 and 4.

10.10 The steam pressure shall actuate a control signal which will position a modulating motor connected to the air damper and fuel control valve. The air-to-fuel ratio shall be mechanically set by means of levers, links and an adjustable cam, or similar positive device, over the modulating range to give satisfactory combustion conditions and thereafter require little attention.

10.11 For boilers of 4.5 tonne/h capacity and above, feed water to the boiler shall be modulated according to actual boiler water level, using a level transmitter.

For boilers below 4.5 tonne/h capacity, control of the feed water to the boiler shall either be by modulation as above, or by means of an intermittent ON/OFF switch at pre-determined levels. The feed regulating valve shall be provided with isolating and bypass valves for emergency manual operation.

10.12 Two direct-reading water level gages shall be fitted on each end of the boiler shell and preferably diagonally opposed. Audible water level alarms shall be incorporated, located at high, low and extra low positions. At the low level alarm position, the fuel supply shall be cut off but may be automatically restored if the level recovers. At the extra-low level position, the firing shall be shut down and a lock-out condition introduced which shall require manual re-setting, including sequence purging for re-start.

11. BOILER FEED PUMPS

11.1 Boiler feed pumps when supplied, shall be in accordance with IPS-M-PM-115 "Centrifugal Pumps for General Service".

11.2 Boiler feed water pumps shall be protected from excessive temperature rise under minimum flow conditions, e.g. by the provision of a minimum leak-off path.

11.3 For a boiler operating on modulated feed control, the feed pump shall normally run continuously. For the ON/OFF system, the pumps may be arranged to start up as required, unless supplying several boilers.

11.4 Feed water pumps on modulated feed control shall have a capacity of 110% of MCR.

11.5 Feed water pumps on an ON/OFF system of feed control shall have a capacity in the range 125-175% of MCR.

12. FANS, DUCTING AND STACKS

12.1 Forced Draft Fans

12.1.1 The fan shall meet the following requirements at its rated point:

a) Rated air flow shall be 120% of the air flow required by the unit operating at MCR and firing design fuel at 20% excess air for oil fuel and 15% excess air for gas fuel.

b) Rated static head shall be 145% of the head required at MCR and firing design fuel at 20% excess air for oil fuel and 15% excess air for gas fuel.

c) Fan shall be rated at summer design air temperature plus 14°C, summer design relative humidity, and altitude at site of installation.

12.1.2 Fan blading design shall be either of the airfoil or backward curved nonoverloading type.

12.2 Ducting

12.2.1 Ducting for flue gas and air shall be of continuous seal welded construction to insure air tightness with flanged connections for field assembly. Ducts shall be reinforced and stiffened for the operating air pressure and temperature under all conditions within the guaranteed operation.

12.2.2 Minimum thickness of flue gas ducts shall be 6 mm.

12.2.3 Minimum thickness of air ducts shall be 5 mm.

12.2.4 Expansion joints in ducting shall be designed and furnished by the Manufacturer. Designs shall be submitted to the Company for approval.

12.2.5 The dampers shall be designed for tight shutoff and shall be braced sufficiently to withstand maximum forced draft fan discharge pressure.

12.3 Stacks

12.3.1 The stack shall be designed as individual self-supporting steel stack with minimum height specified for the boiler. Stacks shall be checked for dynamic and static wind loadings.

12.3.2 Aircraft warning lights may be required by local regulations

12.3.3 Stacks may require facilities for flue gas sampling and smoke and temperature measurement if suitable locations in the flue ducts cannot be provided.

12.3.4 Steel work external surface shall be given protective, treatment on the ground, before erection.

13. FABRICATION

13.1 The rules in the following paragraphs apply specifically to the fabrication of boilers and parts thereof that are fabricated by welding and shall be used in conjunction with the general and specific requirements for fabrication in the applicable Sections of BS 2790 that pertain to the type of boiler under consideration.

13.2 Cutting Plates and other Stock

In accordance with ASME PG-76.

13.3 Plate Identification

In accordance with ASME PG-77.

13.4 Repairs of Defects in Materials

In accordance with ASME PG-78.

13.5 Tube Holes and Ends

In accordance with ASME PG-79.

13.6 Distortion

In accordance with ASME PG-80.

13.7 Tolerance for Formed Heads

In accordance with ASME PG-81.

13.8 Holes for Stays

In accordance with ASME PG-82.

13.9 Welding Processes

The welding processes that may be used under this Section shall meet all the test requirements of BS 2790 Clause 5.4.6 and restricted to the following:

13.9.1 In accordance with ASME PW-27.1.

13.9.2 In accordance with ASME PW-27.2.

13.9.3 Manufacturer shall submit copies of welding procedures, before production commences for comments and approval by company.

13.9.4 The proposed welding procedures shall include the following information:

a) Welding process of combination of processes.

b) Name and designation of welding consumables.

Note:

Where no related material specifications are available, all chemical and mechanical data shall be supplied with the welding proposals.

c) Dimensioned sketch of joint design.

d) Method of making weld preparations.

e) Details of welding techniques i.e. diameter of electrodes or filler wire and sketch showing sequence of welding.

f) Welding position.

g) Range of production thicknesses to which welding specification applies.

h) The welding proposal shall include details for the removals of deleterious weld defects and the subsequent re-welding operation.

i) Pre and postweld heat treatment.

j) Shielding and purging composition and flow rates, (for gas shielded arc welding).

k) Type of power sources, amperage, speed of travel.

l) Base metal chemical composition.

13.9.5 All root pass on tubes or pipes including nozzles and branches must be made with Tungsten inert gas shielded arc welding method with a suitable filler wire.

All filler runs on tubes and pipes shall be made with the electric arc coated electrode on the butt and fillet welds.

13.9.6 The outside surface of the weld shall be free from undercuts, abrupt edges or valleys. The weld reinforcement should not to exceed 2.4 mm.

Every precaution shall be taken to avoid excessive penetration of root runs, on the inside of the tubes.

13.9.7 All longitudinal and circumferential welds on the pressure vessel including tube membrane walls should be made by submerged arc method.

13.9.8 Permanent back-up rings are only permitted on the closing circumferential seams of vessels without an external manway with approval by company. Back-up rings, when permitted, shall match the analysis of the base material. If back-up rings are removed, the area shall be dressed and examined for cracks by the magnetic particle method.

13.9.9 Welds which are deposited by procedures differing from those properly qualified and approved shall be rejected and completely removed from the equipment.

13.10 Base Metal Preparation

In accordance with ASME PW-29.

13.11 Assembly

13.11.1 Parts that are being welded shall be fitted, aligned, and retained in position during the welding operation within the tolerance specified in Clause 13.13.

13.11.2 In accordance with ASME PW-31.2.

13.11.3 Tack welds used to secure alignment shall either be removed completely when they have served their purpose or their stopping and starting ends shall be properly prepared by grinding or other suitable means so that they may be satisfactorily incorporated into the final weld. Tack welds, whether removed or left in place, shall be made using a fillet weld or butt weld. Tack welds to be left in place shall be made by qualified welders and shall be examined visually for defects and, if found to be defective, shall be removed.

13.11.4 In accordance with ASME PW-31.4.

13.12 Alignment Tolerance

In accordance with ASME PW-33.

13.13 Tube to Tubesheet Joints

13.13.1 To obtain sound tube/tubesheet welded joints absolute cleanliness shall be maintained until all joints have been proved to be sound and all repair welds complete. The following stages of the manufacturing process shall be observed:

a) Initial cleanliness of component parts and the removal of oil, moisture, shop dirt, etc.

b) Expansion of tubes before welding shall not be permitted since air trapped between tube and tube sheet causes weld porosity.

c) To avoid contamination of welds by water, no hydraulic testing is to be carried out until joints have been proven sound and all weld repairs have been completed.

13.13.2 The basic requirements for cleanliness shall be as follows:

a) Tube holes must be free from scale, shop dirt, oil and grease before welding commences. These clean conditions shall be maintained until all welding, including weld repair is concluded.

b) Welding consumables shall be stored prior to use in accordance with the manufacturer's recommendations and filler wire shall be cleaned immediately before use with a suitable solvent.

c) The work pipes shall be maintained above ambient condensing temperature for the duration of the welding operation and for the periods when the work piece is standing without work being carried out on it.

d) For some welding processes it is essential to mechanically position tubes in the tubeholes before welding. When this is required; expansion of the tube with the tubehole shall not be allowed. Instead a light expansion with a drift pin can be used to produce a line contact. The positioning contact line should be such that it forms part of the subsequent weld root run. No lubricants shall be used in the positioning operation.

e) Weld shall be examined by any non-destructive testing means but after test all dye, oil, shall be completely removed from the tube sheet before proceeding.

f) A pneumatic pressure test shall be applied to the tube/tube sheet weld before any hydrostatic test is carried out. Medium may be air or air freon mixtures, using soapy water or a halogen leak detector to determine faulty welds.

All welds shall be pneumatically tested again after any weld repairs have been carried out.

g) Carry out the full hydraulic test on the tube side of the boiler.

h) When all welds are proven satisfactory, the tubes should be lightly expanded onto tube sheet to minimize cyclic bending stresses on the weld joint.

i) Final hydrostatic proving tests on the shell side and tube side of the boiler shall proceed after all the foregoing steps have been completed.

13.14 Heat Treatment

All postweld or postoperation heat treatment whether carried out in a furnace or by local induction heating, shall have pyro-metric control, with automatic chart recorders. Thermocouples must be attached to the metal. It is not sufficient to measure only furnace atmosphere. No heat treatment is permitted without this instrumentation.

14. INSPECTION AND TESTING

14.1 All materials and work including the work of sub-suppliers shall be subject to inspection as indicated in the conditions of contract.

14.2 Certificates of shop inspection and all related test reports plus material mill test certificates shall be furnished to the Company by the boiler manufacturer.

14.3 Hydrostatic Test

14.3.1 After a boiler has been completed, it shall be subjected to pressure tests using water at not less than ambient temperature, but in no case less than 7°C.

14.3.2 All welded pressure parts shall be subjected to a hydrostatic test pressure of not less than 1.5 times the design pressure. The hydrostatic test may be made either in the manufacturer's shop or in the field.

14.3.3 In accordance with ASME PG-99.3.3.

14.3.4 In accordance with ASME PW-54.2.

14.3.5 In accordance with ASME PG-99.4.1.

14.3.6 The test pressure shall be applied and maintained for a sufficient length of time to permit a thorough examination to be made of all seams and joints, but not less than 60 minutes, excluding inspection time.

14.3.7 After completion of the hydrostatic tests, the water shall be immediately drained and the equipment tested, and dried by blowing with dry compressed air.

15. PREPARATION FOR SHIPMENT

Boiler manufacturer shall properly prepare the boiler for shipment to the jobsite.

15.1 Outside exposed metal surfaces shall be prepared and painted in accordance with painting project specification.

15.2 Machined surfaces and flange faces shall be coated with heavy rust preventive grease.

15.3 All threads of bolts, including exposed parts, shall be coated with a metallic base waterproof lubricant to prevent galling in use and corrosion during shipment and storage.

15.4 To prevent damage, all flange facings shall be protected with gaskets and 6 mm thickness plates, and all couplings shall be protected by steel pipe plugs.

15.5 Suitable bracing and supports shall be provided to prevent damage during shipment.

16. GUARANTEE

16.1 The Contractor, unless explicitly states any exceptions in his proposal, shall guarantee the unit(s) furnished by him to meet the requirement with regard to mechanical design, steam flow rate, steam delivery pressure and temperature, safety and reliability under all specified operating conditions.

16.2 The unit(s) supplied shall be guaranteed for a minimum of one(1) year after start-up or eighteen(18) months after delivery, whichever occurs first. Should any equipment or any component of the boiler fail or show evidence of foreseeable failure within the guarantee period, the Contractor shall be responsible for repairing or replacing the times at their own cost.

16.3 The Company may run acceptance tests on the equipment within one(1) year of startup. The Contractor shall be responsible for any changes and modifications required as a result of the acceptance tests.