



**GS 156-4**

# **SHELL TYPE FIRED STEAM GENERATING PLANT**

**September 1997**

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| <b>BP GROUP RECOMMENDED PRACTICES AND SPECIFICATIONS FOR ENGINEERING</b>                                                                                                                                                                                   |      |                       |                  |
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| <p style="text-align: center;"><b>SHELL TYPE FIRED STEAM<br/>GENERATING PLANT</b></p> <p style="text-align: center;">(Replaces BP Std 212)</p>                                                                                                             |      |                       |                  |
| <b>APPLICABILITY</b>                                                                                                                                                                                                                                       |      |                       |                  |
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| <b>SCOPE AND PURPOSE</b>                                                                                                                                                                                                                                   |      |                       |                  |
| <p>This Guidance for Specification defines BP general requirements for design, fabrication, cleaning, testing and painting of cylindrical land steam boilers of fusion welded construction</p>                                                             |      |                       |                  |
| <b>AMENDMENTS</b>                                                                                                                                                                                                                                          |      |                       |                  |
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## FOREWORD

### Introduction to BP Group Recommended Practices and Specifications for Engineering

The Introductory Volume contains a series of documents that provide an introduction to the BP Group. Recommended Practices and Specifications for Engineering (RPSEs). In particular, the 'General Forward' sets out the philosophy of the RPSEs. Other documents in the Introductory Volume provide general guidance on using the RPSEs and background information to Engineering Standards in BP. There are also recommendations for specific definitions and requirements.

### Value of this Guidance for Specification

This Guidance for Specification defines BP General requirements for the design, fabrication, cleaning, testing and painting of cylindrical land steam boilers of fusion welded construction. These requirements are based upon BP's knowledge and experience worldwide.

### Application

This Guidance for Specification is intended to guide the purchaser in developing a 'fit for purpose' specification for enquiry or purchase.

Text in *italics* is Commentary. Commentary provides background information which supports the requirements of the Specification, and may discuss alternative options. It also gives guidance on the implementation of any 'Specification' or 'Approval' actions; specific actions are indicated by an asterisk (\*) preceding a paragraph number. Resolution of the 'Approval' actions is the responsibility of the purchaser's professional engineer.

This document may refer to certain local, national or international regulations but the responsibility to ensure compliance with legislation and any other statutory requirements lies with the user. The user should adapt or supplement this document to ensure compliance for the specific application.

### Principal Changes from Previous Edition

This document is an update of BP Standard 212 (August 1981). No technical changes have been made, the update comprises only re-formatting into the Guidance for Specification (GS) style. Users should be aware that this document retains the prescriptive requirements of BP Standard 212.



## **Feedback and Further Information**

Users are invited to feed back any comments and to detail experiences in the application of BP Group Recommended Practices, to assist in the process of their continuous improvement.

For feedback and further information, please contact Engineering Practices Group, BP International or the Custodian. See Quarterly Status List for contacts.



## 1. SCOPE

This Guidance for Specification defines BP general requirements for design, fabrication, cleaning, testing and painting of cylindrical land steam boilers of fusion welded construction.

## 2. GENERAL

### 2.1 **Quality Assurance**

*Verification of the vendor's quality system is normally part of the pre-qualification procedure, and is therefore not specified in the core test of this specification. If this is not the case, clauses should be inserted to require the vendor to operate and be prepared to demonstrate the quality system to the purchaser. The quality system should ensure that the technical and QA requirements specified in the enquiry and purchase documents are applied to all materials, equipment and services provided by sub-contractors and to any free issue materials.*

*Further suggestions may be found in the BP Group RPSEs Introductory volume.*

### 2.2 **General**

2.2.1 The boiler shall be of the economic type having up to three internal circular furnaces and not more than three flue gas passes.

2.2.2 When a boiler has one circular furnace, it shall not be considered for continuous duty.

2.2.3 Units shall be skid mounted and suitable for placing on to prepared foundations, connecting into the service system and putting into operation with minimum site work.

### 2.3 **Main Design Standards**

Boilers may be constructed to [BS 2790](#) Parts 1 and 2, [ASME Boiler & Pressure Vessel Code](#) Section I, [ISO R831](#) or equivalent national standards according to the requirements of the country in which the boiler is to be installed. For UK installations this will normally be specified as [BS 2790](#). The code used shall be clearly stated by the boiler designer.



## 2.4 Guarantees

The following aspects of performance shall be guaranteed by the boiler supplier:-

- (a) Boiler MCR at the specified steam, feed and fuel conditions, taking account of the required blowdown.
- (b) Steam quality at MCR and specified part loads, at the maximum allowed boiler water TDS.
- (c) Steam temperature at MCR and specified part loads.
- (d) Excess combustion air at MCR and specified part loads.
- (e) Steam consumption of steam-atomising burners.
- (f) Solids burden and other contaminants, e.g. NO<sub>x</sub>, in flue gases released to atmosphere when firing the specified fuel(s).
- (g) Overall thermal efficiency when burning the specified fuel at MCR, with a specified radiation and unaccounted loss declared in the tender.
- (h) Flue gas velocity and temperature at the boiler supplier's defined terminal point.
- (i) Electrical power or steam consumption at MCR on ancillary equipment in the boiler supplier's scope.
- (j) Generated noise level in accordance with 4.7 of this Guidance for Specification.

## 3. INFORMATION FROM SUPPLIER

\* 3.1 The supplier shall provide the following documentation for approval by BP:-

- (a) With the proposal
  - (i) General specification.
  - (ii) Statement of design code compliance.
  - (iii) Outline arrangement and cross-sectional drawings of boiler, ducting and stack, showing burner and platform location.



- (iv) Specification of burner type, layout, model, size and manufacturer.
- (v) Soot blower type, location, manufacturer and arrangement.
- (vi) Guarantees as required by 2.4 of this Guidance for Specification.
- (vii) Noise information as required by 4.7 of this Guidance for Specification.
- (viii) Statement of maximum permitted boiler water TDS.
- (ix) Statement of furnace positive and negative pressures.
- (x) Furnace maximum and average heat flux density.
- (xi) Heat flux to cause 'departure from nucleate boiling' (DNB).
- (xii) Furnace flue gas exit temperature.
- (xiii) Method of fuel consumption and thermal efficiency tests, with correction formulae, curves, etc. used in the calculations.
- (xiiii) Statement of percentage radiation loss for the whole boiler.

(b) Prior to order

- (i) Individual specification data sheets for fans and other ancillary equipment.
- (ii) Recommended spares list for 12 months operation.
- (iii) Specifications for instrument piping and cable.
- (vi) Design and construction of flue gas dampers.
- (v) Burner fuel gas flow rate and automatic control.
- (vi) Breakdown of total feedwater pressure requirement.

*Items (ii) and (vi) may be deferred by agreement with BP.*

(c) During design and prior to manufacture

- (i) Valve data sheets for HP steam, feedwater, safety relief and pressure-reducing over 14 bar (203 psig).
- (ii) Details of connections and conditions at supply limits
- (iii) Specifications, individually completed data sheets (including process performance, constructional and test data) and cross-sectional drawings, for all machinery.
- (iv) Local control panel layout and location.
- (v) List of instrument makes and models.
- (vi) Schematic and hook-up drawings of emergency shutdown systems and automatic trip systems, burner management and controls, accompanied by a detailed description of operation.
- (vii) Foundation general arrangement and details.



- (viii) Cable trench layout and details.
  - (ix) Structure loading under various design conditions, together with design stresses.
  - (x) Piping specifications.
  - (xi) Welding procedures.
  - (xii) Design details and mode of operation for isolating plates in common ducting or stack.
  - (xiii) Burner flame detection equipment
  - (xiiii) Lighting levels at burner and access platforms and stairways.
  - (xv) Design of stack duct entries.
  - (xvi) Winterisation proposals for plant protection.
  - (xvii) Any special type screwed pipework fittings.
  - (xviii) Flue gas ducting internal lining.
- (d) Prior to operation
- (i) Plant operating manual, at a date after any order to be specified by BP.

## 4. BASIC DESIGN

### 4.1 General

- 4.1.1 Combustion air shall be provided by a forced draught fan. This may operate at either one or two fixed speeds, as may be selected by the supplier.
- 4.1.2 The flue gas velocity in the tubes shall be not less than 6 m/s (20 ft/s) at maximum turndown.

### 4.2 Steam Quality

- 4.2.1 The dryness of the steam leaving the boiler shall be not less than 95% when the steam is for process use or tank heating, etc., not less than 99% dry when used in turbines.
- 4.2.2 A steam separator shall be provided at the boiler steam outlet, to obtain maximum dryness of the steam under all specified conditions of load and load changes.
- 4.2.3 The velocity of the steam leaving the boiler water surface shall not be greater than 0.06 m/s (0.2 ft/s).
- \* 4.2.4 BP will specify the purity of the steam required, and the boiler designer shall state the maximum TDS in the boiler water at which the steam purity can be maintained.



### 4.3 Pressure Parts

- 4.3.1 All pressure parts, unless approved otherwise by BP, shall be constructed in carbon steel of a quality such that neither pre nor post weld heat treatment is required.
- \* 4.3.2 Welding procedures shall be approved by BP and the requirements of BP Group [GS 118-3](#) and BP Group [GS 118-5](#) shall be met.
- 4.3.3 Facilities shall be provided to enable inspection of internal surfaces without recourse to cutting and rewelding.
- 4.3.4 Manhole, headhole and handhole covers shall be of the internal type and meet the requirements of [BS 470](#) or equivalent national standard.
- 4.3.5 Extended surface designs shall not be used
- \* 4.3.6 Insulation material will be specified by BP, and shall be applied in sufficient thickness to prevent any part of the casing from buckling, to reduce radiation losses to an economic minimum and to ensure personnel protection.
- BP Group [RP 52-1](#) gives guidance on thermal insulation.*
- 4.3.7 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.
- 4.3.8 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.
- 4.3.9 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.
- 4.3.10 Superheater tubes shall be to [BS 3059](#) or equivalent national standard.
- 4.3.11 Internal pipework which is the responsibility of the boiler supplier, shall be based generally on [ANSI B 31.3](#) for fuel piping, [BS 806](#) for steam piping, or other equivalent national standards. Exceptions may be made where necessary to meet special requirements and any such exceptions shall be stated.



- 4.3.12 Flanges shall be kept to the minimum consistent with maintenance requirements and, other than terminal flanges, be of steel to [BS 4504](#) or equivalent national standard. Steel screwed-boss flanges shall not be used. All flanges shall be raised face type.
- 4.3.13 Terminal flanges connecting to external pipework shall be of the raised face type complying with [ANSI B 16.5](#) or [BS 1560](#), adopting the pressure/temperature ratings of [ANSI B 16.5](#) or national equivalent.
- 4.3.14 Gaskets and jointing shall be to BP Group [GS 142-7](#)

*BP Group [RP 42-2](#) gives guidance on Bolting.*

- 4.3.15 Pipework shall use pipes or tubes to [BS 3601](#), [3602](#) or [3604](#) according to the duty concerned, or to the equivalent national standard.

#### **4.4 Boiler Mountings, Valves, Gauges and Safety Fittings**

- 4.4.1 Mountings, valves, gauges and safety fittings shall be in accordance with [BS 759](#), [ASME Boiler and Pressure Vessel Code](#) Section I, [ISO R831](#), or to the equivalent national codes of the country in which the boiler is to be installed.
- 4.4.2 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.
- 4.4.3 Boiler isolation from the range shall be to double-isolation standard. As a minimum, a block valve and screwdown non-return valve and a drain shall be provided.
- 4.4.4 Subject to BP approval, bronze valves may be used where it is the boiler supplier's standard fitting and well proven for its particular duty. This shall not include steam and feed duties.
- 4.4.5 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.
- 4.4.6 Valve bonnet covers shall be of the bolted type, unless otherwise specified by BP.
- 4.4.7 Back-seating valves shall be used, unless otherwise specified by BP.



- 4.4.8 The boiler shall have an internal feed water distribution pipe.
- 4.4.9 Two blowdown valves, of a size depending upon the size of the boiler, shall be fitted at the bottom of the boiler water space.
- 4.4.10 An air cock shall be fitted to the top of the boiler shell.
- 4.4.11 An anti-syphon valve shall be provided to prevent the boiler filling with water as the internal pressure falls during shutdown operations.
- 4.4.12 Boiler shell fittings necessary to ensure control of circulation and the production of steam quality as specified, such as nozzles, baffles, separators and scrubbers, etc., shall be provided. All shall be of robust design and, although securely fixed, must be easily removable for inspection purposes.

#### **4.5 Burners**

- \* 4.5.1 Fuels to be used and conditions of supply will be specified by BP. Heating for fuel oil shall be provided as necessary so that the viscosity required at the burners can be achieved at all times.
- 4.5.2 Liquid fuels shall be filtered through mesh of nominal 0.25 mm (0.01 in) aperture for heavy fuel oils and 0.18 mm (0.007 in) 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 gauge shall be provided across the filters.
- 4.5.3 Steam-atomised, 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-atomised burners are used, the boiler designer shall justify any steam consumption greater than 0.5% of boiler MCR.
- 4.5.4 During the works tests the opportunity shall be taken to measure the noise levels of the combustion equipment, etc.
- 4.5.5 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 (3 to 5 psig), for which the gas supply shall be from a source independent of the main fuel. Each pilot burner shall incorporate an electric igniter 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.



- 4.5.6 Both main and pilot burner shall have proven flame detection equipment responsible for controlling fuel admission and cut-off to their respective burners.
- 4.5.7 Fuel gas burners shall be of the multi-spud or gun type. The provision of the facilities for the burning of fuel gas shall meet the requirements of the Institution of Gas Engineers Communication 1000, or any national equivalent standard of the country in which the boiler is to be installed.
- 4.5.8 When both liquid and gaseous fuels are specified, all burners shall be capable of burning satisfactorily any of the fuels separately or simultaneously.
- 4.5.9 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.
- 4.5.10 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 1 ½- 2% for liquid fuels and 3 - 3 ½% for gaseous fuels, over the turndown range of 50 - 100% MCR.
- 4.5.11 For boilers above 4.5 tonne/h (10,000 lb/h) capacity, the burner turndown shall not be less than 4:1, provided that where steam superheaters are fitted, the steam flow shall always be adequate to prevent overheating of any element.
- 4.5.12 Unburnt carbon in the flue gas shall not be greater than 0.05% wt. of the fuel, or such limits as laid down by local authorities.
- 4.5.13 Carbon monoxide in the flue gas shall not be greater than 0.01% by volume at specified  $O_2$  content in flue gases.
- \* 4.5.14 The Smoke Index Number shall not be greater than Shade 1 on the Ringelmann scale. During periods of bringing the boiler on load, when sootblowing, or during periods of severe load fluctuation, emission of smoke shall not exceed Shade 2, or such limits as will be specified by BP or as laid down by local authorities.
- The total particulate emission shall be within the limits specified by BP, which will in any case be not more than  $0.115g/m^3$  (0.05 grains/ $ft^3$ ) of flue gas at specified  $O_2$ .
- 4.5.15 The pilot flame shall be visible through the burner peep- hole, at least prior to the ignition of the main flame, and shall be monitored by a reliable flame detector, preferably of the ionisation 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.

- 4.5.16 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.
- 4.5.17 Duplex type filters, or two filters in parallel, of 125 microns (5 x 10<sup>-3</sup> in) 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.
- 4.5.18 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 stabiliser and the root of the flame.
- 4.5.19 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.
- 4.5.20 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 shut-off and no external leakage over the full operation period between boiler overhauls which shall be taken as 26 months. Valves shall preferably be of the ball valve type to [BS 5351](#) 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.
- 4.5.21 Where gas only will be fired, the system shall be so arranged as to reduce automatically the fuel gas flow rate to each burner, during the ignition and proving stages. The boiler designer shall inform BP of the flow rate proposed and how he intends to provide the automatic control of the fuel flow without affecting those burners already in operation.

- \* 4.5.22 Before the first burner on a boiler can be ignited, an adequate purge of the furnace and gas passes shall be automatically carried out. The air flow rate and duration of this purge procedure shall be agreed between the boiler designer and BP, and this will depend upon the shape of the furnace and complexity of the flue gas passes. The air flow shall not be less than 25% of MCR air flow for a period of at least 5 minutes with all air registers open, or for such a length of time as to give at least five volume changes of the furnaces and flue gas passes up to the exit, whichever is greater.
- The purge procedure shall be an inescapable action prior to start-up of the first burner on every occasion, i.e. one which the operator cannot override, reduce in flow rate or shorten in duration.
- 4.5.23 After purging, the sequence of events of start-up shall embody the following principles'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 close bleed valve.
- \* 4.5.24 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 BP, coloured lamps on the panels shall indicate the status of burners.
- 4.5.25 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 draught.



- (e) Loss of induced draught.
  - (f) Loss of main burner flames (individual burner fuel cut off).
  - (g) Loss of atomising 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). Refer to 4.6 of this Guidance for Specification.
  - (i) Loss of electric power supply (start-up conditions only; 'fail-locked' would operate when on load). Refer to 4.6 of this Guidance for Specification.
- 4.5.26 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 shut-off valves.
- 4.5.27 Fuel oil and fuel gas pipework shall have electrical tracing, thermostatically controlled.
- 4.5.28 Atomising steam lines shall be lagged separately from fuel lines.
- 4.5.29 The atomising 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.
- 4.6 Instruments, Controls and Safety Equipment**
- \* 4.6.1 Where boilers are required for critical duties and specified as such by BP, 'fail-locked' shut-down systems shall be provided on loss of electrical power or instrument air supply. In other cases 'fail-safe' shut-down systems are required.
- 4.6.2 Where 'fail-locked' control circuits are specified, digital signals shall be used. Provision shall also be made for local tripping of critical equipment.
- 4.6.3 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

- \* 4.6.4 Controls may be pneumatic or electronic, or a combination of both, as BP may specify, but they must, together with all safety equipment and instruments, meet the requirements of the national and local authorities of the country in which the boiler is to be installed.
- 4.6.5 Solid state burner management equipment shall be used unless BP specifies or agrees otherwise.
- \* 4.6.6 The boiler supplier 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 BP for approval before placing orders.
- \* 4.6.7 The boiler designer shall be responsible for the auxiliary equipment necessary to raise and control the temperature and/or pressure of the liquid fuels to the boiler if the conditions at which the fuels are to be supplied are not satisfactory for the burners he intends to use. Duplicate fuel pumps and heaters shall be provided, when specified by BP.
- 4.6.8 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.
- 4.6.9 For boilers of up to 4.5 tonne/h (10,000 lb/h) capacity the fuel may be controlled at two firing rates, one high and one low related to boiler steam pressure band over which the burner is controlled shall normally be no more than 5% of the operating pressure, unless otherwise agreed with BP.
- 4.6.10 Above 4.5 tonne/h (10,000 lb/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 on 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.
- 4.6.11 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 and the British Gas Code of Practice for Large Gas and Dual Fuel Burners - [Report No. 1M/7](#).



- 4.6.12 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.
- 4.6.13 For boilers of 4.5 tonne/h (10,000 lb/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 (10,000 lb/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.
- 4.6.14 Two direct-reading water level gauges 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.
- 4.7 Noise Limitations**
- 4.7.1 Noise limits will normally be specified in detail in the enquiry. However, in the absence of such requirements, noise levels at, or further than, 1 m (3ft) from equipment surfaces shall not exceed 87 dB(A).
- 4.7.2 The boiler supplier shall provide details of the noise emission in octave bands from his equipment, obtained by the methods of test as specified in [OCMA Specification NWG-1](#) or a method of test agreed with BP.
- 4.7.3 The supplier shall also provide details of any narrow-band or impulsive noise emitted by his equipment, which is noticeable to the ear, and the octave band or bands in which it occurs.
- 4.7.4 When the boiler supplier cannot meet the noise limits without the addition of noise attenuation measures, the levels with and without these measures shall be stated in the proposal. Any noise attenuation measures proposed by the supplier shall not conflict with the other requirements of this Guidance for Specification.

## **4.8 Boiler Feed Pumps**

- \* 4.8.1 BP will specify what standby feed pump capacity is required, if the pumps are to be in the boiler designers supply. Automatic start-up of standby pumps shall be arranged, together with alarms.
- \* 4.8.2 Boiler feed pumps when supplied, shall be in accordance with a Standard to be agreed by BP.
- 4.8.3 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.
- 4.8.4 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.
- 4.8.5 Feed water pumps on modulated feed control shall have a capacity of 110% of MCR.
- 4.8.6 Feed water pumps on an ON/OFF system of feed control shall have a capacity in the range 125-175% of MCR.

## **5. ELECTRICAL EQUIPMENT**

- \* 5.1 Detailed requirements for electrical equipment shall be as specified by BP in an accompanying specification,  
  
*BP Group [RP 12-1](#) gives guidance on electrical aspects.*
- 5.2 Unless otherwise specified by BP, all electrical equipment attached to or closely associated with the boiler shall be of the normal industrial standard suitable for 'non-hazardous' areas, except for items on the fuel systems that have only one seal between the fuel and the electrical components, e.g. motorised valves and pressure switches on fuel lines. Such electrical items shall be at least to Zone 2 standard.
- 5.3 Gauges for water level, steam pressure and fuel pressure, shall be provided with local lighting, but the provision of lighting to the boiler area generally will be the responsibility of BP.



## **6. BOILER FEED AND BOILER WATER QUALITY AND CHEMICAL CONDITIONING**

- \* 6.1 Boiler feed water treatment shall be as specified separately by BP in an accompanying specification.
- \* 6.2 BP will specify the quality of the boiler feed water available, including condensate if intended to be used.
- 6.3 The boiler designer shall notify BP of any objection or any difficulties he may foresee in using the specified water, and shall recommend to BP any further treatment or conditioning of the feed water he considers necessary or advisable.
- 6.4 The recommended maximum TDS in the boiler water shall be stated by the boiler designer.
- 6.5 Unless otherwise agreed by BP, all blowdowns shall be led to a blowdown drum with atmospheric venting and spray cooling as necessary. Each boiler shall be provided with its own blowdown drum. Continuous and intermittent blowdown shall be provided and separately routed to the blowdown drum.
- \* 6.6 Any necessary chemical mixing and injection equipment shall be included by the boiler supplier, and BP will specify the required extent of duplication of equipment such as injection pumps and chemical mixing tanks.
- \* 6.7 BP will specify the type of container to be used for delivery of chemicals. All equipment necessary for the safe handling and storage in a closed system of hazardous chemicals shall be provided local to the injection pumps.
- 6.8 Water sampling points for both boiler feed and boiler water, complete with coolers, shall be provided.
- 6.9 For boilers intended to operate at low or zero solids in the boiler water, the quality of the boiler water shall be continuously monitored and recorded, including pH, conductivity before and after an ion exchange vessel, residual ammonia level, and any other condition which might indicate a change in water quality of any serious consequence. Appropriate alarms at a control position shall be provided.



## 7. STACKS

- \* 7.1 Detailed requirements for stack design shall be as specified by BP in an accompanying specification.

## 8. FOUNDATIONS

- \* 8.1 General requirements for foundations shall be as specified by BP in an accompanying specification.

*BP Group [RP 4-3](#) gives guidance on Civil Engineering aspects*

- \* 8.2 The boiler supplier shall provide the foundation loads and data as required by the Civil Engineer nominated by BP, who will approve the foundation design.

## 9. CHEMICAL CLEANING

- \* 9.1 Boilers shall be given an alkaline boil-out before being commissioned. The procedure shall be subject to BP approval.

9.2 In cases where a boiler has been stored in a corrosive environment without adequate protection and the waterside surfaces are rusting, the interior shall be cleaned by a chemical cleaning method based on the requirements of BP Group [GS 156-3](#) dealing with water-tube boilers, unless specified otherwise by BP.

## 10. SOLIDS EMISSION IN FLUE GASES

10.1 Emission of solids in the flue gases from a boiler burning fuel oil must meet the requirements of national or local authorities of the country in which the boiler is to be installed.

10.2 Where there are no specific national or local authority set limits or guidelines, the emission from boilers with MCR's up to 18 tonne/h shall be no greater than 0.4% wt of the fuel burned at MCR. The emission from boilers in the range 18 tonne/h to 230 tonne/h shall decrease from 0.4% wt at the lower end to 0.2% wt at the top of the range.

10.3 Sampling shall be carried out in the chimney or as near to the chimney as possible. If the plant includes a grit arrestor, then sampling shall be before the arrestor. If the arrestor is so placed that this cannot be done, then sampling shall be done after the arrestor and, during the period of test, the weight of the grit and dust collected shall be determined.



- 10.4 Samples shall be taken at a minimum of four points uniformly distributed across the section, and shall be isokinetic. Three results shall be obtained, the mean value representing the measured value. During these periods of measurement the excess  $O_2$  in the flue gases shall be as specified for the boiler.
- 10.5 If there is the possibility that, with the proposed fuel and burners, the solids emission will exceed that allowed, then cyclones shall be fitted in the chimney base, or other convenient position, to reduce the emission to an acceptable level.

## 11. TESTING

The boiler supplier shall provide all the equipment and instruments needed to carry out the tests and shall be responsible for obtaining calibration certificates.

### 11.1 Thermal Efficiency

- 11.1.1 The boiler's thermal efficiency shall be tested against the guarantee, on at least one of the type and number of boilers newly-installed.
- \* 11.1.2 The thermal efficiency shall be determined in accordance with [BS 2885](#), or an equivalent national standard, by the heat-loss method, unless otherwise specified by BP.
- \* 11.1.3 If there are accurate means for determining the actual quantity of fuel used during the test, and its quality is constant, then BP may decide to use the heat input/heat output method to ascertain the boiler efficiency. The method to be used shall be agreed between the boiler supplier and BP prior to contract when, at the same time, the supplier shall state the R and U losses and submit all correction formulae, graph curves, etc. to be used in the calculations, for approval by BP.

### 11.2 Steam Purity

- 11.2.1 Tests shall be carried out as soon as possible after commissioning to ascertain:-
- (a) The steam dryness fraction.
  - (b) That the purity of the steam meets the guarantee under the declared conditions of boiler water, TDS, boiler load, steam drum water level and normal water level fluctuations.
  - (c) The limits of adverse conditions such as high TDS, high water level, high silica content and severe load swings, which might cause a deterioration in steam quality beyond that acceptable.



### **11.3 Solids Emission in Flue Gases**

11.3.1 Tests shall be undertaken to prove that the total particulate matter in the flue gases, discharged by the boiler to air, does not exceed the amount specified (refer also to Section 10 of this Guidance for Specification).

### **11.4 Gas Tightness of Ducting**

11.4.1 During pre-commissioning, the ductwork shall be visibly leak tight when tested with smoke bombs under a positive pressure of at least 12 mm (½in) water gauge. The supplier shall provide all the equipment necessary for this test.

## **12. PAINTING**

12.1 Painting shall be in accordance with BP Group [GS 106-2](#).

12.2 Colour codes for the various steam lines, fuel pipes, water services, etc. shall be to the requirements of the national codes of the country in which the boiler is to be installed, or as specified by BP.

## **13. SPARES**

- \* 13.1 Detailed requirements for spares shall be as specified by BP in an accompanying specification.
- 13.2 Spares shall be considered in 3 categories as follows:-
  - (a) Pre-Commissioning
  - (b) Commissioning
  - (c) Permanent
- 13.3 The supplier shall specify in his proposal all pre-commissioning spares (category (a) above).
- \* 13.4 The supplier shall submit, prior to any order, a list of commissioning spares (category (b) above). These will include consumable spares for 12 months operation and spares for installation at the first overhaul. BP will approve this list before ordering.
- \* 13.5 The supplier shall submit, prior to pre-commissioning work, a complete spares manual, to include all spares recommended as permanent stock.



This will also be subject to approval by BP who will specify the manual format to be used.

#### **14. WINTERISATION**

- \* 14.1 In general, all plant and equipment, including auxiliaries, shall be protected against damage or inability to operate under the winter conditions specified or agreed by BP for the location concerned.
- \* 14.2 Detailed requirements for winterisation shall be as specified by BP in an accompanying specification.

*BP Group [RP 44-2](#) gives guidance on winterisation.*



**DEFINITIONS AND ABBREVIATIONS**

**Definitions**

Standardised definitions may be found in the BP Group RPSEs Introductory Volume

- |                 |   |                                                                                             |
|-----------------|---|---------------------------------------------------------------------------------------------|
| Boiler Designer | - | The Company responsible for the design of a boiler                                          |
| Boiler Supplier | - | The Company responsible for the supply of a boiler, who may not necessarily be the designer |

**Abbreviations**

|                |                                          |
|----------------|------------------------------------------|
| ANSI           | American National Standards Institute    |
| ASME           | American Society of Mechanical Engineers |
| BS             | British Standards                        |
| DNB            | Departure from Nucleate Boiling          |
| HP             | High Pressure                            |
| O <sub>2</sub> | Oxygen                                   |
| R and U        | Radiation and Unaccounted                |
| TDS            | Total Dissolved Solids                   |



**LIST OF REFERENCED DOCUMENTS**

A reference invokes the latest published issue or amendment unless stated otherwise.

Referenced standards may be replaced by equivalent standards that are internationally or otherwise recognised provided that it can be shown to the satisfaction of the purchaser's professional engineer that they meet or exceed the requirements of the referenced standards.

**International Standards**

[ISO R831](#) Rules for the construction of Water Tube Boilers (Technische Regeln für Dampfkessel)

**British Standards**

[BS 470](#) Access and Inspection Openings for Pressure Vessels  
[BS 759](#) Valves, Gauges and Other Safety Fittings for Application to Boilers and to Piping Installations for and in Connection with Boilers  
[BS 799](#) Oil Burning Equipment, Parts 3 and 4  
[BS 806](#) Ferrous Piping Systems for and in Connection with Land Boilers  
[BS 1560](#) Steel Pipe Flanges and Flanged Fittings for the Petroleum Industry  
[BS 2486](#) Recommendations for Treatment of Water for Land Boilers  
[BS 2790](#) Shell Boilers of Welded Construction (Other than Water-Tube Boilers), Parts 1 and 2  
[BS 2885](#) Code for Acceptance Tests on Stationary Steam Generators of the Power Station Type  
[BS 3059](#) Specification for Steel Boiler and Superheater Tubes  
[BS 3601](#) Steel Pipes and Tubes for Pressure Purposes ; Carbon Steel with Specified Room Temperature Properties  
[BS 3602](#) Specification for Steel Pipes and Tubes for Pressure Purposes ; Carbon and Carbon Manganese Steel with Specified Elevated Temperature Properties  
[BS 3604](#) Specification for Steel Pipes and Tubes for Pressure Purposes: Ferritic alloy steels with Specified Elevated Temperature Properties  
[BS 4504](#) Flanges and Boltings for Pipes, Valves and Fittings, Metric Series  
[BS 5351](#) Shell Ball Valves for the Petroleum, Petrochemical and Allied Industries.



## American Standards

|                             |                                                           |
|-----------------------------|-----------------------------------------------------------|
| <a href="#">ANSI B 16.5</a> | Steel Pipe Flanges and Flanged Fittings                   |
| <a href="#">ANSI B 31.3</a> | Chemical Plant and Petroleum Refining Piping              |
| <a href="#">ASME</a>        | Boiler and Pressure Vessel Code, Section 1 -Power Boilers |

## BP Group Documents

|                             |                                                                                                                                          |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <a href="#">BP GS 106-2</a> | Painting of Metal Surfaces                                                                                                               |
| <a href="#">BP GS 118-3</a> | General Standard for Welded Fabrication and Construction                                                                                 |
| <a href="#">BP GS 118-5</a> | The fabrication, assembly, erection and inspection of carbon, Carbon manganese and Low alloy Ferritic Steel pipework to ANSI/ASME B31.3. |
| <a href="#">BP RP 52-1</a>  | Thermal Insulation                                                                                                                       |
| <a href="#">BP GS 142-7</a> | Supply of Gaskets and Ring Joints for Bolted Flange Joints                                                                               |
| <a href="#">BP RP 12-1</a>  | Electrical Systems and Installations - General                                                                                           |
| <a href="#">BP GS 156-3</a> | Water-Tube Boilers                                                                                                                       |
| <a href="#">BP RP 44-2</a>  | Winterisation - Low Temperature Protection measures                                                                                      |
| <a href="#">BP RP 4-3</a>   | Civil Engineering                                                                                                                        |
| <a href="#">BP RP 42-2</a>  | Bolting for Flanges Joints                                                                                                               |

## Industry Documents

|                            |                               |
|----------------------------|-------------------------------|
| <a href="#">OCMA NWG-1</a> | Noise Procedure Specification |
|----------------------------|-------------------------------|

## Others

(Available from the Custodian of this document)

Association of Shell Boilermakers Publication “The Treatment of Water for Shell Boilers”

Safety Standards for Large Burners: New Criteria for Burner Start Up - The Institution of Gas Engineers Communication 1000

British Gas Code of Practice for Large Gas and Dual Fuel Burners - Report No. IM/7

