ENGINEERING AND MATERIAL STANDARD

FOR

WATER TUBE BOILERS

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APPENDICES:

1. SCOPE

1.1 This Standard covers the minimum requirements for engineering, material, installation, fabrication, inspection and preparation for shipment of water tube boilers and accessories.

1.2 Boilers covered in this Standard are intended to be suitable for heavy duty uses in, oil and gas refineries, petro-chemical plants and other oil industry applications where necessary.

These boilers shall be designed for outdoor uses which automatically can be satisfactorily used for indoor applications, when required.

1.3 This Standard specifies general requirements for design, fabrication, cleaning, testing and painting of water-tube type steam generating plants. This includes integral steel tube economizers and superheaters, and all parts connected to the pressure parts of the boiler without the interposition of a shut-off valve and other ancillary equipment. Natural, forced, assisted, controlled-circulation and once through boilers are included. These may be for use either in a central power station or in an installation for supplying steam directly to a process plant.

1.4 Boilers shall be constructed to ASME Boiler & Pressure Vessel Code Section 1, BS 1113 shall be subject to prior approval by Company.

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 STANDARDS INSTITUTE)

B 16.5	"Pipe Flanges and Flanged Fittings"
B 16.11	"Forged Steel Fittings, Socket-Welding and Threaded"

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

Boiler and Pressure Vessel Code Section I	
PTC	"Performance Test Code"
ASME/AWS D1.1	"Structural Welding Code-Steel"

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

A 193	"Standard Specification for Alloy-Steel"
D 1066	"Method for Sampling Steam"
D 1125	"Test Methods for Electrical Conductivity and Resistivity of Water"
Publication	"Special Technical Publication No. 148"

AGMA (AMERICAN GEAR MANUFACTURERS ASSOCIATION)

420.03	"Standard Practice for Helical and Herringbone Gear Speed Reducers and Increasers"
421.05	"Standard Practice for High Speed Helical and Herringbone Gear Units"

BSI (BRITISH STANDARDS INSTITUTION)

BS 449	"Specification for the Use of Steel in Building"
BS 476	"Method for Determination of the Fire Resistance of Elements of Construction"
BS 1113	"Specification for Design and Manufacture of Water-Tube Steam Generating Plants"
BS 2885	"Code for Acceptance Test on Stationary Steam Generators of the Power Station Type"
BS 3059	"Steel Boiler and Superheater Tubes"

IPS (IRANIAN PETROLEUM STANDARDS)

C-PI-100	"Piping Specification"
E-CE-120	"Foundations"
E-CE-260	"Fire Proofing"
E-EL-110	"Electrical Area Classification & Extent"
E-SF-400	"Fire Protection of Stairs, Ladders and Platforms"
E-SF-860	"Air Pollution Control"
E-SF-900	"Noise and Vibration Control"
E-TP-100	"Paints"
M-IN-280	"Miscellaneous Instruments"

ISA (INSTRUMENT SOCIETY OF AMERICA)

S.77.42	"Fossil Fuel Powers Plant, Feed Water Control System Drum Type" (1987)

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 1129	"Steel Tubes for Boilers, Superheaters and Heat Exchangers-Dimensions, Tolerances and Conventional Masses per Unit Length"

SAMA (SCIENTIFIC APPARATUS MAKERS ASSOCIATION)

PMC 22.1-1981	"Functional Diagramming of Instrument and Control Systems" (1981)

3. UNITS

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

4. GENERAL

4.1 Where there is conflict between this specification and detailed engineering drawings, or between the Vendor and the Company over the interpretation of this specification, the Company shall be called upon to make a final decision.

4.2 Where there is conflict between any additions or changes to the codes as specified in Clause 2 of this Standard and the contents of this specification, the Company shall be consulted for application of changes.

4.3 Steam boiler data sheets showing expected performance, fuel requirements and characteristics, materials of construction, etc., form a part of this specification.

4.4 Steam boiler shall be a standard unit where possible.

4.5 The boiler unit as a whole shall be designed, fabricated and mounted in a manner which will facilitate ease of maintenance.

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

4.7 The Vendor shall supply all equipment completely fabricated, assembled, tested and dismantled only to the extent necessary for inspection and practical shipping.

4.8 The boiler unit shall be of modern design and shall be selected to allow maximum interchangeability of spare parts consistent with proper performance characteristics.

4.9 Spare parts must be readily available. If a stock of parts is not maintained by the Vendor, strategic spare items shall be furnished with the unit.

5. BASIC DESIGN

5.1 Steam Quality

5.1.1 Steam drums shall be equipped internally with steam separators and scrubbers to ensure that the carry-over of total solids from the boiler water shall not exceed the following:

1 ppm up to 65 bar (950 psig)
5 ppm from 65 bar (950 psig) up to 135 bar (2000 psig)

The boiler manufacturer shall state the maximum total dissolved solids (TDS) in the boiler water at which the required steam quality can be obtained.

5.1.2 The steam as measured at the drum outlets shall have an impurity not greater than 0.02 ppm silica.

5.1.3 The wetness of the steam leaving the drum shall not exceed 0.02%.

5.2 Circulation

5.2.1 In order to evaluate the drum stability, the boiler designer shall indicate the drum water content (effective) at normal low-level and maximum continuous rating (MCR) loading.

5.2.2 The boiler designer shall state the minimum and maximum water levels between which the boiler should be allowed to continue operating.

5.2.3 Furnace wall, floor, and roof tubes shall not incorporate such bends or sets sufficiently small in radius to interfere significantly with water circulation. In particular, roof tubes exposed to radiant heat shall be free from bends and sets as far as possible, so as not to upset the division of flow between tubes or bring to a doubtful value the head available to promote circulation in any part of the circuits.

5.2.4 Downcomers supplying the furnace wall, etc., with feed water shall preferably be outside the flue gas path. If the downcomers are in contact with the flue gases, the heat transfer shall not significantly affect the circulation head.

5.3 Pressure Parts

5.3.1 All pressure parts, wherever reasonably possible, shall be constructed in carbon steel of a quality such that neither pre nor post weld heat treatment is required. The boiler supplier shall inform company in his proposal where higher grade material is proposed. Drums of high-tensile, low-ductility steel shall not be used where the thickness of the drum would otherwise be less than 75 mm.

5.3.2 Steam drums shall not be less than 0.61 m internal diameter.

5.4 Furnace

5.4.1 Furnaces shall be water cooled of membrane-wall (also referred to as mono-wall or panel-wall), or skin-cased, construction.

5.4.2 Pressurised furnaces shall be of membrane-wall construction.

5.4.3 Where the boiler design incorporates a refractory front wall around the burner area, the boiler manufacturer shall obtain the company's approval on the suitability of the method of attachment and anticipated life of this refractory.

5.4.4 Special attention shall be given to the design of burner throat refractory, whether brick, cast or plastic material applied to studded or plain tubes. Evidence of satisfactory service experience shall be submitted.

5.4.5 At least one furnace access door shall be provided with at least 600 mm diameter and designed to give efficient sealing and ease of operation over the useful life of the boiler. The sizing of the doors shall be adequate for the passage of necessary maintenance materials including internal access equipment.

5.4.6 There shall be a clear space in front of the access door to facilitate handling and entry of all materials and equipment.

5.4.7 Observation ports shall be furnished to permit visual checking of furnace and flame conditions, the furnace floor and the superheater space during operation of the boiler. Observation ports for pressurised boilers shall be furnished with a sight glass type resistant against the heat and pressure.

5.4.8 Drains shall be furnished at the low point of the boiler furnace and bank areas to permit removal of flue gas deposits by water washing. Drain openings shall be effectively sealed against flue gas bypassing and casing overheating.

5.4.9 Cavities above furnace roof tubes shall be so designed as to prevent the accumulation of gases that might form explosive mixtures. This may be achieved by purging with air, reliable sealing, or some other proven method. Access to such areas for the examination of tubes, penetration seals and hangers, etc., shall be possible during boiler inspections.

5.4.10 For site-erected boilers, the average heat release rate in the furnace, based on the net calorific value, shall not exceed the following:

for fuel oil firing: 380 kW/m^2 (120,000 Btu/ft^2h)
for fuel gas firing: 470 kW/m^2 (150,000 Btu/ft^2h)

Where high availability is required, lower heat release rates may be specified by the Company.

5.4.11 The maximum heat flux density at any localized "hot spots' shall not exceed 300 kW/m^2 (95,000 Btu/ft^2h). The boiler designer shall present with his proposal the predicted furnace heat flux distribution along the length and height of the furnace at MCR and state the maximum and average heat flux and the furnace flue-gas exit temperature.

Note:

The heat flux density is the quantity of heat passing through unit surface area in unit time and is expressed as kW/m^2 (Btu/ft^2h). The surface area shall be that of the flat projected area of exposed tubes and exposed extended surface, integral with the tube. Refractory covered surfaces shall not be included.

5.4.12 The furnace width shall enable sufficient spacing of burners to ensure burner flame discrimination by individual viewing heads and also to make certain that there is no flame impingement on the side walls. The furnace depth shall be sufficient to ensure that burner flames do not impinge on the rear wall or penetrate the screen tube arrangement.

The depth of furnace shall not be so disproportionate to the width that a significant volume of furnace is not occupied by the flame, thereby making the total projected surface area not truly reckonable for the radiant heat rate calculations.

5.4.13 Floors shall not be utilized for heat transfer and shall be effectively shielded from furnace radiant heat by refractory tiles and insulation as necessary.

5.4.14 The angle to the horizontal of floor tubes shall not be less than 15°, and the angle of roof tubes shall not be less than 5°. Where the roof tubes have to be offset for any reason, continuity of drainage should be ensured, but such offset shall be avoided where possible.

5.5 Generation Tube Banks

5.5.1 Tubes shall normally be plain, positioned in line. However, finned tubes may be used where fuel gas or distillate fuel is to be fired and if additional surface is needed which cannot be provided by installing further plain tubes. This may be the case, particularly in supplementary fired wasteheat boilers associated with gas turbines.

5.5.2 If finned tubes are proposed they shall not be used in zones where the flue gas temperature exceeds 670°C (1240°F). Fins shall be in carbon steel, continuously welded to the tubes and shall have a minimum spacing of 5 fins per 25 mm, a maximum height of 19 mm and a minimum thickness of 1.25 mm.

5.5.3 Finned tubes shall not be placed at any angle that would facilitate the accumulation of deposits. Vertical tubes may be acceptable, but their use shall be approved by Company.

5.5.4 Tube banks shall be arranged, as far as practicable, to permit access for tube renewal with minimum cutting out of serviceable tubes.

5.5.5 If low-grade fuels are to be employed and regular soot blowing is envisaged, company will specify whether provision is to be made for the off-load water washing of tube banks, with facilities for collection and disposal of effluent.

5.5.6 Flue gas baffles should preferably be water-tube walls or constructed of refractory tiles securely positioned, easily replaced and with ready access.

Where refractory baffles or protective screens are supported or reinforced with metal parts, the boiler designer shall demonstrate that the materials selected are suitable for the intended service life.

5.6 Superheater

5.6.1 Superheater tubes shall be to BS 3059 or ASME Section II or Company Approved Equivalent.

5.6.2 Self-draining type superheaters, integrated with the boiler, are preferred if these can be conveniently arranged, provided the boiler type is in all other respects suitable for the particular duty.

5.6.3 Where horizontal sections of a superheater are proposed, the span between supports shall not be so great, or the angle of inclination so near to the horizontal, that sagging of tubes will occur with the consequent collection of condensate in pockets.

5.6.4 On boilers which are required to produce a specified degree of superheat to the steam over a wide range of boiler operation, or on units where superheat temperatures are expected to be near maximum design temperature of the tube metal concerned, attemperators shall be provided. In the former case attemperation may be performed at the final outlet before the stop valve, but in the latter case the attemperator shall be positioned between the primary and secondary stages of the superheater.

5.6.5 Surface-Type attemperators shall not be used unless approved by Company.

5.6.6 Spray-Water type attemperators shall be used, provided that there is a supply of demineralized water of suitable quality for this duty. Spray-Type attemperators must not be capable of blocking the steam flow through the superheater in the event of mechanical failure.

5.6.7 Where interstage de-superheating is used, the downstream construction material shall be capable of temporarily withstanding the resulting higher temperature, should the spray water supply fail.

5.6.8 If the proposed tube metal temperature or fuel constituents require higher grades of steel to be used, a nominal 9% chromium, 1% molybdenum steel is preferred to the austenitic steels.

5.6.9 Metal temperatures shall not be high enough to allow corrosion to take place in the presence of vanadium and sulphur compounds, or other corrosive constituents resulting from the use of the specified fuels.

5.6.10 To monitor metal temperatures during boiler start-up, skin thermocouples shall be secured to the tubes at appropriate points. These thermocouples and their connecting leads shall be so positioned and protected that they will not suffer rapid deterioration by exposure to the flue gases or radiant heat of the furnace. Any requirement for tube skin thermocouple details will be specified by Company.

Junction boxes shall be located against the insulation of the external plating of the boiler or some other convenient position where they will be protected against the heat of the furnace.

5.6.11 To prevent overheating of tubes during steam pressure raising, superheater drains shall be arranged to facilitate removal of condensate from the appropriate points and the final superheater drain shall be large enough, together with any additional blow-off vent, to ensure sufficient flow of steam through the superheater to prevent overheating of tubes. Such drains and vents shall be equipped with silencers, unless routed to a blowdown drum.

5.6.12 Hangers, which should be cooled where possible, and spacers shall be of such material and design that overheating will not occur during start-up or normal operation of the boiler, up to 110% MCR. Where tubes or supports pass through baffles on the furnace roof, efficient and durable seals shall be provided. The materials shall be selected to give the intended service life.

5.6.13 Air vents shall be provided where necessary.

5.6.14 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% MCR.

5.7 Refractory, Insulation and Casings

5.7.1 Refractory shall only be used where it is absolutely necessary. Where used, it shall be a proven design feature and of a quality of material and construction appropriate to the duty involved. It should not be of lower quality than 42% alumina.

5.7.2 The furnace wall and floor refractory shall be suitable for use at the temperatures concerned, subject to a minimum of 1450°C (2640°F). The boiler designer shall state the thermal conductivity of the materials he proposes for use.

5.7.3 Where brickwork is installed, the mortar joints shall not be thicker than 2.5 mm.

5.7.4 Insulation shall be applied in sufficient thickness to prevent casing distortion, to reduce radiation losses to an economic minimum and to ensure personnel protection. The percentage radiation loss for the whole boiler shall be stated in the proposal.

5.7.5 Outer casings shall be of metal, not less than 1.5 mm thickness, of adequate stiffness and be capable of being easily removed and replace without damage or requiring extensive dismantling of equipment, pipework, etc. The method of fixing shall, whenever economical, be suitable to withstand repeated removal and replacement without deterioration, cutting and rewelding. Each sheet of cladding shall be independently supported.

5.7.6 Outer casings shall be corrosion-resistant and shall not support combustion in the event of fire. Aluminum and its alloys shall not be used.

5.7.7 Casings shall be designed to prevent escape of the flue gases or the circulation of gases into cool sections of the casings or structural steelwork, thereby creating conditions for internal or external corrosion. The temperature of the casing plus attachment shall be maintained above the dew point of gases by the installation of adequate external insulation. The above is particularly important on pressurized furnaces.

5.7.8 The design of casings for balanced draught furnaces shall preclude the influx of air, so as to ensure maintenance of the required combustion excess air throughout the entire setting.

5.8 Integral Pipework

5.8.1 All integral pressure pipework shall be designed and constructed in accordance with one of the following: BS 1113, ASME Boiler and Pressure Vessel Code Section 1, ISO 1129 or to the national design requirements.

5.8.2 The pipework shall be welded, with flanges provided only at valves and fittings used for pressures up to 45 bar (ANSI Class 300). Above this pressure, flanges shall be eliminated altogether unless company specifies or agrees otherwise. Control valves may be an exception to this requirement, as specified or agreed by company.

5.8.3 For pressures above 45 barg (ANSI Class 300), only integral or weldneck flanges shall be used for those connections where flanges cannot be eliminated.

5.8.4 Flanges shall comply with ASME/ANSI B 16.5, or equivalent national standards. All flanges shall be raised face type and no screwed flanges shall be used.

5.8.5 Flanges on pipework used for fuels shall be minimum ANSI Class 150.

5.8.6 Screwed connections and unions shall not be used unless the fittings are of a special type approved by company.

5.8.7 Socket-welding fittings and screwed fittings, where permitted, shall be in accordance with ASME/ANSI B 16.11, as applicable.

5.8.8 The feed water system arrangement shall be such that the feed regulating valve, isolating valves and bypass valves can be manually operated from the floor level in the event of an emergency.

5.8.9 Drains from the boiler, superheater, economizer and soot blowers, etc., shall be operable from the floor level where practicable. Pipework shall not be positioned where it may possibly obstruct or trip operators. All clean drain pipework shall terminate at the clean drains tank. No drain or atmospheric trap shall discharge into any gulley under, or leading to, the covered areas. Any potentially contaminated stream shall be led to the blowdown system.

5.8.10 Pipework supports shall be capable of accepting the additional weight of water during the hydrostatic test.

5.8.11 When differential settlement between items of equipment may be expected, sufficient flexibility shall be provided in the connecting pipework.

5.8.12 Pipework to fans, pumps and similar equipment which may be required to be periodically removed for overhaul shall be self-supporting when the item is removed. Such supports must, whenever possible, be provided by the overhead pipe track. Individual pipe supports from grade must be minimized.

5.8.13 Valves shall be line size, except that pump discharge valves (check and block) shall be the same size as the pump discharge or greater, if the discharge is one of the sizes given in 5.8.18 of this Standard.

5.8.14 Screwed and socket-welding valves shall be of the bolted bonnet type unless otherwise specified.

5.8.15 Bolting shall be in accordance with ASTM A-193.

5.8.16 Compressed asbestos fibre jointing may be used for classes 150 and 300 duties up to 400°C (752°F). Above this temperature, and in Classes 600 and 900, spiral wound gaskets shall be used.

5.8.17 Where pipework is laid on overhead structures, in tracks or in permanent trenches, the arrangement and clearance shall permit removal of any pipe fitting or valve without the necessity to disturb adjacent pipework.

Piping systems shall be designed, and equipment laid out, to provide adequate access by mobile maintenance equipment. Access ways should be planned accordingly and minimum headroom clearances for this purpose shall be:

a) 4.5 m over railways and clearways for mobile equipment.
b) 5.5 m over access roads and where specified over clearways or heavy equipment.
c) 2 m over walkways and platforms.

The minimum clearance for walkways around pumps, fans, motors, compressors, etc., is 0.9 m. This clearance shall be measured from the furthest projection on the equipment including associated pipework, filters, valves in their open position, drains, cabling, instruments, etc. between grade and 2 m above grade.

5.8.18 Pipe smaller than 15 DN (½ in) shall not be used without agreement, except for instruments. The use of steel pipe in 32 DN (1¼ in), 65 DN (2½ in), 90 DN (3½ in), 125 DN (5 in), 175 DN (7in), 225 DN (9 in) sizes shall be avoided, except for alloy steel pipe, which may include 65 DN (2½ in) size.

5.8.19 Valves 200 DN (8 in) and above shall be fitted with double valved integral type bypasses, unless otherwise specified.

5.9 Steam Trapping

5.9.1 Steam traps shall be selected and agreed between the boiler supplier and trap supplier, according to their required duty and shall be of cast or forged steel. The trap supplier shall provide data sheets for all duties.

5.9.2 A trap size shall be based on the maximum quantity to be discharged at the minimum pressure difference between inlet and outlet.

5.9.3 No trap shall be connected to more than one steam line nor to more than one section of the same steam line.

5.9.4 Where condensate may collect downstream of closed valves, drain valves shall be provided. Traps shall not be fitted.

5.9.5 Normally, traps operating on different steam pressures shall discharge to a separate condensate collecting header but, providing the condensate line is sized to accommodate the flash steam, the discharges may be taken into a common line. Where there is condensate back-pressure, a non-return valve shall be installed in the individual condensate return lines.

5.9.6 Traps shall be supported whenever possible by the lines to which they are attached.

5.9.7 In locations specified as subject to exceptionally low temperatures, steam traps shall, where possible, be grouped together and installed on racks in steel cupboard-type enclosures so that satisfactory operation of each trap can readily be checked and frost damage to any inoperative traps prevented.

5.9.8 Any atmospheric discharge of the steam traps shall be in accordance with 5.8.9 of this Standard.

5.10 Economizer

5.10.1 Economizers shall generally be an integral part of the boiler but may be supplied as separate untis when a boiler, as a standard model design, cannot readily incorporate an economizer, or the physical limitations of the proposed site make it necessary or desirable to position the economizer away from the boiler.

5.10.2 Construction shall be steel tubes, either plain or finned. Fins may be of steel or cast iron according to the existing flue gas conditions (refer to 5.10.3 of this Standard).

5.10.3 With fuels containing no sulphur, either steel or cast iron fins may be used. With fuels containing sulphur, the metal operating temperature in contact with the flue gases shall preferably not fall below 150°C (302°F), and fins may be of steel or cast iron. Company may specify or agree flue gas temperatures down to 105°C (220°F), when cast iron fins shall be used. Designs involving any metal temperatures below 105°C (220°F) shall not be used.

5.10.4 Tube bends shall be all-welded except where feed water conditions make it necessary for frequent cleaning or inspection, in which case, for boiler pressures up to 38 barg (ANSI Class 300), steel bends shall be flanged.

5.10.5 In-Line tube arrangement is preferred. Water velocity shall be of the order of 1 m/s for water upflow circuits and 2 m/s for down-flow. Headers should preferably be external to the casing and tubes efficiently sealed where they pass through to the bends and headers.

5.10.6 Feedwater operating pressure and temperature in the economizers shall at no time permit the possibility of steam being generated. Recirculating type economizers shall not be included unless agreed by Company.

5.10.7 When economizers can be isolated on the water side, a safety relief valve shall be fitted.

5.10.8 Flue gas bypass and/or recirculating facilities shall only be provided with the agreement of Company.

5.10.9 Means for off-load water washing of economizers shall be provided on boilers firing residual fuel oils or un-sweetened gas.

5.11 Air Heater

5.11.1 Air heaters, utilizing the flue gas sensible heat to raise the temperature of the combustion air, will be accepted when there is a need to obtain higher thermal efficiencies than can be attained by an economizer alone. When an air heater is proposed the boiler designer shall satisfy company concerning the advantages of higher efficiency, considering the increased capital cost, increased maintenance costs, effectiveness of soot blowing, expected operating time, efficiency, and likely problems.

5.11.2 Air and gas bypasses shall be provided, together with proven soot blowing equipment.

5.11.3 The flue gas exit temperature from the air heater shall not be less than 120°C (250°F), but may need to be considerably higher to meet the environmental requirements. In any case the gas exit temperature shall not be less than that recommended by the air heater manufacturer who must consider the air/flue-gas temperature differential in relation to the possibility of corrosion.

5.11.4 Air heaters using surplus low-pressure steam shall be considered. The condensate discharge shall be returned to the deaerator. On-line cleaning facilitis for the finned tubes shall be provided.

5.12 Feed Heaters

5.12.1 Company will specify, or agree, the temperature at which the feed water will be available to the boiler from the deaerator, and the cost and condition of the steam which may be used for further heating of the feed water.

5.12.2 The boiler supplier shall provide a feed heater within the feed circuit of the boiler integral pipework, if it is necessary or desirable to raise the water temperature above that specified or agreed under 5.12.1.

5.12.3 The heater shall be a shell and U-tube type, unless otherwise agreed.

5.12.4 Normally, the feed heater shall be of the high-pressure type receiving water direct from the boiler feed pump. The water shall be on the tube side and the steam on the shell side.

5.12.5 A burst tube shall be considered as a design case, and safety relief provided if necessary. A non-return valve shall be fitted on the steam side at the steam inlet to prevent water entering the steam main.

5.12.6 The heater shall be provided with a bypass and isolating valves. The assembly shall be arranged for the easy removal of the shell or tube bundle for inspection, as necessary.

5.13 Draught Equipment

5.13.1 Draught fans shall be of centrifugal type, and preferably of aerofoil construction, designed for a maximum operating speed not exceeding 1500 rpm for forced-draught (FD) fans, and not exceeding 1050 rpm for induced-draught (ID) fans, having characteristics particularly suited to the duties concerned. Fans shall have design margins of +15% on capacity and +32% on pressure for an MCR basis, or +10% on capacity and +21% on pressure for a peak-load basis.

5.13.2 Fans shall provide stable operation under all conditions of boiler load, and shall have non-overloading power characteristics. Flue gas fans shall have, where necessary, self-cleaning impellers, and be resistant to abrasion. For ID and FD fans, overall efficiencies should not be less than 80%.

5.13.3 Specific attention shall be given to the fan head/volume characteristics, especially to the maximum negative head that can be experienced in the furnace and/or flue, imposed by the ID fan under emergency operating conditions. A main fuel trip (MFT), or a restriction occurring in the flue gas paths, must be considered in the design to avoid unacceptable negative pressures.

If the possible draught excursion under any of the conditions thought likely to arise with the selected centrifugal fan cannot be accommodated in the design, then an axial flow fan with variable pitch-angle blades shall be used. The stall line for this fan shall be so paced as to ensure that no unacceptable negative pressures could be applied to the furnace and/or duct. The selection of an axial flow fan will require special attention to achieve an acceptably low noise level.

5.13.4 For boilers supplying steam to process units and production plant, fan drivers shall normally be steam turbines, with the turbines exhausting to an LP steam system serving deaerators. If electric motors are used to drive the fans of such boilers, continuity of power supply shall be arranged to cover the situations where the normal power supply might fail. This may take the form of an alternative source of power supply, or a dual-drive facility at the fan shafts such as clutch-connected steam turbines or diesel engines.

5.13.5 In circumstances where boiler start-up from cold, or a hot re-start, may involve temporary loss of auxiliary steam pressure, the dual-drive arrangement of motor/steam turbine or steam turbine/diesel engine shall be considered for at least one or two of the boilers in the installation.

5.13.6 Draught regulation should preferably be effected by the use of adjustable inlet guide vanes on each fan. Regulation may alternatively be by speed control if the response rate is demonstrated to be satisfactory and shall be agreed by company.

Dampers in the ducts may be regarded as satisfactory for combustion air control to burner registers. However, single or multi-blade dampers located in the flue gas ducts shall only be used for isolating duties, or where chimney natural draught has to be modulated at low operating loads. Dampers positioned in the flue gas ducting shall be arranged to prevent complete closure during boiler operation.

5.13.7 On boilers of 200 tonne/h capacity and greater, or where a high dependence is to be placed on boiler reliability, two separate fans for both FD and ID functions should be provided unless otherwise specified. The part-duty rating,between 50% and 75%, will be considered by company in relation to the steam load reduction which can be readily made in the event of the failure of one fan. On-load isolating facilities shall be provided for each draught unit.

5.13.8 Rotor shafts of fans shall be stiff, and bearings sleevetype with forced or oil ring lubrication. Bearings shall have spherical seatings in their housings and shall be mounted on individual pedestals independent of the fan casing.

5.13.9 Where speed-regulated fans are specified, a positive means of setting the minimum speed shall be provided. The lubrication of the driver, gearbox and fan bearings shall be adequate at speeds of 90% of the minimum speed.

5.13.10 Fans shall have integral thrust bearings, and transmission of axial thrust to the prime mover bearings shall not be permitted.

5.13.11 ID fan bearings shall be water-cooled. Internal flexible water connections shall not be used.

5.13.12 Fan casings shall be sufficiently heavy gage material, stiffened as necessary, to prevent 'drumming' over the entire range of operation.

5.13.13 Shaft couplings and seals shall be capable of continuous and efficient service without maintenance, for periods of not less than 26 months.

5.13.14 Fans and their drivers shall be freely accessible for maintenance and rotor removal, and shall be mounted on foundation blocks at grade level.

5.13.15 Geared drivers shall preferably be avoided but, where gears are used, they shall be totally-enclosed. Parallel shaft gearing shall meet the requirements of:

AGMA 420.03 "AGMA Standard Practice for Helical and Herringbone Gear Speed Reducers and Increasers"
AGMA 421.05 "AGMA Standard Practice for High Speed Helical and Herringbone Gear Units"

whichever is applicable.

For high speed transmissions an epicyclic type is preferred.

5.13.16 Couplings shall be of the Metastream spacer type, or equal, capable of operating for not less than 26 months without attention.

Couplings shall be capable of accommodating misalignments, both angular and lateral, and shall allow both the driving and driven shafts to take up their individual positions against their thrust bearings without the transmission of unacceptable forces due to end-float of the shafts concerned.

5.13.17 Safety guards must be fitted to cover all exposed moving parts. They shall be easily removable for machinery maintenance.

5.14 Air and Flue-gas Ducting

5.14.1 The air and gas velocities in ducting shall not exceed 13.7 m/s (45 ft/s) and 15.2 m/s (50 ft/s) respectively, taking all internal bracing and stiffeners into account.

5.14.2 Guide vanes shall be fitted internally to ducts, e.g., at elbows and severe bends, to ensure a satisfactory air/gas flow characteristic.

5.14.3 Ducting shall be of welded construction from carbon steel, not less than 5 mm in thickness for air duties and not less than 6 mm for flue gases except as specified in 5.14.4 of this Standard.

Heavier plate shall be used, with stays and angle or tee stiffeners where duct surface areas might be conducive to drumming, or if strengthening is necessary against ID fan maximum negative head. Stays and stiffeners shall only be used internally when there is agreed economic advantage and the effect on air/gas flow is insignificant. Expansion joints shall be provided to prevent unacceptable forces and moments being transmitted to the boiler windbox, fan casing or stack, etc. and shall be capable of operating for not less than 26 months without attention. Packed gland type joints shall not be used.

5.14.4 When there is the possibility of flue gases reaching dew point temperature of any corrosive constituent, ducting shall be in metal having high resistance to corrosion or be metal coated internally, with zinc or other corrosion resistant metal sprayed onto the duct metal. The whole method and procedure to be to the approval of Company.

5.14.5 Duct anchor points shall be incorporated in the support structure to ensure that the expansion joints accommodate the duct movements.

5.14.6 Sliding supports and guides shall be designed to provide free movement without attention over a period of not less than 26 months between boiler surveys.

5.14.7 Headroom clearances under ducts shall be in accordance with 5.8.17 of this Standard.

5.14.8 Insulation shall be applied externally to duct walls, anchor supports and any other attachments, to maintain air and flue gas temperatures and for the protection of operators.

5.14.9 Access doors giving a minimum access of 600 mm × 600 mm shall be provided, where duct size permits, to facilitate access to all parts of the ducting. For smaller ducting, inspection doors shall be provided, as agreed by company. Side entry from grade level is preferred, but the erection of temporary scaffolding to gain entry is acceptable unless otherwise specified by Company.

5.14.10 Painting of steelwork external surfaces below a metal temperature of 425°C shall be in accordance with IPS-E-TP-100. Any supplementary requirements above this temperature will be specified or agreed by Company.

5.14.11 Dampers shall preferably be of the multiblade type, set in a channel frame and provided with indicators and means of positive operation from grade level. Where ducting is elevated to heights at which it is impracticable to operate the dampers from grade level by direct mechanical/hydraulic means, a caged ladder and platform shall give access to the damper operating mechanism, including the whole operating drive unit.

5.14.12 The design, material and construction of dampers shall be subject to approval by Company.

5.14.13 Materials for damper blades, shafts, and all damper components exposed to the flue gas shall be limited to a maximum service temperature as follows:

Carbon Steel	343°C
1-¼ Cr - ½ Mo	454°C
Type 321 Stainless Steel	760°C
Type 310 Stainless Steel	927°C

Special attention shall be given to ensure adequate blade clearances in the frame and adjacent ducting, under the operating and upset conditions. A suitable allowance shall be made for material expansion, differential expansion and fouling likely to occur in service.

5.14.14 Damper shafts shall be supported in self-aligning dry sleeve bearings, mounted externally to the ducting. Adequate allowance must be made for relative expansion of the components.

5.14.15 When motorized operation of dampers is to be used, control push-buttons shall be located both at grade and damper levels. A friction clutch shall be fitted to the motor shaft, and reliable limit switches incorporated. Position of damper opening shall be clearly indicated at points of operation.

5.14.16 For boilers connected to a common duct or stack shared by other boiler or process heaters, isolating plates shall be provided in each flue connection.

5.14.17 Isolating plates shall be arranged so that they operate vertically downwards to shut. Facilities to permit locking in the open position shall be provided. where it is considered that alternative arrangements to the use of isolating plates would permit significant economies to be made, these alternatives shall be approved by Company. In any case, full design details and proposed mode of operation shall be stated.

5.15 Boiler Mountings, Valves, Gages and Safety Fittings

5.15.1 Mountings, valves, gages and safety fittings shall be in accordance with ASME Boiler and Pressure Vessel Code Section 1.

5.15.2 For steam and feed water shut-off duties, parallel slide valves shall be used. All valves shall be of steel construction. Cast iron shall not be used for any valve or fitting.

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

5.15.4 All gate type 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.

5.15.5 Double valving shall be fitted in all drain and blowdown lines connected to boiler pressure parts. Isolating facilities required for maintenance of boiler or equipment without shutting down the plant shall also be equipped with double isolation valves and a vent valve.

5.15.6 Such internal fittings to boiler drums as are 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 of which shall be of robust design, suitable material and, although securely fixed, must be easily removable for inspection purposes.

At least two direct-reading level gages. One installed at each end of the drum, shall be provided, and in addition one level gage easily visible from the operating platform.

5.15.7 Safety relief valve vent piping shall be complete with drains, expansion chambers and exhaust mufflers, the latter meeting any noise level requirements of the local authorities. Safety relief valve drains shall be open-ended. They shall not be connected into a collecting system, nor present a hazard to personnel. For further information regarding the noise level see standard IPS-E-SF-900, "Noise and Vibration Control.

The safety valves shall be of the direct spring-loaded type with the springs exposed to the open air, i.e., with open bonnets. They shall be provided with lifting gear.

All safety valves shall have flanged connections. They shall be adequate to meet the requirements of the service but shall have inlet and outlet flange ratings of at least ANSI Class 300 RF and ANSI Class 150 RF respectively. Welded connections are not allowed.

Rating and adjustment of the safety valves shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section 1. Blowdown pressure shall be not more than 4% of the set pressure.

The set pressure of any boiler drum safety valve shall be at least 5% in excess of the maximum operating pressure in the drum or 2.5 bar in excess of the maximum operating pressure in the drum, whichever is the higher.

Vertical outlets, at least 2000 mm high, shall be provided for the safety valves. They shall blow off to a safe location.

All valve outlets shall be adequately supported to take care of the reaction forces. They shall have safe drainage facilities which shall prevent accumulation of water in the outlets.

5.16 Boiler Support Structure

5.16.1 The boiler support structure shall be minimized by placing equipment such as fans at ground level wherever practicable, and locating stacks separately.

5.16.2 The design of steel-framed structures shall comply with the requirements of BS 449, ASME/AWS D 1.1.

5.16.3 In meeting the requirements of 5.16.2 of this Standard, allowance shall be made for all applicable dead and live loadings including:

a) Weight of boiler including test fluids.
b) Lifting equipment and maintenance requirements.
c) Dynamic loads resulting from vibrating equipment.
d) Loads resulting from wind-excited oscillations.
e) Wind loading in accordance with 5.16.4 of this Standard.
f) Earthquake loading.

5.16.4 Earthquake loads shall not be considered as acting simultaneously with wind loads.

5.16.5 The boiler main load supporting steelwork shall be fireproofed to give two hour rating in accordance with IPS-E-CE-260. Unless company specify otherwise, it shall be fireproofed up to a level of 7.5 m (25 ft) above the highest fuel line.

5.16.6 Painting and the preparation for painting shall be in accordance with IPS-E-TP-100.

5.17 Platforms, Stairways and Ladders

5.17.1 Platforms, stairways and ladders shall be comply with the requirements of IPS-E-SF-400.

5.18 Burners

5.18.1 Fuels to be used and conditions of supply will be specified by Company.

5.18.2 The boiler designer shall state the viscosity required at the burners so that any additional heating can be installed.

5.18.3 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 pressure gage shall be provided and shall be connected to the inlet and outlet of the filters.

Liquid fuel burners shall normally be of the steam atomizing type. The boiler designer shall justify any atomizing steam consumption greater than 0.5% of boiler MCR. Company will state whether there will be a reliable supply of steam for use with steam atomizing burners under cold-start conditions, or if the boiler supplier is to provide a special facility to meet this situation.

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

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

5.18.6 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.

5.18.7 Multi-Fuel firing arrangements shall provide an even distribution of the waste fuel burners in the burner firing pattern. The boiler designer shall recommend the arrangement for agreement by Company.

5.18.8 Burners for augmenting the exhaust heat shall be one of the following types, listed in order of preference:

- **a)** Conventional register burners.
- **b)** Sidewall burners with flame protection channels.
- **c)** Inter-Tube burners of fabricated construction with integral gas supply chambers.
- **d)** Grid burners of cast construction in high-grade alloy steel.

Note:

Types (c) and (d) require the specific approval of company.

Liquid fuels or contaminated gas fuels shall only be burned in these burners when burner tip cleaning can readily be effected with the other burners remaining in operation.

5.18.9 Burner minimum turndown shall be 3:1 for liquid fuels and 10:1 for fuel gas, with the boiler supplier's guaranteed low O_2 in the flue gas maintained over the ranges mentioned in 5.18.12 of this Standard.

5.18.10 Burner air registers may be of parallel or venturi shape. Boilers with only a single burner shall have burners equipped with two guns, one concentric and the other in an angular position, to enable either gun to be withdrawn without reducing the boiler firing rate.

5.18.11 Boilers having four or more burner assemblies for use with fuel gas or commercial grade liquid fuel shall operate satisfactorily with combustion conditions as near stoichiometric as practicable. The excess air shall not exceed 3% for liquid fuels and 5% for gaseous fuels. Over the full operating range of the boiler the following O_2 vol. percentage in flue gases should be achieved with liquid fuels:

0.5% O_2	between	70 - 100% MCR
1.0% O_2	"	25 - 75% "
5.0% O_2	"	0 - 25% "

5.18.12 Excess O_2 for boilers with less than four burners should not be greater than 1% over the load range 70% to 100% MCR., with up to 2% at loads 40% to 70% MCR.

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

5.18.14 Unburnt carbon in the flue gas shall not be greater than 0.05% wt. of the fuel, or such limits as specified in IPS-E-SF-860.

5.18.15 Each burner shall be sized either for 110% of its design load, or such that the boiler MCR can be maintained with one burner out of use, whichever is greater.

5.18.16 A fixed gas fired pilot burner, removable for maintenance while the boiler is in operation, shall be provided at each burner assembly. It must be suitable to ensure safe and efficient ignition of all fuels specified. Each pilot burner shall be permanently lit when its main burner is in use.

When a permanent clean gas supply is not available, or in other exceptional circumstances, the use of discontinuous pilots may receive the approval of Company.

5.18.17 Each pilot burner shall be fitted with an electrically-operated igniter as an integral part of its assembly. The pilots shall operate from a sweet gas supply independent of the main gas supply to the boilers, and be suitable for a gas supply pressure of 0.2 to 0.35 bar (3 to 5 psig).

5.18.18 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 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.

5.18.19 The boiler supplier shall state the heat input of the proposed pilot burner.

5.18.20 The combustion air supply to pilots must be arranged separately if the main windbox supply, under all pressure changes normally experienced, can not be relied upon to maintain the flame in a satisfactory condition.

5.18.21 Duplex type filters, or two filters in parallel, of 125 microns (5×10^{-3} 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.

5.18.22 Horizontal distance between main burners, and the vertical distance between rows of burners shall be such as to facilitate discrimination between individual flames by the proposed flame detector. Each main burner flame shall be monitored by flame detection equipment in accordance with 5.20.8.7, 5.20.8.8 and 5.20.8.9 of this Standard.

5.18.23 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.

5.18.24 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.

5.18.25 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 not less than 26 months. Valves shall preferably be of the ball valve type 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.

5.18.26 Flame traps shall be provided on all gas vent pipework.

5.18.27 Non-retracting type guns should be used, provided that the gun nozzles and stabilizers are adequately cooled when not in use. This shall not significantly increase the excess AIR in the furnace.

5.18.28 Where retracting guns are proposed, connection between fuel pipe, etc. and burner inlets shall be by flexible hose of three-ply construction; inner hose of close pitch corrugated monel tubing; middle layer of type 321 stainless steel braid and outer layer of interlocked galvanized armour. The hose shall be proven for the duties. Different hose connectors shall be provided for each hose duty so that they cannot be wrongly connected. The fuel hose connectors shall be self-sealing on disconnection from the burner.

5.18.29 Company may specify that, where no more than four burners are proposed for a boiler, the air duct may be divided into individual branches in which modulating dampers are fitted, enabling a strict fuel/air flow ratio to be provided to each burner.

5.18.30 Where gas only will be fired, the system shall be so arranged as to reduce automatically the fuel gas flow rate to each burner, or column of in-duct burners associated with gas turbine waste-heat recovery, during the ignition and proving stages.

The boiler designer shall inform company 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.

5.18.31 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 company, and this will depend upon the shape of the furnace and complexity of the flue gas passes. However, 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 plant combustion chamber and gas passages up to the exit of the flue, whichever is greater.

The purge procedure shall be an inescapable action on every start-up, and one which the operator cannot override, reduce in flow rate or shorten in duration.

5.18.32 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 company, colored lamps on the panels shall indicate the status of burners.

5.18.33 It shall not be possible for the fixed periods of fuel admission to be extended or overridden by the operator before the flame is established.

5.18.34 If fully-reliable flame detection equipment is not installed, (see 5.20.8.7 of this Standard) individual flame detection bypass switches shall be provided on boilers having more than two burners, in order to make it possible to

maintain a boiler on full load. Such bypasses shall be operable only by a special key, which shall be removable. The bypasses shall be arranged to be ineffective for a minimum of the first two burners lit and the last two burners in service.

5.18.35 Interlocks shall be provided to prevent burner start-up if the furnace conditions are not satisfactory. These shall initiate shut-off 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 in steam drum.

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 (FD).

e) Loss of induced draught (ID).

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). Refer to 5.20.1 of this Standard.

i) Loss of electric power supply (start-up conditions only; 'fail-locked' would operate when on load). Refer to 5.20.1 of this Standard.

5.18.36 Following a main fuel valve trip, the ID and FD equipment and tripping equipment shall be so arranged that the furnace shall not be unacceptably pressurized.

5.18.37 Whilst burners may be arranged for control from a remote control room, the start-up of a boiler, and every additional burner thereafter, shall be initiated and observed by an operator at the boiler firing floor. The control and indicating equipment shall, therefore, be arranged accordingly. On large boilers having two or more burner platform levels, the local control panel shall be divided into sections positioned appropriately at each platform level.

5.18.38 To ensure the effective isolation of all fuels to a furnace, solenoid-operated valves shall be inserted in the air lines to pneumatically-operated ball valves placed immediately upstream of the control valves. These isolating valves shall be arranged for remote manual activation in emergency and to work, automatically, in conjunction with the safety interlocks, when unacceptable conditions arise.

5.18.39 The general physical arrangement of pipes, valves and control equipment, etc., at each burner and in the firing floor area as a whole, shall be given specific attention so as to provide a neat, uncluttered and logical layout, capable of being readily identified by the operator and facilitating easy access for operation and maintenance.

5.18.40 Gas offtakes for individual burners shall be from the top of the header. Each header supplying a horizontal row of burners shall connect to a main vertical header which shall be connected at its base to the outlet of a knock-out pot. The gas main to the boiler shall be connected to the knock-out pot, with provision for flexibility of pipework to accommodate all boiler relative movements due to thermal expansion and vibration.

5.18.41 Platforms at each burner level shall be provided, together with stairways and escape ladders as necessary. The platforms shall be wide enough to enable burner guns to be withdrawn without difficulty and to be safely handled by the operator.

Drip trays shall be fitted where necessary, and racks for spare guns, with facilities for gun maintenance, shall be provided in agreed positions.

5.18.42 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.

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

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

5.18.45 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.

5.18.46 Expansion bellows shall be avoided and shall not be used in fuel gas lines of 50 mm (2 in) diameter and above without the approval of Company.

5.19 Soot Blowers

5.19.1 Boilers which will be fired on residual fuel oils or sour gas shall be equipped with soot blowers to enable the unit to be kept in operation continuously for not less than 26 months without loss of thermal efficiency.

5.19.2 Where the future possibility of a conversion to residual fuel oil firing is specified, boilers shall have the necessary soot blower openings and wall boxes fitted and blanked off. Additionally, any brackets and supports, etc. which cannot readily be inserted after boiler erection, shall be provided at the necessary spacing between tube banks.

5.19.3 Steam blowing soot blowers are preferred, using steam from the boiler, where the pressure is acceptable, i.e., up to approximately 14 bar (200 psig). A blanked-off pipe branch shall also be included for connecting to an alternative steam supply when specified.

5.19.4 Retractable lance or nozzle type soot blowers shall be used in the high temperature zones, with calorised tube rotary blowers installed in the zones where flue gas temperature permits. Economizer banks may be provided with rake or lance type soot blowers. The boiler supplier shall support his proposals with details of steam flows, jet angle, extent of effective penetration, etc. Suitable stops shall be fitted to the tracks inside the boiler, to prevent lances coming off the rails due to overtravel of the drive mechanism.

5.19.5 On boilers requiring frequent soot blowing, the soot blowers shall be arranged for auto-sequence operation. The supervisory controls shall ensure that soot blowing does not commence until all the soot blower steam distribution system has reached its working temperature and all condensate has been removed.

5.19.6 On completion of the operation, complete shut-off of the steam supply shall be assured and drains opened. The drains shall not be connected to other systems from which a blow back might occur.

5.19.7 The automatic sequence and system management control shall monitor and indicate all stages of operation. Facilities to interrupt the sequence or obtain selective operation of soot blowers shall be included.

5.19.8 It shall not be possible to interrupt the supply of steam to a retractable soot blower until it is in the fully-retracted position.

5.19.9 Means of manually retracting a soot blower shall be provided, and it shall be possible to remove all soot blowers completely from the boiler, for maintenance, while the boiler is on load.

5.19.10 Automatic retraction of the lances shall be at twice the speed of entry.

5.19.11 Sealing of wall boxes, lances and nozzles shall be provided.

5.20 Instruments, Controls and Safety Equipment

5.20.1 General

5.20.1.1 Detailed requirements for control equipment shall be as specified by company in an accompanying specification (IPS-M-IN-280, Part 1) and functional diagrams based on SAMA, PMC 22.1.

5.20.1.2 Where boilers are required for critical duties or specified as such by Company, 'fail-locked' shutdown systems shall be provided on loss of electrical power or instrument air supply. In other application fail-safe shut-down systems shall be employed. The shut-down system shall be subject to approval by Company.

5.20.1.3 All instrumentation shall be suitable for continuous working in the conditions of their location. The burner management systems shall be reviewed in detail and approved by the boiler designer.

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

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

a) Fuel supply to burners.
b) Combustion conditions.
c) Steam superheat.
d) Steam drum water level.
e) Feed water supply.

5.20.1.6 Company will specify whether controls are to be pneumatic or electronic.

5.20.1.7 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 company for approval before placing orders.

5.20.1.8 Local indicators shall be provided, except where local panels are used for boiler start-up. In the latter case, the local indicators may be located on the start-up panel.

5.20.1.9 For extra-high-pressure steam lines requiring welded-in primary elements, flow nozzles shall be specified by Company.

5.20.1.10 The instrumentation technology employed shall be based on single loop digital controllers (SLDC) or distributed control system (DCS) as indicated in the purchase order.

5.20.1.11 Feed water control of the boiler system shall be according to ISA S 77.42 "Fossil Fuel Power Plant Feed water Control System-Drum Type" (1987).

5.20.1.12 The instrumentation system shall be in accordance with IPS-M-IN-280, Part 1 "Packaged Equipment Instrumentation".

5.20.1.13 Control scheme shall be submitted for company's approval according to PMC 22.1-1981 "Functional Diagramming of Instrument and Control System" (1981).

5.20.2 Control valves

5.20.2.1 Control valves shall be specifically selected for the full dynamic turndown of the system, i.e., for start-up and over the full firing range. For high turndown, split-range valves or special start-up valves shall be used.

5.20.2.2 The type of valve shall be selected according to the service. Specialist valves shall be used where cavitation, noise, flashing or erosion may occur. Cage-guided-valves may be considered for these specialist services, except on dirty or erosive applications.

5.20.3 Fuel supply to burners

5.20.3.1 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.

5.20.3.2 The flow rate of fuels to the burners shall be controlled by the pressure of the steam in the boiler steam drum or the discharge header common to other units with flow-limiting override where necessary. Alternatively, company may specify a preference for the fuel flow to be controlled by steam flow from the unit and modulated by pressure compensator.

5.20.3.3 Provision shall be made to prevent the fuel supply pressure from falling when additional burners are lit.

5.20.3.4 Individual burner and main fuel trips shall be arranged as described in 5.18 of this Standard, dealing with burners.

5.20.4 Combustion controls

5.20.4.1 An increase in demand of fuel, caused by falling steam pressure, or increase in steam flow in some cases, shall increase the supply of combustion air. Measured increase in air flow shall then initiate an increase in fuel flow, maintaining the correct fuel/air ratio. Falls in demand of fuel shall initiate the reduction in fuel flow, followed by a corresponding reduction in air flow.

5.20.4.2 A reliable O_2 analyser shall be supplied. The air flow shall be constantly 'trimmed' within adjustable limits dependent on load, to maintain the specified excess O_2 in the flue gases, in accordance with 5.18.11 of this Standard.

5.20.4.3 Supply of combustion air from the FD fans shall be measured and regulated to meet the precise needs of the burners, according to the quantity of fuel that the steam pressure (or flow) controller demands. The control signal thus obtained shall vary the position of the fan inlet guide vanes, or change the speed of the fan, depending upon the system adopted.

5.20.4.4 In boilers having balanced draught, the ID fan inlet guide vane setting or fan speed shall be varied to maintain a constant negative pressure in the furnace of minus 6 mm to minus 12 mm water gage.

5.20.4.5 Provision shall be made to prevent a change in windbox pressure, when additional burners are introduced or withdrawn, from significantly affecting the combustion condition of those burners already in service.

5.20.4.6 The following indications and recordings shall be included, unless specified otherwise, mounted on the boiler control panel or locally as appropriate:

a) Pressures at:

1) FD fan outlet.
2) Air heater outlet (air side).
3) Burner windbox.
4) Furnace at burner level.
5) After superheater.
6) Boiler outlet.
7) Economizer outlet.
8) Air heater outlet (flue gas side).
9) ID fan outlet.

b) Air and flue gas temperature at:

1) Air heater inlet (flue gas).
2) Air heater outlets (air and flue gas).
3) Flue gas after secondary stage of superheater.
4) Flue gas after primary stage of superheater.
5) Flue gas at boiler outlet.

c) Flue gas O_2 analyser/controller/recorder (also local indication).
d) Smoke density indicator with audible alarm.
e) Feed flow recorder.
f) Drum level recorder.
g) Fan speed indicator.
h) Air flow indicator recorder.
i) Steam pressure recorder.
j) Drum and superheater outlet pressure (also local gage).
k) Steam flow indicator recorder.
l) Instrument air pressure gage.
m) Battery charger failure alarm of instrumentation power supply (where applicable).
n) Fuel flow indicator recorder with integrator for each fuel.
o) Fuel supply pressure (also local instruments).
p) Fuel pressure after control valve (also local instruments).
q) Fuel temperatures at burners (also local instruments).
r) Atomizing steam pressure (also local instruments).
s) Burner and pilot ON/OFF indication.

5.20.5 Steam superheat

5.20.5.1 Where attemperators are proposed to control the degree of steam superheat, the temperature of the steam at the boiler stop valve shall be the control criterion. The steam temperature leaving the attemperator shall also be used in the control loop to ensure maximum response rate and accuracy.

5.20.5.2 Control of surface-type attemperators shall be by regulating the amount of steam passed to the cooling surfaces. The spray-water type shall be controlled by regulating the amount of spray water injected into the steam.

5.20.5.3 The final temperature of the steam shall not vary more than ±5° from the specified figure at any load, for steady state operation of the boiler, i.e., ±3% MCR.

5.20.5.4 For rapid load changes at a rate of 10% MCR per minute, limited to a total of 10% MCR, the variation in final steam temperature shall not be greater than ±8°C, above 60% MCR.

5.20.5.5 Instruments shall be provided for the following duties on the boiler control panel, or locally-mounted, as appropriate:

a) Final steam temperature (also recorded).

b) Spray water supply pressure (where applicable).

c) Conductivity indication for saturated steam leaving the steam drum, including sample cooler, with facilities for conductivity recording if specified.

d) Conductivity indication for superheated steam leaving the superheater, including sample cooler, with facilities for conductivity recording if specified.

5.20.5.6 Skin thermocouple installations on boiler tubes shall be designed on an individual basis, having regard to the accuracy of the measurement required and protection against burnout of the thermocouple for each installation.

5.20.6 Steam drum water level

5.20.6.1 Under normal operating conditions, including the load fluctuation stated by company, the water level in the steam drum shall not rise or fall to the point of operating the level alarms, which shall be normally set to operate at not more than ±100 mm (4 in) from the design level.

5.20.6.2 The control elements for the operation of the valve regulating the supply of feed water to the boiler shall be measurement of the actual level of the water in the drum, the measurement of the steam flow from the boiler and the measurement of the feed water flow to the boiler. On boilers subject to significant load fluctuation all control elements shall be used.

5.20.6.3 For boilers in the small output range, i.e., up to approximately 60 tonne/h and subject to only gradual load changes, Company may specify the use of only two control elements: the water level and the steam flow.

5.20.6.4 Two direct-reading water level gages, or other primary level devices as approved by the Company, shall be provided on each steam drum, preferably one at each end. Each gage shall be capable of being blowndown or isolated for removal and repair without taking the boiler off load.

5.20.6.5 The connections to the drum for mounting the water level transmitter shall be separate from those for the direct-reading gages.

5.20.6.6 The transmitter used for water level control for boilers in the smaller output range of up to approximately 100 tonne/h, may also be used for providing the signal to the remote level indicator on the control panel. For larger boilers there shall be a separate transmitter.

5.20.6.7 Where the drum elevation above operating floor level prevents the operator from viewing the direct water level gages, a remote direct-reading gage of a proven type shall be provided in addition to the two gages local to the drum.

It shall be located at operating floor level and positioned so as to be easily seen by the operator standing at the feed water regulating and bypass valves. Bicolor gages equipped with mirrors to reflect a view of the drum gages down to operating floor level shall not be used, although the bicolor gage itself is acceptable to improve identification of the water column.

5.20.6.8 A displacement-type 'high' and 'low' water alarm shall be separately mounted on the steam drum, and operated by the steam. The 'extra-low' water level switch should be similarly mounted and shall cause the fuels to the boiler to be cut off and an emergency alarm to be raised, both visual and audible, in the boiler control room. The point at which this switch operates shall be at a water level high enough to protect all pressure parts from overheating and to be still visible in the gage glasses. It must not be so near to the 'normal-low' water alarm level that there would be insufficient time for an operator to make adjustments for the first condition before the second arises, causing the shut down of the boiler.

5.20.6.9 The boiler designer shall state the holding time provided by the reserve of water in the steam drum between 'low' level and 'extra-low' level, and Company will approve this time against that required to introduce effectively the standby boiler feed pump. The size of the steam drum may have to be increased to provide a longer period in which to recover water level without incurring the automatic shut down of the boiler.

5.20.6.10 For boiler drum level control applications, a water column shall be used, designed to reduce errors due to temperature effects to a minimum.

5.20.6.11 Boiler drum water level gages shall be selected to suit individual applications. Proprietary level gages of established design shall be used.

5.20.7 Feed water supply

5.20.7.1 Feed water to the boiler shall be controlled by a regulating valve in the feed line to the economizer, or to the steam drum direct if no economizer is supplied.

5.20.7.2 The control signal for positioning the opening of the regulating valve shall be derived from the three elements (two in some cases) described in 5.20.6.2 of this Standard.

5.20.7.3 The regulating valve shall be supplied by the boiler supplier and installed in the integral pipework associated with the unit.

5.20.7.4 The operation of the regulating valve may also have to take into account a pre-set pressure differential across the valve in order to avoid excessive wear of the valve seating.

5.20.7.5 The boiler supplier shall inform Company of the pressure of the feed water required at the inlet to that section of the feed pipework in his supply. He shall provide Company with the breakdown of the total pressure requirement, indicating maximum operating pressure of the boiler and the various pressure losses in the feed system, including static head to be overcome.

5.20.7.6 Within the steam drum, a feed water distribution pipe shall be arranged to ensure a proper distribution of the incoming water along the length of the drum, suitably placed to feed the downcomer tubes but not to interfere with the correct function of the water level gages.

5.20.7.7 The following instruments shall be provided and mounted on the boiler control panel:

a) Feed water supply pressure, indication and recording.
b) Feed water flow, indication and recording.
c) Feed water temperature at inlet to economizer.
d) O_2 in boiler feed water, indication and recording.
e) PH of feed water.

5.20.8 Burner management

5.20.8.1 Burner management systems shall be installed local to the burners.

5.20.8.2 The systems shall use solid-state logic, unless specified otherwise by Company. Shutdown systems only may use relay logic if the required functions cannot be achieved with solid-state logic.

5.20.8.3 The systems shall jointly monitor the burner and boiler to ensure safe start-up and shut-down of burners and boilers.

5.20.8.4 Unless otherwise required by Company, the system shall, on the pressing of push-buttons, arrange for the whole sequence of burner light-up or shut-down to be automatically carried out with a high degree of safety and reliability. It shall also automatically shut down burners on identification of a fault condition serious enough to warrant such action, or raise alarms to indicate faults of a less serious nature.

5.20.8.5 Separate buttons shall be provided to initiate purge and individual burner start-up, and also for individual burner and boiler shut-down.

5.20.8.6 Reset facilities shall be provided for both boiler and individual burner trips.

5.20.8.7 Unless otherwise approved by Company, flame monitors shall be:

Either:

a) The Babcock dual-signal type, or similar, monitoring both the high frequency flicker signals generated at the root of the flame, and the brightness of the flame.

Or:

b) More advanced equipment when available, but subject to agreement by Company.

5.20.8.8 Where a very high degree of operating availability is specified, two main flame detectors shall be fitted to each burner, with any one detector signal arranged to give an alarm and the two signals together to cause lockout of the fuels to the burner.

5.20.8.9 Automatic self-checking flame detectors are preferred and are mandatory if ultra-violet sensing is used.

5.20.8.10 The system shall be complete, without any areas of split responsibility, especially regarding furnace purging and boiler safety. The boiler designer shall ensure that the actions of the interlock equipment, in the event of a plant failure, are compatible with the actions of the analogue control equipment.

5.20.8.11 Local and control-room panels shall provide all the information necessary to enable the operators to ascertain the condition of each burner and all the associated functions of fans, purging, register positions, fuel valve positions and safety interlocks.

5.20.8.12 The systems shall be 'fail-locked' or 'fail-safe', and shall lock out the boiler or individual burners if faults occur during the start-up sequence. After successful starting, the system shall lock in and the boiler shall shut down only by means of the manual or automatic trip system.

5.20.8.13 Key-operated override switches shall be provided for all shut-down functions. These switches shall also override those start 'permissives' which are also shut-down functions. The override switches shall normally be located on the front of the main control panel. If located on the rear of the panel, then indication of over-ride condition shall be given on the panel face.

5.20.8.14 All shut-down systems shall be capable of full function testing from primary sensor up to final actuation device while the plant is on line. Test key-operated override switches shall be provided for this function. These shall override the minimum number of function components. Alarms shall be provided to show automatically when the trip circuit is being overriden for test. Final element trip testing on a 'single fuel' basis should be provided where more than one fuel is used. Where the loss of an individual burner can be tolerated in the steam system, the test facility shall include tripping individual burners. Company will specify those trip functions where it is necessary to provide duplication for trips or a two-from-three voting system to give increased reliability.

5.20.8.15 All override test facilities shall be mechanically protected and accessible only to personnel authorized to carry out testing.

5.20.8.16 All systems shall preferably be energised during normal operation, but if systems that are de-energized during normal operation are used, they shall be provided with power supply and trip ciruit monitoring.

5.21 Noise Limitations

5.21.1 Noise limits will normally be specified in detail in the inquiry. However, in the absence of such requirements, noise levels shall not exceed 87 dB(A), at a distance of 1 m from equipment surfaces.

5.21.2 The boiler supplier shall provide details of the noise emission in octave bands from his equipment, as given in IPS-E-SF-900.

5.21.3 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.

5.21.4 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 Standard.

6. ELECTRICAL EQUIPMENT

6.1 Detailed requirements for electrical equipment shall be as specified by Company in an accompanying specification based on IPS-E-EL-110 "Electrical Area Classification & Extent".

6.2 Unless otherwise specified by Company, 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., motorized valves and pressure switches on fuel lines. Such electrical items shall be at least to Zone 2 standard.

6.3 Lighting shall be provided at all platforms, ladders and stairways and around the boiler and its auxiliaries. The lighting levels shall be approved by Company.

6.4 A separate system of emergency lighting shall also be installed, with lights positioned at critical points, including lighting to facilitate the reading of water level and other important gages, the easy identification of emergency valves, etc., and to permit safety of movement for personnel.

6.5 Electrical cables shall be routed to avoid areas where there is a potential high risk of damage from fire, high temperatures or any other cause. Where this cannot be achieved, suitable fire resistant cables shall be used or a fire protection system shall be installed.

7. BOILER FEED AND BOILER WATER QUALITY AND CHEMICAL CONDITIONING

7.1 Boiler feed water treatment shall be as specified separately by Company.

7.2 Company will specify the quality of the boiler feed water available, including condensate if intended to be used.

7.3 The boiler designer shall notify Company of any objection or any difficulties he may foresee in using the specified water, and shall recommend to Company any further treatment or conditioning of the feed water he considers necessary or advisable.

7.4 The recommended maximum TDS (total dissolved solids) in the boiler water shall be stated by the boiler designer.

7.5 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.

7.6 Any necessary chemical mixing and injection equipment shall be included by the boiler supplier, and Company will specify the required extent of duplication of equipment such as injection pumps and chemical mixing tanks.

7.7 Company 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.

7.8 Water sampling points for both boiler feed and boiler water, complete with coolers, shall be provided.

7.9 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 control position shall be provided.

8. STACKS

8.1 Detailed requirements for stack design shall be as specified by Company in an accompanying specification based on below.

8.1.1 The stack shall be designed as an individual self-supporting steel stack with minimum height specified for each boiler, but in any case not less than 30 meters. Stack linings shall be vendors standard design. Material for stack shall be ASTM A-36 carbon steel.

The anchor bolts for stacks shall have a ¼" minimum corrosion allowance. Stacks shall be checked for dynamic and static wind loadings.

8.1.2 Stacks shall be of welded construction and have a minimum thickness of 6 mm. A minimum allowance for corrosion from the inside of the stack of 3 mm shall be specified.

8.1.3 Each boiler shall have separate stack, unless otherwise specified.

8.1.4 An access opening for internal inspection and cleanout shall be provided at the base of each stack.

8.1.5 Stacks shall be equipped with aircraft warning lights.

8.1.6 Maintenance access for boiler stacks shall be provided. This should enable two men, with paint spray or gunite machine to work inside or outside each stack. Inside access will be via 3 point stack tip mounted stainless trolley bars and stainless pilot cables, and outside access via a trolley rail around stack tip with pilot cable. In both cases loading should be designed for a trolley capacity of a minimum of one ton. Stack ladders are no required, unless specified.

8.1.7 Stacks shall be provided with sufficient protection against corrosion, subject to approval by the Purchaser.

9. PURCHASING REQUIREMENTS

9.1 General

9.1.1 Steam boilers shall be supplied in accordance with the contents of this specification which shall include all the applicable sections of the codes and regulations etc., listed herein.

9.2 Basic Design

9.2.1 Terminal points

The terminal points for the work of this standard specification provided by the vendor, shall include but not be limited to the following.

9.2.1.1 Outlet of main steam valve.

9.2.1.2 Boiler feed water inlet, upstream of the stop and check valves.

9.2.1.3 Outlets of all safety valves.

9.2.1.4 Steam drum, economizer and super heater vents, downstream of the tandem valves.

9.2.1.5 Boiler drain, downstream of the tandem valves.

9.2.1.6 Boiler blowoff, downstream of the tandem valves.

9.2.1.7 Chemical injection, upstream of the stop and check valves.

9.2.1.8 Fuel inlets at the burners and igniters upstream of the flexible hoses.

9.2.1.9 Motor electrical terminals boxes.

9.2.1.10 Forced draft fan air ducting inlet.

9.2.1.11 Boiler flue gas duct at stack.

9.2.1.12 Stacks shall be provided with sufficient protection against corrosion, subject to approval by the Purchaser.

9.3 Boiler Mountings

9.3.1 Safety valves

The safety valves shall be of the direct spring-loaded type with the springs exposed to the open air, i.e., with open bonnets. They shall be provided with lifting gear. All safety valves shall have flanged connections. They shall be adequate to meet the requirements of the service but shall have inlet and outlet flange ratings of at least ANSI Class 300 RF and ANSI Class 150 RF respectively. Welded connections are not allowed.

Rating and adjustment of the safety valves shall be in accordance with the ASME boiler and Pressure Vessel Code, Section 1. Blowdown pressure shall be not more than 4% of the set pressure.

The set pressure of any boiler drum safety valve shall be at least 5% in excess of the maximum operating pressure in the drum or 2.5 bar in excess of the maximum operating pressure in the drum, whichever is the higher.

Vertical outlets, at least 2000 mm high, shall be provided for the safety valves. They shall blow off to a safe location.

All valve outlets shall be adequately supported to take care of the reaction forces. They shall have safe drainage facilities which shall prevent accumulation of water in the outlets.

9.3.2 Water level gages

At least two direct-reading level gages. One installed at each end of the drum, shall be provided, and in addition one level gage easily visible from the operating platform.

9.4 Fabrication Requirements

9.4.1 Welding

Joints shall be made by welding wherever possible, unless otherwise specified. All welded connections to the steam and water drums shall be of the full-penetration type. The connections shall be of the set-on or set-through type, so as to obtain the minimum weld volume. If set-on nozzles are applied and wall thicknesses are greater than 30 mm, the material shall have reduction of area, through thickness properties, established by means of a tensile test of 25%.

For set-on nozzles which cannot be back welded, the bore of the nozzle shall be machined to sound metal in the root of the weld.

9.5 Performance Requirements

9.5.1 Performance/acceptance tests

Performance and acceptance testing shall start only after the installation has been operating satisfactorily at maximum continuous rating for a consecutive period of 5 days. The Company may, however, stipulate a lower load and/or period to suit conditions prevailing at the time. Performance guarantees made by the supplier shall be met.

At least the following tests shall be carried out using such fuel as specified by the Company:

- at 100% of maximum continuous rating - for 8 hours

- at minimum load on automatic control - for 8 hours

- any additional performance test, as specified on the data/requisition sheets

- tests for automatic control and load response

- a test at 100% maximum continuous rating with one burner out of operation, if specified on the data/requisition sheets

- tests for operation of the safeguarding system.

Tests will be done by the purchaser in the presence of the supplier who shall give assistance, if necessary. Unless otherwise specified, the plant instruments may be used for the performance tests after agreement has been reached between the purchaser and the supplier on the calibration of the plant instruments.

If it is specified that the plant instruments may not be used for the performance tests, or if the supplier does not agree to the use of plant instruments, the supplier shall provide the test instruments and apparatus for the tests.

Methods for the determination of steam quality shall be agreed between the Company and supplier. Efficiency tests and calculations shall be carried out according to the "Losses Method" described in the ASME Performance Test Code PTC 4.1.

9.5.2 Air and gas

9.5.2.1 The unit shall have sufficient forced draft fan capacity available to provide the necessary air for combustion at a pressure at the burner windbox required to overcome all of the resistance through the unit including the ducting and stack. Means shall be provided to control the furnace pressure and the supply of air throughout the operating range.

9.5.2.2 The CO_2 or excess air in gas leaving the furnace shall be determined by sampling uniformly across the width of the furnace where the gases enter the convection heating surface. There shall be no delayed combustion at this point nor at any point beyond.

9.5.2.3 The fuel burning equipment shall be capable of operation without objectionable smoke.

9.5.3 Water

9.5.3.1 The boiler water concentration in the steam drum shall be specified into job specification.

Samples of water for testing shall be taken from the continuous blowdown. Samples shall be taken through a cooling coil to prevent flashing. Sampling and determination of boiler water conditions shall be under the methods contained in ASTM Special Technical Publication No. 148.

9.5.3.2 Test Procedure for Solids in Steam: Samples of condensed steam for determination of solids shall be obtained in accordance with the method specified in the latest edition of ASTM D-1066 entitled "Tentative Method for Sampling Steam".

The Electrical Conductivity Method shall be used to determine the dissolved solids in the steam. The test shall be made in accordance with ASTM D-1125.

9.6 Spares

9.6.1 Detailed requirements of spares required for two years of operation shall be as specified by Vendor.

9.6.2 Spares shall be considered in 3 categories as follows:

a) Pre-Commissioning
b) Commissioning
c) Permanent

9.6.3 The supplier shall specify in his proposal all pre-commissioning spares [Category (a) above].

9.6.4 The supplier shall submit, for company's approval prior to any order, a list of commissioning spares [Category (b) above]. These will include spares for installation at the first overhaul.

9.6.5 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 company who will also specify the manual format to be used.

9.7 Special Tools

All special tools required for maintenance and operation, such as tube expanders, special wrenches, etc., which are not normally found in a workshop shall form part of the installation.

9.8 Preparation for Shipment

Boiler manufacturer shall properly prepare the boiler parts for shipments to the jobsite.

9.8.1 Outside exposed metal surfaces shall be prepared and painted in accordance with IPS-E-TP-100 Painting Specification.

9.8.2 Machines surfaces and flange faces shall be coated with heavy rust preventive grease.

9.8.3 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.

9.8.4 To prevent damage, all flange facings shall be protected with gaskets and ¼" plates, and all couplings shall be protected by steel pipe plugs.

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

9.8.6 Equipment must be suitably crated, packaged and weather protected to guard against damage while in transportation. All pieces of equipment and spare parts shall be identified by item number and services, and shall be suitably marked inside and outside of boxes.

9.9 Guarantee

In addition to the mechanical guarantee required by the conditions of contract, the Vendor shall guarantee in writing that each boiler will produce from Load to Full ¼ Load of Steam Rating as specified on the Data Sheet and section 9.2.3 of this specification without detrimental carry-over into the superheater tubes and without flame impingement upon any boiler tubing when burning any combination of the gas, gasoline and oil fuels specified herein.

The Vendor shall also guarantee that each boiler will be capable of producing the overload requirements of the 4 hours overdesign capacity specified in Paragraph 9.2.3.2 and the minimum load for a continuous period of 24 hours.

9.10 Informations Required with Quotations

9.10.1 General

The English language shall be used throughout unless otherwise specified. However, descriptions on drawings may be in other languages, provided English translations are given.

The supplier shall provide all drawings, design details, operation and maintenance manuals, and other in- formation necessary for the design assessment, erection, operation and maintenance of the installation.

All information, especially the manuals for operation and maintenance shall be clear and not open to misinterpretation and shall apply specifically to the installation supplied.

9.10.2 Informations required by purchaser

Data sheet per specification sheets No. 1 to 4 attached to this Standard will be filled out by the purchaser. Additional data normally supplied by Vendor shall be given separately.

9.10.3 Schedule of vendor's documentations

Specification sheets No. 5 to 8 attached to this Standard shall be completed and the following documentation and information shall be given by supplier.

a) Drawings of:

- Dimensioned general arrangement, front and side elevations, of complete installation showing boiler, burners, galleries and ladders, ducting, fan and stack.

- Dimensioned front and side sectional elevation of boiler,showing drum, casing, furnace, burners, access and observation ports, soot blowers and all tube banks. The furnace in particular shall be fully dimensioned including burner center lines.

b) Description of:

- Extent of shop fabrication;
- general description of installation;
- boiler, indicating site fabrication required;
- casing;
- refractory, insulation, stack lining;
- burners;
- desuperheater;
- aspirating, sealing and cooling air system;
- fan and drive;
- soot blowing system;
- mountings, valves and fittings, including safety valves;
- graph showing superheated steam temperature against load;
- control schemes and description of all controls especially combustion control scheme.

c) The capital costs of:

- Boiler including furnace, superheater, economizer, drum;

- combustion air supply (fans, air ducting, controls);
- fuel burning equipment;
- flue gas ducting, stack and flue duct per metre run;
- pipework;
- mountings, valves, including safety valves and fittings;
- refractories;
- instrumentation;
- miscellaneous items;
- erection/supervision of erection.

d) Period of delivery:

- Time from award of contract to arrival f.o.b. at port;
- time from arrival at site to acceptance;
- estimated man-hours and minimum time needed for erection.

e) Lists of:

- Reference boilers of the same type, including location, capacity, superheated steam pressure and temperature and fuels fired, and if possible, feed water quality;

- any deviations from the requirements of this specification;

- sub-suppliers;

- all instruments needed and their location (local, local panel, control room);

- major shipping weights and dimensions;

- provisions made for safety and emergencies;

- fabrication procedures, tests and inspection certificates.

APPENDICES

UNIT NAME	IPS-G-ME-180	PROJ. No.	
		P.O. No.	
	SPECIFICATION SHEET No.1	DATE	SH. OF
UNIT No.	TO BE PROVIDED BY PURCHASER		1 8

WATER TUBE BOILER DATA SHEET

1	SERVICE	ITEM	
2	MANUFACTURER	MANUFAC. JOB. No	
3	PURCHASE ORDER No. :	NUMBER OF UNITS:	
4	OPERATING CONDITIONS:	☐ CONTINUOUS	☐ STANDBY
5	MAIN/STANDBY UNIT No. :	SPEC. No.	
	BOILER TYPE	FIELD ERECTED ☐	SHOP ASSEMBLED ☐
		ITEM.	
	MAIN CHARACTERISTICS GUARANTEED VALUES		
6	STEAM CAPACITY, FOR EACH BOILER Kg/hr MAX CONTINUOUS	PEAK.	
7	STEAM PRESS. AT SUPERHEATER OUTLET VALVE	bar(g)	NORM=
8	MAX. ALLOWABLE WORK PRESSURE	bar(g)	
9	STEAM TEMPERATURE AT SUPERHEATER OUTLET VALVE	°C	NORM=
10	FEED WATER TEMP. °C	BOILER FEED WATER PRESSURE NORM /DES	bar(g)
11	OVERALL EFFICIENCY (REF. TO L.H.V. AND AMB. TEMP. = °C)		
12	STEAM SOLIDS CONTENT P.P.M. WITH P.P.M. OF T.D.S.		
13	SUPERHEATED STEAM TEMPERATURE CONTROL RANGE	FROM	TO
14	MINIMUM LOAD UNDER AUT. CONTROL Kg/h	MINIMUM ALLOWED LOAD IN MAN.	Kg/h
15	FUEL TYPE ☐ GASOIL	☐ FUEL GAS	
16	NATURAL CIRCULATION ☐	CONTROLLED CIRCULATION ☐	
17	AMBIENT CONDITIONS		
	WIND VELOCITY Km/h	PREVAILING WIND DIRECTION	
	EARTHQUAKE FACTOR	RAIN FALL mm	
	HEIGHT A.S.L. m	TEMPERATURE MIN./MAX. °C	
	BAROMETRIC PRESSURE m bar	RELATIVE HUMIDITY %	
18	INSTALLATION		
	☐ OUTDOOR	☐ UNDER ROOF	
	☐ INDOOR	☐ ROOF ON THE BURNER FRONT	
	☐ ANTIFREEZE PROTECTION	☐ NOISE LEVEL MAX dB A. AT m	
19	SUPPLY DESIGN AND TESTING GENERAL CODES		
	GENERAL SPEC.		
	PRESSURE PARTS DESIGN		
	MATERIALS		
	PIPING DESIGN		
	ELECTRIC MOTOR DESIGN	HAZARDOUS AREA CLASSIFICATION	
	STEAM TURBINE DESIGN	OIL COOLERS FOR TURBINE	
	GEAR DESIGN		
	INSTRUMENTATION DESIGN	TESTING	
	REMARKS :		

REV	DESCRIPTION	DATE	BY	APPR	REV	DESCRIPTION	DATE	BY	APPR
2					5				
1					4				
0					3				

UNIT NAME	IPS-G-ME-180	PROJ. No.	
		P.O. No.	
	SPECIFICATION SHEET No.1	DATE	SH. OF
UNIT No.	TO BE PROVIDED BY PURCHASER		2 8

FUEL CHARACTERISTICS

20	FUEL CHARACTERISTICS			
	TYPE		GASOIL	FUEL GAS
	LOW HEATING VALVE (L.H.V)	Kj/Kg		
	DENSITY	Kg/m^3		
	PRESS AT BATTERY LIMIT	MIN/NOR/MAX/D barg		
	TEMPERATURE	MIN/NOR/MAX/D °C		
	VISCOSITY AT °C	CST		
	VISCOSITY AT BURNERS	CST		
	COMPOSITION	VOL. % ☐ WT. % ☐		
	METHANE			
	ETHYLENE			
	ETHANE			
	PROPYLENE			
	PROPANE			
	ISO BUTANE			
	N-BUTANE			
	PENTANE +			
	HYDROGEN			
	NITROGEN			
	SULFUR			
	MOLECULAR WEIGHT			
	HIGH HEATING VALUE	Kj/Kg		

REMARKS:

REV	DESCRIPTION	DATE	BY	APPR.	REV	DESCRIPTION	DATE	BY	APPR.
2					5				
1					4				
0					3				

UNIT NAME	IPS-G-ME-180	PROJ. No.	
		P.O. No.	
	SPECIFICATION SHEET No.1	DATE	SH. OF
UNIT No.	TO BE PROVIDED BY PURCHASER		3 8

WATER AND STEAM CHARACTERISTICS

21	FEED WATER CHARACTERISTICS		
	RESIDUAL HARDNESS	mg/Kg	$CaCO_3$
	O_2	mg/Kg	
	CO_2	mg/Kg	
	CU	mg/Kg	
	FE	mg/Kg	
	SiO_2	mg/Kg	
	OIL	mg/Kg	
	PERMANGENATE MAX.	$KMNO_4$	
	PH AT 25°C		
	CONDUCTIVITY AT 25°C	µS/Cm	
22	BOILER WATER CHARACTERISTICS		
	CONDUCTIVITY AT 25°C	µS/Cm	
	PH AT 25°C		
	PO_4 MAX.	mg/Kg	
	SiO_2 MAX.	mg/Kg	
	ALKALINITY	mg/Kg	$CaCO_3$
23	STEAM CHARACTERISTICS		
	SiO_2 MAX	mg/Kg	
	CONDUCTIVITY AT 25°C	µS/Cm	

REMARKS:

REV	DESCRIPTION	DATE	BY	APPR	REV	DESCRIPTION	DATE	BY	APPR
2					5				
1					4				
0					3				

UNIT NAME	IPS-G-ME-180	PROJ. No.	
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	SPECIFICATION SHEET No.1	DATE	SH. OF
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AVAILABLE UTILITIES CHARACTERISTICS

24 MEDIUM PRESSURE STEAM
PRESSURE MIN. /NORM. /MAX /DES bar(g)
TEMPERATURE MIN. /NORM. /MAX. /DES. °C
TOTAL CONSUMPTION Kg/hr

25 LOW PRESSURE STEAM
PRESSURE MIN. /NORM. /MAX /DES bar(g)
TEMPERATURE MIN. /NORM. /MAX /DES °C
TOTAL CONSUMPTION Kg/hr

26 ELECTERIC POWER FOR INSTRUMENTATION
ALTERNATE VOLT HZ No. OF PHASE
DIRECT VOLT

27 ELECTERIC POWER FOR MOTORS
☐ VOLT HZ No. OF PHASE
☐ VOLT HZ No. OF PHASE
☐ VOLT HZ No. OF PHASE
☐ VOLT HZ No. OF PHASE
☐ VOLT HZ No. OF PHASE

28 INSTRUMENT AIR
NORMAL PRESSURE/DESIGN bar (g) TEMPERATURE °C
☐ DECLED CONSUMPTION Nm³/h
DEW POINT °C

29 UTILITY AIR
NORMAL PRESSURE/DESIGN bar (g) TEMPERATURE °C
☐ DECLED CONSUMPTION Nm³/h

30 NITROGEN
NORMAL PRESSURE/DESIGN bar (g) TEMPERATURE °C
☐ DRY ☐ WET

31 COOLING WATER
COOLING CIRCUIT TYPE ☐ OPEN ☐ CLOSED
WATER TYPE
PH HARDNESS ALKALINITY
INLET/OUTLET °C NORM /DES PRESSURE bar(g)
ΔP MAX bar AT MAX °C
FOULING FACTOR M² °C/W CONSUMPTION m³/h
REMARKS :

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2					5				
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0					3				

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CONSTRUCTION FEATURES

32	BUNDLE TUBE				
	NUMBER		DIAMETER/THICKNESS mm.		
	ARRANGEMENT	☐ INLINE		☐ STAGGERED	
	PITCH	☐ LONGITUDINAL mm.		☐ TRANSVERSE mm.	
	MATERIAL				
	☐ SMOOTH	☐ FINNED			
	FIN PITCH mm		HEIGHT/THICKNESS FIN mm		
	FLUE GAS PASSAGE No.	☐ LONGITUDINAL		☐ TRANSVERSE	
33	SUPERHEATER	☐ YES	☐ NO		
	TYPE	☐ RADIANT	☐ CONVECTION	☐ COMBINATION	
		☐ PENDANT	☐ HORIZONTAL	☐ DRAINABLE	

SUPERHEATER ELEMENT	FIRST STAGE	SECOND STAGE	THIRD STAGE
DIAMETER/THICKNESS TUBES mm			
TUBES MATERIAL			
DIAMETER/THICKNESS MANIFOLDS mm			
MANIFOLD MATERIAL			

34	DESUPERHEATER	☐ NON CONTACT	☐ DIRECT	
	INSTALLATION	☐ INTERSTAGE	☐ FINAL	
	NOZZLE DIAMETER inch.	MAX WATER FLOW RATE FOR DESUPERHEATER	m³/h	
	P MAX NOZZLE	FLANGE RATING	MATERIAL	
	MAX SPRAY WATER FLOW RATE FOR DESUPERHEATER m³/h		I STAGE	II STAGE III STAGE
35	ECONOMIZER	☐ YES	☐ NO	
	TUBE TYPE	☐ SMOOTH	☐ IN STEEL FINNED	☐ CAST IRON FINNED TUBES
	DIAMETER/THICKNESS mm		MATERIAL	
	TRANSVERSE PITCH		LONGITUDINAL PITCH	
	HEIGHT/THICKNESS FIN mm		FIN PITCH mm	
	TUBES ROW PER BANK		BANK HEIGHT mm	
36	RECOVERY AIR PREHEATER	☐ YES	☐ NO	
		☐ REGENERATIVE VERTICAL SHAFT	☐ REGENERATIVE HORIZONTAL SHAFT	
		☐ REGUPERATIVE		
	SEALS LOSSES %			
	MAIN DRIVER TYPE	☐ ELECTRIC MOTOR A.C		
	TYPE STAND BY DRIVER	☐ ELECTRIC MOTOR A.C		
		☐ ELECTRIC MOTOR D.C		
		☐ AIR TURBINE		
	AIR PREHEATER WASHING SYSTEM TYPE	☐ INCLUDED	☐ EXCLUDED	
37	STEAM AIR PREHEATER	☐ REQUIRED	☐ NOT REQUIRED	
	AT MAX. °C AIR SIDE	☐ SURFACE m²	☐ ΔP MAX m. bar AIR SIDE	

REMARKS :

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CONSTRUCTION FEATURES

38	BOILER CIRCULATION PUMPS ☐ YES ☐ NO					
	TYPE					
	NUMBER UNIT MAIN/SPARE					
	FLOW DIFFERENTIAL HEAD m ABSORBED POWER Kw					
	MAIN DRIVER/SPARE /					
	FOR OTHER CHARACTERISTICS SEE DATA SHEET					
	FOR TURBINE CHARACTERISTICS SEE DATA SHEET					
	FOR ELECTERIC MOTOR SEE DATA SHEET					
39	FUEL SYSTEM					
	TYPE OF FIRING ☐ GASOIL ☐ GAS ☐ OIL+GAS ☐ NATURAL GAS FOR S/U					
	BURNER CONTROL RANGE OIL GAS					
	ATOMIZING TYPE ☐ MECHANICAL ☐ STEAM ☐ MIXED					
	BURNERS Nr FOR GASOIL FOR GAS					
	BOILERS MCR WITH N-1 BURNERS REQUIRED ☐ YES ☐ NO					
	GAS BURNERS TYPE PILOT BURNER TYPE					
	BURNERS DETAILS					
	BURNER TYPE					
	BURNER DAMPER DIAMETER mm THROAT OUTLET DIAMETER mm					
	SWIRLER DIAMETER mm AXIAL DISTANCE BETWEEN TIP AND THROAT OUTLET mm					
	DAMPER SERVOMOTOR INCLUDED ☐ YES ☐ NO					
	PRESSURE/FLOW AT BURNERS	25% MCR	100% MCR	115% MCR	DESIGN	
	GASOIL bar/Kg/r	/	/	/	/	
	FUEL GAS bar/Nm³/r	/	/	/	/	
	PRESSURE/CONSUMPTION ATOMIZING STEAM bar/Kg/hr					
	LENGHT/DIAMETER OIL FLAME AT MCR mm					
	LENGHT/DIAMETER GAS FLAME AT MCR mm					
	AIR EXCESS FOR OIL/GAS AT MCR %					
	No. 1 SPARE BURNER GUN INCLUDED ☐ YES ☐ NO					
	No. 2 SERIES OF TIPS FOR EACH TYPE INCLUDED ☐ YES ☐ NO					
	☐ FLAME PROTECTION SYSTEM					
	ACCORDING TO NFPA 85 TYPE "SUPERVISED MANUAL" ☐ YES ☐ NO					
	EXECUTION TYPE LOCAL CONTROL ROOM					
	BURNER MANAGEMENT PANEL ☐ LOCAL ☐ CONTROL ROOM					
	LOGIC TYPE ☐ SOLID STATE ☐ WITH RELAIS ERMETICALLY SEALED IN INERT GAS					
	LOGIC ☐ LOCAL ☐ CONTROL ROOM					
	NUMBER OF PHOTOCELLS PER BURNER					
	VOLTMETER FOR PHOTOCELLS ☐ YES ☐ NO					
	SELF CHEKING TYPE					
40	FANS					
	SERVICE ☐ AIR ☐ SMOKE ITEM					
	FLOW AT MCR/DESIGN Nm³/h DESIGN TEMP. °C					
	TOTAL HEAD m bar ABSORBED POWER Kw					
	SPEED RPM					
	CHARACTERISTICS ACCORDING TO DATA SHEET					
	SEALING AIR FAN ☐ YES ☐ NO. INSTALLED POWER Kw					
	REMARKS :					

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CONSTRUCTION FEATURES

	FAN ELECTRIC MOTOR CHARACTRISTICS				
	POWER Kw	No. POLES		TRANSMISSION	
	SEE ATTACHED DATA SHEET				
	FAN STEAM TURBINE CHARACTERISTICS				
	POWER Kw SPEED RPM	TRANSMISSION		DIRECT ☐	GEAR ☐
	STEAM SPECIFIC CONSUMPTION	Kg/Kw h			
	SEE ATTACHED DATA SHEET				
	SELF SYNCRONIZING COUPLING	☐ YES	TYPE		
	FAN INLET SILENCER	☐	ΔP m. bar		
	COMBUSTION AIR VENTURIMETER	☐ YES	ΔP m. bar		
	FAN INLET CONTROL VANE (WITH SERVOMETER)		TYPE		
	BYPASS AND STOP DAMPERS (WITH SERVOMETER)		☐ INCLUDED		☐ EXCLUDED
41	☐ AIR DUCTS BETWEEN VARIOUS PARTS		THICKNESS mm		
42	☐ FLUE GAS BETWEEN VARIOUS PARTS		THICKNESS mm		
	☐ INSULATED	☐ UNITED			
43	SOOT BLOWERS	☐ YES	☐ NO		
	FOR EVAPORATOR	No.	TYPE		
	FOR ECONOMIZER	No	TYPE		
	FOR AIR PREHEATER	No	TYPE		
	FOR SUPERHEATER	No.	TYPE		
	SOOT BLOWERS PANEL	☐ LOCAL	☐ CONTROL ROOM		
		☐ MANUAL	☐ AUTOMATIC		☐ BY SEQUENCE
	EXECUTION TYPE				
44	SAFETY VALVE ON UPPER DRUM				
	No. SETTING PRESSURE bar(a)		/FLOW OF EACH VALVE Kg/h		
	MANUFACTURER	TYPE			
45	SAFETY VALVE ON SUPERHEATER				
	No. SETTING PRESSURE bar(g)		/FLOW OF EACH VALVE Kg/h		
	MANUFACTURER	TYPE			
46	REFRACTORIES				
	INSTALLATION/THICKNESS	mm			
	ALUMINA CONTENT %	FUSION POINT °C			
47	INSULATION				
	MATERIAL	SPECIFIC GRAVITY Kg/m³		THICKNESS mm	
48	CASING				
	THICKNESS INNER/OUTER mm				
	MATERIAL				
	REMARKS				

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CONSTRUCTION FEATURES

56 STACK

☐ MATERIAL SELF SUPPORTING ☐ CONCRETE ☐ INCLUDED ☐ EXCLUDED
☐ INTERNALLY GUNITED ☐ EXT. INSULATION FOR PERSONNEL PROTECTION
☐ EXTERNAL ANTIRUST PAINTING ☐ EXTERNAL LADDER
WIND LOAD/SPEED bar/Kg/h ☐ PLATFORMS FOR EXT. LADDER
THICK./DIAMETER BASE mm TOP mm
HEIGHT CORROSION ALLOWANCE mm.
☐ No 1 FOR BOILER ☐ COMMON TO THE BOILERS
STACK DAMPERS ☐ YES ☐ NO TYPE

57 VALVES LEVELS AND LOCAL INSTRUMENTATION

VALVES ON PRESSURE PARTS	☐ SINGLE	☐ DOUBLE
FEED WATER VALVES	☐ GATE	☐ CHECK
CONTINUOUS BLOW DOWN VALVES	☐ WITH OPENING INDEX	
STEAM STOP VALVE	☐ MANUAL	☐ MOTOR
CHECK VALVE ON STEAM OUTLET		
START-UP BLOW OFF VALVES	☐ DOUBLES	☐ MOTOR
DRAIN AND VENT VALVES	☐ SINGLE	☐ DOUBLES
VALVES FOR INSTR. ON PRESS PARTS	☐ DOUBLES	☐ SINGLE
FUEL VALVES	AS PER SPEC	
SILENCES ON STEAM LINE TO ATM.	☐ YES	☐ NO
	FLOW RATE	NOISE LEVEL dbA

58 STEAM DRUM LEVEL INDICATORS

No. TYPE ILLUMINATED ☐ YES ☐ NO ELEC. FEEDING

59 REMOTE LEVEL INDICATOR ☐ YES ☐ NO

60 SAMPLE COOLERS

No. TYPE MANUFACTURER
BOILER WATER ☐ SATURATED STEAM ☐ SUPERHEATED STEAM

61 BOILER DIMENSIONS AND WEIGHT

TOTAL LENGTH	mm.				
TOTAL WIDTH	mm.				
TOTAL HEIGHT	mm.				
MAX. DIMENSIONS AND WEIGHTS FOR TRANSPORT.	Kg	x	x	mm	
DRUMS WEIGHT	Kg	LOWER		UPPER	
EVAPORATOR TUBES WEIGHT	Kg	ECONOMIZER	Kg	SUPERHEATER	Kg
STEEL STRUCTURE WEIGHT	Kg				
STACK WEIGHT	Kg				
DUCT WORK WEIGHT	Kg	FIRING EQUIPMENT WEIGHT	Kg		
AUXIL. PIPING WEIGHT	Kg	VALVES WEIGHT	Kg		
REFRACT. WEIGHT	Kg	INSULATION WEIGHT	Kg		
STEAM AIR HEATER WEIGHT	Kg	AIR HEATER WEIGHT	Kg		
FAN WEIGHT	Kg	TURBINE WEIGHT	Kg	MOTOR WEIGHT	Kg
TOTAL WEIGHT OF SUPPLY	Kg				

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