ENGINEERING STANDARD

FOR

PROCESS DESIGN OF STEAM BOILERS

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APPENDICES:

0. INTRODUCTION

"Process Design of Combustion Type Heat Exchange Equipment" are broad and contain various subjects of paramount importance. Therefore, a group of process engineering standards are prepared to cover the subject of combustion type heat exchange equipment.

This group includes the following Standards:

STANDARD CODE	STANDARD TITLE
IPS-E-PR-800	"Process Design of Steam Boilers"
IPS-E-PR-810	"Process Design of Furnaces"

This Engineering Standard Specification covers:

"PROCESS DESIGN OF STEAM BOILERS"

The requirements outlined herein are supplementary to the specifications listed on the individual boiler data sheets (typical boiler data sheet is shown in Appendix A).

In the event of conflict among the various documents, the order of precedence shall be as follows:

- Individual boiler data sheets

- Iranian Petroleum Standards (IPS), Engineering Standard for Process Design of Steam Boilers, IPS-E-PR-800.

If conflict is discovered between the items listed, it shall be the responsibility of the Vendor to call attention to the conflict.

Approval of Vendor's drawings shall not relieve the Vendor from his responsibility in performance of the equipment specified herein.

1. SCOPE

This Engineering Standard Specification is intended to cover minimum requirements for process design of field erected water tube boilers.

The application of this Engineering Standard Specification shall be exercised, only in combination with the relevant mechanical standards, i.e., IPS-G-ME-170 "Fired Tube Boilers", and IPS-G-ME-180 "Water Tube Boilers", respectively.

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/Consultant:

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

PTC-4.1	"Heat Loss Abbreviated Method"
ASME	"Boiler and Pressure Vessel Code, Section I"

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

	"Special Technical Publication No. 148"
ASTM D-1066	"Tentative Method for Sampling Steam"
	"Test method ASTM D-1125-50T"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-PR-200	"Basic Engineering Design Data"
IPS-G-ME-170	"Fired Tube Boilers"
IPS-G-ME-180	"Water Tube Boilers"

NAFM (NATIONAL ASSOCIATION OF FAN MANUFACTURERS)

"Standard Test Code"

3. DEFINITIONS AND TERMINOLOGY

3.1 Air Heater or Air Preheater

An air heater or air preheater is a heat transfer apparatus through which combustion air is passed and heated by a medium of higher temperature, such as the products of combustion, steam or other fluid.

3.2 Atomizer

An atomizer is a device used to reduce a fluid to a fine spray, Atomization means are normally either steam, air or mechanical.

3.3 Blowdown

The drain connection including the pipe and the valve at the lowest practical part of a boiler, or at the normal water level in the case of a surface blowdown. The amount of water that is blown down.

3.4 Burner

A burner is a device for the introduction of fuel and air into a boiler at the desired velocities, turbulence and concentration to establish and maintain proper ignition and combustion. Burners are classified by the types of fuel fired, such as: oil, gas or a combination of gas and oil. A secondary consideration in classifying burners is the means by which combustion air is mixed with the fuel.

3.5 Burner Management System

That portion of a boiler control system associated with the supply of fuel to the burners. This includes the complete fuel train, safety shut-off valves, fuel pressure and temperature limits, burner starting and sequencing logic and annunciation of trouble signals.

3.6 Carryover

The moisture and entrained solids forming the film of steam bubbles, a result of foaming in a boiler. Carryover is caused by a faulty boiler water condition.

3.7 Combustion Control System

The portion of a boiler control system associated with the control and maintenance of air/fuel mixtures throughout the operating range of the burner and during changes in firing rate.

3.8 Company/Employer/Owner

Refers to one of the related affiliated companies of the petroleum industries of Iran such as National Iranian Oil Company (NIOC), National Iranian Gas Company (NIGC), National Petrochemical Company (NPC), etc., as parts of the Ministry of Petroleum.

3.9 Contractor

Refers to the persons, firm or company whose tender has been accepted by the Employer and includes the Contractor's personnel representative, successors and permitted assigns.

3.10 Damper

A damper is a device for introducing a variable resistance for regulating the volumetric flow of gas or air.

3.11 Downcomer

A tube or pipe in a boiler or waterwall circulating system through which fluid flows downward between headers.

3.12 Draft

Draft is the negative pressure (vacuum) of the flue gas measured at any point in the boiler, expressed in millimeters of water column (kilopascals).

3.13 Economizer

A series of tubes located in the path of the flue gases. Feedwater is pumped through these tubes on its way to the boiler in order to absorb waste heat from the flue gas.

3.14 Efficiency, Fuel

Efficiency, fuel refers to the heat absorbed divided by the net heat of combustion of the fuel as heat input, expressed as a percentage.

3.15 Efficiency, Thermal

Efficiency, thermal refers to the total heat absorbed divided by total heat input, expressed as a percentage.

3.16 Excess Air

Excess air is the amount of air above the stoichiometric requirement for complete combustion expressed as percentage.

3.17 Ignitor

A term used in industry to denote the device that provides the proven ignition energy required immediately to light on the pilot flame.

3.18 Low Heating Value (LHV)

The high heating value minus the latent heat of vaporization of the water formed by burning the hydrogen in the fuel.

3.19 Mud or Lower Drum

A drum or header-tube pressure chamber located at the lower extremity of a water tube boiler convection bank which is normally provided with a blowoff valve for periodically blowing off sediment collecting in the bottom of the drum.

3.20 Pressure Part

A component that contains pressurized water or steam or a mixture of the two.

3.21 Shop-Assembled Boilers

Water tube boilers, wholly or partly assembled in the manufacturer's workshop, requiring no further fabrication work on the pressure parts and shipped as one unit. It should be noted that such boilers are sometimes referred to as Packaged Boilers by suppliers.

4. SYMBOLS AND ABBREVIATIONS

ABMA American Boiler Manufacturers Association.

ANSI American National Standard Institute.

API American Petroleum Institute.

ASME American Society of Mechanical Engineers.

ASTM American Society for Testing and Materials.

BEDD Basic Engineering Design Data.

BSI British Standards Institution.

BSP Burner Start-up Panel.

CCR Central Control Room.

DCS Distributed Control System.

DN Diameter Nominal, in (mm).

FDF Forced Draft Fan.

HPP High Point of Paving.

ID Internal Diameter.

LHV Low Heating Value.

LLL Low Liquid Level.

LLLL Low Low Liquid Level.

MCR Maximum Continuous Rating.

MFT Master Fuel Trip.

NAFM National Association of Fan Manufacturers.

NPS Nominal Pipe Size, in (inch).

ppm parts per million.

PTC Performance Test Code.

TDS Total Dissolved Solids.

vol% Volume Percent.

5. UNITS

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

6. DESIGN DATA

6.1 Vendor's guarantee of boiler performance shall be based on specified ambient conditions at plant site.

The design shall be proven in practice, rugged and reliable, tenderer shall provide a list of similar installations which have already been built and which are in operation.

Ease of operation, safety, inspection, maintenance, repair and cleaning shall be of major concern in design and arrangement of boilers.

The boilers and auxiliary equipment shall be designed and erected in accordance with the latest edition of section I of the ASME boiler and pressure vessel code, including all published addenda and interpretations thereto. The boiler and all auxiliary equipment listed as being supplied by Vendor shall be suitable for outdoor installation.

6.2 Boiler and ancillaries shall be capable of continuous 24 hours a day operation between a 36 month statutory shut down period .

6.3 The boiler supplier shall inform Contractor/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 Contractor/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.

6.4 Boiler shall be designed for the following operating conditions:

6.4.1 Guaranteed net steam capacity, for each boiler at superheater outlet excluding all blow down, heat losses and all steam used for boiler auxiliaries such as fans, soot blowers, burners, etc., as specified on data sheet.

6.4.2 Over design capacity for four hours continuous operation with an interval of not less than 20 hours between periods, Vendor to specify (minimum acceptable 15%).

6.4.3 Guaranteed turn down ratio, Vendor to specify.

6.4.4 Minimum thermal efficiency, as specified in the project specification, on fuel gas firing based on LHV.

The above mentioned boiler efficiency shall be guaranteed under the following conditions:

1) Final superheater/desuperheater pressure.
2) Final superheater/desuperheater temperature.
3) Feed water temperature at economizer inlet.
4) Ambient air temperature at FDF inlet.
5) Ambient air relative humidity.
6) Barometric pressure.
7) Fuel gas temperature.
8) Based on ASME PTC 4.1 heat loss abbreviated method.
9) Continuous blow down rate.

6.4.5 Superheater (in case desuperheater is not considered) outlet temperature shall be uncontrolled and Vendor shall guarantee the maximum variation in superheater steam outlet temperature throughout the operating range from 40% to full load.

6.4.6 Guaranteed operation superheater/desuperheater outlet pressure specified on the data sheet (typical boiler data sheet is shown in Appendix A).

6.4.7 Feedwater inlet temperature specified on the data sheet.

6.4.8 Purity of produced steam as specified in the project specification in ppm mass (mg/kg) with consideration of ppm mass (mg/kg) of total solids in the boiler water. The boiler manufacturer shall state the maximum TDS in the boiler water at which the required steam purity can be obtained.

6.4.9 The steam as measured at drum outlet shall have an impurity not greater than 0.02 mg/kg (ppm mass) silica. The wetness of the steam leaving the drum shall not exceed 0.02%.

6.4.10 Heat release (maximum and average) per cubic meters of furnace volume (volume enclosed by the effective heating surface) when firing specified fuels, Vendor to specify subject to Company's approval .

Maximum intensity of heat flow rate in kW/m^2 released in furnace based on effective heating surface (as defined below), Vendor to specify subject to Company's approval.

Effective heating surface is defined as the flat projected area of tubes and extended surface integral with tubes exposed to direct radiation (only first row of tubes in flue gas passes exposed to direct radiation should be counted for calculation of flat projected surface and refractory covered surface shall not be counted).

6.4.11 Superheater, drums and boiler tube system maximum design pressure, Vendor to specify, but a minimum of 300 kPa (3 bar) above operating pressure is required.

6.4.12 Steam drum and boiler tube system maximum design temperature specified on data sheet, superheater design temperature per code.

6.4.13 Total continuous and intermittent blowdowns shall not be more than allowable figure specified in the boiler data sheet of steam generated, Vendor to specify capacity at 100% rating.

6.4.14 Steam for fan drivers specified on the data sheet.

6.4.15 Exhaust steam from fan drivers specified on the data sheet.

6.4.16 Stack temperature, Vendor to specify.

6.4.17 Boiler feedwater and chemical injection specified on the data sheet.

7. STRUCTURAL DESIGN

For this Clause reference is made to IPS-G-ME-170, "Fired Tube Boilers", and IPS-G-ME-180, "Water Tube Boilers", respectively.

8. SPECIAL DESIGN FEATURES

8.1 Drums and Steam Generators

Necessary drum connections shall be provided for chemical cleaning and nitrogen sealing of boilers in addition to connections as required, i.e., steam outlet, safety valves, continuous blowdown, chemical feed, water column level controls, level alarm, feedwater, vent and bottom blowdown, etc. In case of necessity for winterization of the boiler, Vendor shall provide steam coils in each lower drum.

8.1.2 Suitable internals shall be provided for the distribution of the incoming feed water to ensure a proper distribution of the incoming water along the length of the drum, suitably placed to feed the down comer tubes but not to interfere with the correct function of the water level gages, and also for the chemical and for the collection of the continuous blowdown.

8.1.3 Provision for acid cleaning of boilers and nitrogen blanketing of (idle) boilers shall be provided.

8.1.4 Adequate provision should be considered for inspection and cleaning of waterwall headers (minimum two, one at each end of header).

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

1 ppm mass (mg/kg) up to 65 bar (ga).

0.5 ppm mass (mg/kg) from 65 bar (ga), to 135 bar (ga).

8.1.6 In order that drum stability may be evaluated, the boiler designer shall indicate the steam drum water content (effective) at normal, low-level and MCR loading.

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

8.1.8 Furnace wall, floor and roof tubes shall not incorporate 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.

8.1.9 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.

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

8.1.11 The boiler designer shall state the holding time provided by the reserve of water in the steam drum, between "low liquid level" (LLL) and "low-low liquid level" (LLLL), and the 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.

8.2 Burners

8.2.1 Combination forced draft steam atomized burners for firing all specified gas, all gasoline, all oil or any combination thereof shall be provided. The fuel on which boiler performance shall be guaranteed shall be specified. Provision shall be made for changing fuel or any one burner without affecting boiler operation in any way. One liquid fuel burner gun and one gas fuel burner shall be provided per each burner, separate tips for fuel oil and gasoline fuel shall be provided. Vendor shall specify the possibility of using single tip for both liquid fuels. Provision shall be made for preventing flue gas leakage when oil burner gun is removed for tip change or cleaning by use of air purge, etc.

8.2.2 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. the pilot flame shall be visible through the burner peep-hole, at least prior to the ignition of the main flame. 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.

8.2.3 Each burner shall be sized for 110% of its design load or such that the boiler MCR can be maintained with one burner out of use, whichever is greater. Burner flames shall be horizontal and not parallel with steam drum. Flame shall not impinge on wall or any metal parts .

8.2.4 The boiler supplier shall state the heat input of the proposed pilot burners.

8.2.5 Each furnace shall be supplied with burners with insulatable forced draft registers with steam atomizing oil units, center fired-type gas units, flexible metallic oil and steam hoses, flexible stainless steel gas hose, oil and steam shut-off valves and oil burner fittings. The oil units shall be equipped with swing check valves and air seals for use in a pressurized type steam generating Unit. The registers shall be equipped with necessary seals. Where gasoline fuel is specified, each burner shall be equipped with an interlocking device on the gasoline and atomizing steam supply complete with valves, interlock discs, piping and flexible joints on gasoline supply lines.

Each burner shall be provided with an electric gas ignitor with complete flame protection system with flame scanners, flame protection relays, interlocks, purge cycle timer, operating switch indicating lights, transformer, safety shut off valves, stainless steel gas hose, air hose, stainless steel gas strainer and air seal.

One burner holder and wrench assembly shall be provided for each boiler. Steam atomizing oil units for gasoline and one spare gun complete with tip end assembly shall be provided for each boiler. Fuel oil return lines should be equipped with non-return valves. The liquid fuel oil lines should be large enough with low friction factor.

8.2.6 The boiler manufacturer shall furnish a burner windbox cut and drilled to accommodate the burners described herein. Windbox shall be complete with necessary supports, division plates and access door, if required.

8.2.7 Specification of fuels to be burnt will be indicated for each installation.

8.2.8 Number of burners and arrangement of burners shall be submitted to the Company for approval.

8.2.9 A complete flame monitoring and safety control system to perform the functions shall be furnished by the Vendor. The system shall be clearly described in the proposal and shall be guaranteed for safe and efficient operation of the

boiler. Logic circuity being proposed shall be included in Vendor's proposal. Burner management systems shall be installed local to the burners, the system shall jointly monitor the burner and boiler to ensure safe start-up and shut-down of burners and boiler. Unless otherwise required by the 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 the burners on identification of a fault condition serious enough to warrant such action, or raise alarms to indicate faults of a less serious nature. Reset facilities shall be provided for both boiler and individual burner trips.

The system shall ensure that the agreed logic on which the sequence of operating functions is based shall not be capable of being interchanged or abridged. It shall be of proven reliability, operating on the stop-check principle where the system can only proceed if the preceding sequence has been completed. A failure to complete a sequence shall operate an alarm and a fault location system will identify the area of malfunction, and where practicable, the fault itself. Separate circuits shall be used so that only those required for actual operation are retained in service, the others maintaining a passive but energized role so that should component failure occur, it can be identified and repaired with the burner in service.

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.

The system shall be complete, without any areas of split responsibility, specially regarding furnace purging and boiler safety.

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

8.2.11 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.

8.2.12 The boiler designer shall justify any atomizing steam consumption greater than 0.5% of boiler MCR.

8.2.13 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 Clause 8.2.14 of this Standard.

8.2.14 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 between 25-70% MCR
5.0% O_2 between 0-25% MCR

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

8.2.16 Duplex type filters, or two filters in parallel, of 125 micrometers (.005 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.

8.2.17 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 detectors.

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

8.2.19 Provision shall be made for the 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.

8.2.20 Before the first burner on a boiler can be ignited, an adequate purge of the furnace and gas passes shall be automatically carried out. 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.

The air flow rate and duration of this purge procedure shall be specified and this shall be based upon the shape of the furnace and complexity of the flue gas passes. However, the air flow shall not be less than 25% 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.

8.2.21 The start up and shut down sequence shall be automatic with push buttons to start and stop the sequence for each burner. Colored lamps on the panels shall indicate the status of burners.

8.2.22 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.

8.2.23 Interlocks shall be provided to prevent burner start-up if the furnace conditions are not satisfactory. These shall initiate master fuel trip (MFT) system to shut-off the main fuel trip valves to the boiler at any time during operation, if they are not continuously satisfied. Conditions producing trip shall include the following:

a) Low-low water level in the 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 draft.
e) Loss of main burner flames (individual burner fuel cut off).
f) Loss of atomizing steam pressure (on liquid fuel firing).
g) Low pressure of instrument air (start up conditions only, "fail-locked" would operate when on load).

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

8.2.25 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 (e.g., upper burner start-up panel (BSP), lower burner start-up panel).

8.2.26 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.

8.2.27 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.

8.2.28 Gas off-takes for individual burners shall be from the top of the header.

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

8.2.30 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.

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

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

8.3 Ducts and Stacks

For this Clause reference is made to IPS-G-ME-170, "Fired Tube Boilers" and IPS-G-ME-180, "Water Tube Boilers", unless otherwise specified herein.

8.3.1 Unless otherwise specified, gas outlet damper for control of furnace pressure should be supplied by Vendor fitted with extended shaft.

8.3.2 All duct work shall be designed for fabrication in flanged sections. Particular attention should be paid to the design of the ducting from the boiler fans to the stack to ensure proper performance of one or both fans at all loads.

8.3.3 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 76 meters. Stack lining shall be Vendor's standard design, subject to Company's approval.

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

8.3.5 Stacks shall be equipped with aircraft warning lights per relevant job specification.

8.3.6 Ducting for air and flue gases shall be air tight and sufficiently stiffened.

8.3.7 Steel stacks shall have a minimum of 3 mm allowance for corrosion.

8.3.8 For air and flue gas ducting the air and gas velocities in ducting shall not exceed 13.7 m/s and 15.2 m/s respectively, taken all internal bracing and stiffeners into account.

8.4 Doors and Openings

For this Clause reference is made to IPS-G-ME-170, "Fired Tube Boilers" and IPS-G-ME-180, "Water Tube Boilers", unless otherwise specified herein.

8.4.1 Observation ports shall be furnished to permit visibility of furnace and flame conditions, the furnace floor and the superheater space during operation of the boiler. Observation ports of pressurized boilers shall be furnished with an aspirating type air interlock to prevent opening if the seal air is not turned on. Seal air shall be sufficient to prevent pressurized furnace gases from blowing out through the observation port.

8.5 Furnace

8.5.1 Maximum temperature on the outside of boiler casing shall be low enough so as not to constitute a hazard to the personnel.

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

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

8.5.4 Cavities above furnace roof tubes shall be designed 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 surveys.

8.5.5 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.

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

8.5.7 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.

8.6 Superheater/Attemperator

8.6.1 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.

8.6.2 Spray-water type attemperators shall normally be used, provided that there is a supply of demineralised 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.

8.6.3 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.

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

8.6.5 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.

8.6.6 Air vents shall be provided where necessary.

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

8.7 Insulation and Casings

8.7.1 Insulation material 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.

8.7.2 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.

8.8 Integral Pipework

8.8.1 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.

8.8.2 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.

8.9 Economizer

8.9.1 Economizers shall generally be an integral part of the boiler but may be supplied as separate units when 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.

8.9.2 Feedwater operating pressure and temperature in the economizer shall at no time permit the possibility of steam being generated.

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

8.10 Air Heater

8.10.1 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 the 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.

8.10.2 Air and gas bypasses shall be provided with proven soot blowing equipment.

8.10.3 Flue 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.

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

8.11 Valves and Accessories

The Vendor shall furnish the following valves and accessories, all as per ASME codes, details of which will be specified on the data sheet:

1) Safety valve (on boiler).
2) Blow-off valve (tandem).
3) Steam drum vent valve.
4) Chemical feed stop valve.
5) Chemical feed check valve.
6) Continuous blowdown micrometer valve.
7) Continuous blowdown line stop valve.
8) Steam gage.
9) Water gage stop valve.
10) Water gage drain valve.
11) Steam gage line stop valve.
12) Water gage.
13) Water wall drain valves (as required).

14) Superheater safety valves (according to ASME Section I PG-71).
15) Superheater inlet header drain valve.
16) Superheater outlet header drain valve.
17) Steam sampling connection from superheater inlet header.
18) Superheater vent valve.
19) Feed-water stop and check valves.
20) Non-return and stop valves on superheater outlet (Non-return valve means combined stop/check valve).
21) Two DN25 (1") ID (R F flanged) openings for the installation of the thermowells at the following locations:

a) boiler air inlet;
b) boiler outlet.

22) Double valves in series should be used for blowdown facilities, steam drum venting, sample connection (boiler water, saturated and superheated steam) and drain connections (lower drum, water walls, superheater). 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.

8.12 Instrumentation

8.12.1 Vendor shall submit the proposed instrument and control schematic drawings including combustion and feed water controls, adequate to fulfill the requirements of his process and mechanical guarantees for Company's approval.

8.12.2 Retractable thermocouples for superheater flue gas inlet temperature and superheater skin temperature thermo-couples, should be included for use during start-up periods.

8.12.3 There shall be local indication of instruments for each boiler and all controls and indicators shall be brought to central control room.

8.12.4 An external float type water column with switches for high and low level alarms with low water cut off shall be separately mounted on the steam drum. Low water cut off (low low water level) shall be separate from low level alarm and shall cause the fuels to the boiler to be cut off and an emergency alarm to be raised, both visual and audible in 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. High and low level alarms shall have different sounds and be sufficiently loud to be heard in the boiler area.

8.12.5 Identical direct reading water level gage glasses shall be provided on each side of each boiler. Each gage glass shall be fed by independent feed lines. Gage glass and water column drain valves shall be furnished. Water columns shall be fitted with flanged shut-off valves installed between the column and the drum. Each gage shall be capable of being blown-down or isolated for removal and repair without taking the boiler off-load.

8.12.6 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. This remote direct-reading gage shall be of sturdy construction to overcome vibration.

8.12.7 Design of low level steam drum switches shall be such as to avoid tripping due to vibration.

8.12.8 A pressure tap connection and thermowell connection at superheater outlet header shall be provided.

8.12.9 Connection of gas sampling shall be provided at boiler outlet, burner air inlet, furnace and shall be DN 25 (1"NPS) size. Their location shall be such that representative samples are obtained.

8.12.10 Boiler controls

8.12.10.1 General

Vendor shall guarantee that proposed control system will permit sound and reliable operation of boilers over the whole range of operation.

Boiler controls shall be designed to fire all types of fuels or combination of them as indicated on the boiler data sheet. The turn down ratio under all firing conditions shall be as defined on boiler data sheet. However, this should be qualified to the extent that: any minimum firing range for a single fuel or a combination of fuels is determined from actual field tests when placing the equipment in operation.

8.12.10.2 Steam header pressure control (general plant control)

The plant master shall control the main header pressure to a set point determined by the operator. The plant master shall control this pressure by changing the firing rate of the boilers. The plant master controls a boiler when its combustion controls are in full automatic.

If the load demand increases, the main steam header pressure will decrease, the plant master shall sense this and increase its output until the main header pressure is back to the set point. If the load demand decreases the opposite is true.

8.12.10.3 Combustion controls

The plant master output shall change to meet load demand. The change in plant master output shall act as air rich control as follows:

1) Boiler load up

- Boiler master signal increase.
- Air flow demand signal increase.
- Fuel flow demand signal increase after actual air flow increase.

2) Boiler load down

- Boiler master signal decrease.
- Fuel flow demand signal decrease.
- Air flow demand signal decrease after actual fuel flow decrease.

8.12.10.4 Feed water control system

The feed-water flow shall be controlled by a three element feed-water control system.

The drum water level shall be measured by a differential pressure transmitter. The level signal from this transmitter shall be compared with the fixed set point in master drum level controller. The output signal of the master level controller, summed with the steam flow signal, is fed to the (salve) boiler feed water flow controller as the set value of the feed-water flow . The output signal of this controller (i.e., feed water flow controller) shall change the boiler feed water flow control valve opening. For start-up period and low load operation single element control shall be provided, the transfer between single element and three element control shall be carried out according to boiler load automatically and also manually through DCS selector switches.

8.12.10.5 Boiler master control system

Boiler master control shall provide two kinds of control mode, one is common master mode and the other one is individual boiler master mode.

1) Common master control: When the boiler is operated in parallel with the other boiler units, this control mode must be selected. In this mode the boiler is controlled as to maintain the common high pressure steam header pressure.

2) Individual boiler master mode: In this mode, the boiler shall be controlled as to maintain the individual superheater outlet steam pressure. This control mode is used for boiler start-up and shutdown and/or special isolated operation. After the steam pressure rises up to the same value as the high pressure steam header pressure, controlled signal must be transferred from superheater outlet line pressure to the common high pressure steam header pressure.

8.12.10.6 Oxygen compensation control

Excess air ratio control shall be achieved by measuring the flue gas oxygen content and trimming the air flow. The O_2 content in flue gas is measured by an oxygen analyzer. The output signal of the analyzer is to be fed to the flue gas oxygen controller. The desired value of oxygen content is to be set according to the steam flow signal. Also, it shall be possible to change the set value of oxygen controller by using the bias function from a hand controller.

Comparing the signal from the oxygen analyzer and the desired value, the controller shall alter the output signal until both signals are the same. The output signal of this controller shall be fed to the air flow control loop to trim the air flow signal.

8.12.11 The following equipment will be mounted on a lighted, free-standing, rear-closed, weather-proof local instrument panel, boiler control panel or locally as appropriate:

1) Draft gages [Pressures at F.D fan outlet, air heater outlet (air side), burner windbox, furnace at burner level/after superheater/ boiler outlet, Economizer outlet, air heater outlet (flue gas side)].

2) Flame safety equipment.

3) Soot blower control equipment.

4) The following indicators shall be easily and significantly visible from the local panel or located on the local panel:

a) Atomizing steam pressure.
b) Combustion air flow.
c) Pressure of fuels and pilot gas downstream of control valves (also local instruments).
d) Fuel supply pressure (also local instruments).
e) Boiler water conductivity.
f) Steam purity analyzer.
g) Air and flue gas temperature at:

- Air heater inlet (flue gas).
- Air heater outlets (air and flue gas).
- Flue gas after secondary stage of superheater.
- Flue gas, primary stage of superheater.
- Flue gas at boiler outlet.

h) Flue gas O_2 analyzer/controller/recorder (also local indication).

i) Feed flow recorder.

j) Drum level recorder.

k) Fan speed indicator.

l) Steam pressure recorder.

m) Drum and superheater outlet pressure (also local gage).

n) Steam flow indicator/recorder.

o) Instrument air pressure gage.

p) Fuel flow indicator/recorder with integrator for each fuel.

q) Fuel temperatures at burners (also local instruments).

r) Burner and pilot ON/OFF indication.

s) Final steam temperature.

t) Desuperheater/attemperator spray water supply pressure.

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

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

8.12.12 Boiler lock-up system: each boiler shall lock up on loss of instrument air to the boiler control panels. A master relay shall trip all lock-up valves on control drives and valves. This shall allow the boiler to operate at a fixed rate. Trimming of bypass valves may be necessary to maintain drum level and steam pressure. An alarm window shall indicate that a boiler is locked-up

8.12.13 All instrumentation shall be suitable for continuous working in the conditions of their location.

8.12.14 Provision shall be made for local tripping of critical equipment.

8.12.15 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 the Company for approval.

8.12.16 Control valves:

a) 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.

b) The type of valve shall be selected according to the service. Special valves shall be used where cavitation, noise, flashing or erosion may occur.

8.12.17 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 fuels are to be supplied are not satisfactory for the burners he intends to use.

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

8.12.19 Under normal operating conditions, including the load fluctuation specified by the 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) higher/lower than the design level.

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

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

8.12.22 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.

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

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 .

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 the economizer.
d) O_2 in boiler feed water, indication and recording.
e) pH of feed water.

8.12.23 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 override condition shall be given on the panel face.

8.12.24 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 overridden for test. Final element trip testing on a single fuel basis should be provided where more than one fuel is used.

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

8.13 Fans and Drivers

8.13.1 Fans, drivers and gearboxes shall be at an easily accessible location (for maintenance and motor removal) at the rear of the boiler, mounted on foundation blocks at grade level. Unless otherwise specified, each boiler shall have two 75% capacity fans. The forced draft fans on all boilers should be identical. Fans shall be of centrifugal type, providing stable operation under all conditions of boiler load. Fans efficiency should not be less than 80%.

8.13.2 Fan performance guarantee shall be in accordance with the standard test code of "National Association of Fan Manufacturers". Fan performance shall also be guaranteed to meet all operating conditions specified on the data sheets. A characteristic fan performance curve shall be submitted in Vendor’s proposal for Company’s approval .

8.13.3 Fans and associated drivers shall be designed, sized, (and capable of handling all air requirements for all fuels) as follows:

1) Fan rating shall be established on the maximum ambient temperature for the location. Unless otherwise specified, each fan shall be sized to provide 75% capacity at the rated load.

2) Fans shall be turbine driven with gear reducer, one fan for one boiler (at least one, total number of dual drive fans to be specified by the Company), should have dual drive for stand-by purpose. One end of this fan shall be coupled to a steam turbine and the other end to an electric motor. Each driver shall be connected through one way clutch for automatic disconnection when either driver is disengaged.

3) Fans shall be supplied with inlet screen, cleanout door and a silencer. The air intake main connection for the silencer shall be flanged and a minimum of 3.2 mm corrosion allowance shall be considered. Pressure drop across each silencer shall not exceed 12.7 mm H_2O (1.25 kPa).

4) Vendor shall furnish for each draft fan inlet a suitable air intake device to reduce sand and dust intake.

5) The control of combustion air shall be accomplished by controlling fan inlet damper. The damper operator shall be furnished by the Vendor and shall be equipped with a pneumatic positioner. The damper operator shall be provided with a continuously connected handwheel.

6) The boiler Vendor shall provide in the air duct between the fan and the burners, a primary air measuring element for the purpose of measuring total air flow rate.

7) Turbines steam inlet and exhaust conditions (maximum/normal/design pressure and temperature) shall be as per Company's relevant Standard Specification IPS-E-PR-200 (BEDD).

8) The elevation of FDF air intake point shall be at least 5 meters above the high point of paving (HPP).

8.14 Soot Blowers

8.14.1 Adequate number of soot blowers shall be provided to keep each boiler clean in service (free of soot). Soot blowers may be of the retractable or rotary type per operational requirement and shall come complete with electric motor drive. Retractable soot blowers shall be operated automatically. Control for automatic sequential operation of soot blowers to be mounted on local panel provided by the Vendor .

8.14.2 Each soot blower shall also be capable of independent manual operation. The system shall be designed for automatic removal of condensate to avoid water shock to the tubes and keeping steam temperature above saturation upstream of the lance tubes.

8.14.3 All headers, branches, fittings, valves, drain valves, control valves, pipe hangers and guides as required for soot blowing systems to be supplied.

8.14.4 The boiler supplier shall support his proposal of soot blowers 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.

8.14.5 The supervisory controls of soot blowers 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.

8.14.6 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.

8.14.7 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.

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

8.14.9 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.

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

8.15 Lighting

8.15.1 Lighting shall be provided at all platforms, ladders and stairways and around the boiler and its auxiliaries. The lighting levels shall be subject to the Company's approval.

8.15.2 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.

8.16 Boiler Feed and Boiler Water Quality and Chemical Conditioning

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

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

8.16.3 The recommended maximum TDS in the boiler water shall be stated by the boiler designer.

8.16.4 Any necessary chemical mixing and injection equipment shall be included by the boiler supplier and the Company will specify the required extent of duplication of equipment such as injection pumps and chemical mixing tanks. Appendix B shows typical data sheet for chemical feed system.

8.16.5 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.

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

8.17 Chemical Cleaning

8.17.1 The internal surfaces of the boiler and economizer shall be mechanically cleaned as necessary and then chemically cleaned before being put into service.

8.17.2 All boilers shall be given an alkaline boil-out, followed by acid cleaning if specified, depending upon the amount of mill scale and iron oxide to be removed and the pressure at which the boiler will operate.

8.17.3 The temporary recirculating system used during chemical cleaning shall be hydraulically tested to 1-1/2 times the pressure at which the cleaning process is to be carried out. Circulation shall be arranged in such a manner as will ensure that no part of the system will be short-circuited.

8.17.4 Superheaters shall not be acid-cleaned but steam blown at velocities calculated to provide a forward momentum greater than the service momentum.

8.17.5 The entire cleaning procedure shall be the responsibility of the boiler supplier and be agreed by the Company.

8.18 Tools

One complete set of pneumatic tube rollers with two complete set of spare tools for each size of tube to be expanded should be furnished. Any other special tools required for maintenance of operation shall be provided. These furnished tools are to be used only for Owner's maintenance.

Any other special tools required for carrying out normal maintenance should be specified and provided.

9. PERFORMANCE CONDITIONS

Performance data for the equipment supplied will be submitted herewith and made part of this Standard in the form recommended by the American Boiler Manufacturers Association and affiliated industries as follows:

9.1 General

9.1.1 It is recognized that the performance of the equipment supplied can not be exactly predicted for every possible operating condition. In consequence, any predicted performance data submitted are intended to show probable operating conditions which may be closely approximated to, but which cannot be guaranteed except as expressly stated in the guarantee clauses.

9.1.2 The general arrangement of the equipment furnished by the boiler manufacturer and the general design and arrangement of related equipment furnished by the purchaser shall be as shown on the drawings submitted by the boiler manufacturer.

9.2 Air and Gas

9.2.1 The unit shall have sufficient forced draft fan capacity available to provide the necessary air for combustion at a pressure in 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.

9.2.2 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.

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

9.3 Water

9.3.1 The boiler water concentration in the steam drum shall be specified in the 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.

9.3.2 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-1125-50T.

9.3.3 Sample collector for checking of boiler TDS shall be provided with sample cooler and pressure reducing device.

9.4 Performance Tests

Prior to acceptance, the boiler manufacturer shall conduct such operating tests as are necessary or required by the purchaser such as:

1) The steam dryness fraction.

2) That the purity of the steam meets the guarantee under the declared conditions of boiler water, TDS, boiler load, steam drum level and normal water level fluctuations.

3) The limits of adverse conditions such as high TDS, high water level, high silica content and severe load swings, which might cause a deterioration in steam quality beyond that acceptable, to demonstrate satisfactory functional and operating efficiency. Boiler manufacturer shall be responsible for furnishing all instruments and equipment, such as portable analyzers, which are required in making the specified performance and efficiency tests.

Performance tests and performance calculation shall be made in accordance with the applicable short test form in the latest edition of the ASME Test Code for Stationary Steam Generating Units and the measure of performance shall be the results of such tests.

10. GUARANTEE

10.1 In addition to the mechanical guarantee required by IPS-G-ME-170 and IPS-G-ME-180, the Vendor shall guarantee in writing that each boiler will produce from ¼ of load to full load of steam rating as specified on the data sheet and "Design Data" section of this Standard without detrimental carryover into the superheater tubes and without flame impingement upon any boiler tubing when burning any combination of the gas, gasoline and fuel oil 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 "Design Data" section of this Standard and the minimum load for a continuous period of 24 hours.

10.2 This equipment shall be guaranteed on the basis of steam output (MCR) specified in the data sheet with steam and feed-water conditions described when burning the specified fuels and taking amount of the blowdown percentage specified by the Company. The supplier guarantees the purchaser that the equipment furnished is free from fault in design, workmanship and material and is of sufficient size and capacity and is of proper material to fulfill satisfactorily the operating conditions specified.

Should any defect in design, material , workmanship or operating characteristics develop after 12 months of operation or after 36 months following shipment from the supplier’s plant, whichever occurs later, the supplier agrees to make all necessary or desirable alterations, repairs and replacements free of charge, if the defect or failure to function can not be corrected, the supplier agrees to replace promptly, free of charge, said equipment or to remove the equipment and refund the full purchase price.

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

a) Steam quality at MCR and specified part loads at the maximum allowed boiler water TDS.
b) Steam temperature at MCR and specified part loads.
c) Excess combustion air at MCR and specified part loads.
d) Steam consumption of steam-atomizing burners.
e) Contaminants, e.g., NOx, in flue gases released to atmosphere when firing the specified fuel(s).
f) Overall thermal efficiency when burning the specified fuels at MCR.
g) Electrical power or steam consumption at MCR of ancillary equipment in the boiler supplier’s scope.
h) Generated noise level in accordance with relevant company’s noise specification.

11. PREDICTED PERFORMANCE CONDITIONS

Predicted performance data should be filled in by Vendor as per boiler data sheet. It is understood that this data is predicted only and shall not be considered as being guaranteed except where conditions given coincide with those stipulated elsewhere in this Standard.

12. INFORMATION REQUIRED WITH QUOTATIONS

12.1 Data sheet per Appendix A should be completely filled out. Additional data normally supplied by vendor shall be given separately. The following data must also be included:

12.1.1 Outside radiant heating surface in square meters.

12.1.2 Outside convection heating surface in square meters.

12.1.3 Outside superheater surface in square meters.

12.1.4 Overcapacity rating and maximum time allowed to run at this overcapacity rating.

12.1.5 Efficiency at full, 75%, 50%, 25% load on fuel gas firing based on LHV. Excess air and ambient temperature used in calculating these efficiencies shall be included.

12.1.6 Heat release in MJ per cubic meters of firebox volume.

12.1.7 Individual specification data sheets for fans and other ancillary equipment, indicating turbine steam rate/power, fan test block conditions at this power (kW) shall be indicated.

12.1.8 Material, type, size and wall thickness of water tubes and superheaters. Material, size and wall thickness of headers. Material, size and design pressure of drums.

12.1.9 Steam and mud drum dimensions including wall thicknesses.

12.1.10 Stack height, diameter and wall thickness.

12.2 Capacity capability using natural draft when draft fans fail.

12.3 Proposed field testing procedures including dry-out, start-up sequencing, time intervals, etc.

12.4 Overall dimensions for layout purpose, ladders, stairways and platforms supplied shall be shown.

12.5 Drawings showing the general layout of the boiler including firebox, tubes, burners, air ducts, soot blowers, inspection and access doors, peepholes, observation windows, piping and valve arrangement, stack ducts and all connections.

12.6 Vendor shall specify maximum anticipated noise levels at full boiler capacity.

12.7 The proposed design shall be proven in practice, rugged and reliable. Tenderer shall provide a list of similar installations already in satisfactory operation for a period of at least 2 years.

12.8 Proposal shall either state compliance with the specifications or list the exceptions taken, exceptions mentioned are subject to Company's approval.

12.9 Superheater steam inlet and outlet temperatures and velocities on basis of boiler load .

12.10 Hold up time and capacity of steam drum between normal level and low level shutdown at rated capacity of boiler.

12.11 Heat balance.

12.12 Quantity of fuel at MCR, heat supplied by fuel, rate of flue gas produced, heat to steam, heat loses due to dry flue gases/moisture in air/atomizing steam/radiation/others, flue gas temperature and pressure leaving furnace/entering and leaving superheater/entering and leaving convection and evaporation sections, flue gas velocity at superheater and boiler passes.

12.13 Specification of burner type, layout, model, size and manufacturer.

12.14 Soot blower type, location, manufacturer and arrangement.

12.15 Statement of maximum permitted boiler water TDS.

12.16 Statement of furnace positive and negative pressures.

12.17 Method of fuel consumption and thermal efficiency tests, with correction formulae, curves, etc. used in the calculations.

12.18 Approximate dimensions, layout and location of local and remote control panels.

12.19 List of the major control loops, general statement of local and remote panel instrumentation.

12.20 Details of steam drum internals.

12.21 Design and construction of flue gas dampers.

12.22 Burner fuel gas flow rate and automatic control.

12.23 Breakdown of total feedwater pressure requirement.

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

12.25 Specifications, data sheets, sizing data and proposed suppliers of control equipment.

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

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

12.28 Burner flame detection equipment.

12.29 Design of stack duct entries.

12.30 Winterization proposals for plant protection.

12.31 Flue gas ducting internal lining.

12.32 Block logic diagrams of the burner management.

13. DRAWINGS AND DATA REQUIRED

Approval of final drawings and detail design is required as listed below:

1) All items specified under Section 12 of this Standard, entitled "Information Required with Quotations".

2) Flame failure system with list of material.

3) Sufficient copies as required by the Company of operating manuals containing procedures for dryout, boil out, safety valves floating, commissioning, etc.

14. SPARE PARTS

Spare parts shall be considered in 3 categories as follow:

a) Pre-commissioning.
b) Commissioning.
c) Permanent (for 24 months operation).

14.1 The supplier shall specify in his proposal all above mentioned spares separately with the required lists.

14.2 The supplier shall submit, prior to pre-commissioning work, a complete spares manual, to include all spares recommended as permanent stock.

15. WINTERIZATION

In general all plant and equipment, including auxiliaries, shall be protected against damage or inability to operate under the winter conditions specified/agreed for the location concerned. Detailed requirements for winterization shall be as per relevant Company's winterization specification.

APPENDICES

APPENDIX A
TYPICAL BOILER DATA SHEET

Job No. ..... Item No. .....
Purchaser Order No. .....
Inquiry No. .....
Page 1 of 11

Rev				
DATE				
APPD.				

NIOC BOILER SPECIFICATION SHEET

PROJECT ..... MFG. .....
DESIGN CAPACITY ..... kg/s SERVICE ..... UNIT .....
No. BOILERS ..... BOILER TYPE .....
PACKAGE/FIELD ERECTED ..... REFERENCE SPECIFICATION: .....

DESIGN DATA

MAXIMUM CONTINUOUS STEAMING CAPACITY EACH BOILER ..... kg/s ..... ALL BOILERS ..... kg/s
OVER CAPACITY REQUIRED ..... % OF DESIGN FOR 4 IN 24 HOURS
OPERATING RANGE ..... % TO 100 % OF OVER CAPACITY
OPERATING STEAM PRESSURE FROM (S.H.) ..... kPa (ga) GUARANTEED
OPERATING STEAM TEMPERATURE FROM (S.H.) ..... °C INCLUDES ..... °C SUPERHEATER.
MAXIMUM ALLOWABLE PRESSURE DROP ACROSS SUPERHEATER ..... kPa (ga)
FEEDWATER TEMP. ..... °C, STACK TEMP. REQUIRED ..... °C
FEEDWATER PRESS. ..... °C ECONOMIZER INLET TEMP. ..... °C
SITE ELEVATION ..... m ABOVE SEA LEVEL, AMBIENT TEMP. RANGE ..... °C TO ..... °C
BLOWDOWN RATE PER SPEC. ..... : COOLING WATER AVAILABLE AT ..... °C
MAXIMUM OUTLET ..... °C CHEMICAL INJECTION .....

FUEL DATA

GAS: TYPE	OIL: TYPE	OTHER .....
LHV ..... kJ/kg	LHV ..... kJ/kg	LHV ..... kJ/kg
HHV ..... kJ/kg	HHV ..... kJ/kg	HHV ..... kJ/kg
MOLECULAR MASS	TEMP. & BURNER ..... °C	MOLECULAR MASS .....
TEMPERATURE ..... °C	VISCOSITY @ ..... °C ..... Pa.s	CATALYST FINS ..... kg/s
.....	REL. DENSITY	MAX. FLOW ..... kg/s
	(SP.GR.) @ 60°C	NORMAL FLOW ..... kg/s

FUEL ANALYSIS	vol.%	ANALYSIS:	%MASS	ANALYSIS:	%MASS
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....

FEED WATER DATA

PH .....
DISSOLVED O_2 ..... mg/kg TOTAL HARDNESS (AS CALCIUM CARBONATE) ..... mg/kg
Na ..... mg/kg Ca HARDNESS (AS CALCIUM CARBONATE) ..... mg/kg
Cl ..... mg/kg Mg HARDNESS (AS CALCIUM CARBONATE) ..... mg/kg
S_1O_2 .....
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(to be continued)

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NIOC BOILER SPECIFICATION SHEET

ITEMS TO BE SUPPLIED BY BOILER MANUFACTURER FOR EACH BOILER ADDITIONAL TO SPEC.

..... BOILER PIPING & WIRING
..... WIND BOX
..... SOOTBLOWER WALL BOXES
..... FEEDWATER REGULATOR
..... FEEDWATER REGULATOR BY-PASS
..... AIR PREHEATER
..... ELECTRIC OIL HEATER & CONTROLS
..... F.W. REGULATOR BY-PASS
..... FURNACE DRAFT REGULATOR
..... BOILER OUTLET DAMPER
..... OIL PUMPING & HEATING SET
..... PLATFORMS, STAIRWAYS & LADDERS-INTEGRAL
..... STACK MIN. HEIGHT ..... m MAX. HEIGHT ..... m
..... STACK LINING
..... ECONOMIZER WITH SUPPORTS
..... SAFETY CONTROLS & LOW WATER Co.

..... No. F.D FANS 2 PER UNIT
..... F.D FAN MOTOR DRIVE
..... F.D FAN TURBINE DRIVE 2 PER UNIT
..... F.D FAN GEAR
..... F.D FAN CAPACITY EACH:
..... COMBUSTION CONTROLS
..... GAS ELECTRIC IGNITION
..... PANEL BOARD(S) NO REQUIRED-LOCAL-CENTRAL
..... (PER SPEC.)
..... PAINT PER PAINT SPEC.
..... INSULATION OR LINING - GAS $ AIR DUCTS
..... ANCHOR BOLTS
..... FREIGHT
..... EXPORT PACKING
..... PRESSURE PARTS TEST
..... CASING PRESSURE TEST

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REMARKS: .....
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(to be continued)

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MECHANICAL DESIGN CONDITIONS
(to be filled by Boiler Manufacturer)

GENERAL

MANUFACTURER .....
MANUFACTURER MODEL No. .....
BOILER SURFACE AREA .....(m²)
DESIGN CAPACITY .....(tonne/h)
OVER CAPACITY .....
OPER. STEAM PRESSURE ..... kPa(ga)

BOILER TYPE .....
OVERALL DIMENSION .....m
TOTAL MASS .....kg
CONT. RATING (MAX.) ..... (tonne/h)
PERCENT OF DESIGN FOR ..... (HOURS/24 HOURS)
OPER. STEAM TEMP. .....°C

FURNACE

FURNACE VOLUME .....(m³)
FURNACE WALL CONSTR. .....
SPACING OF WALL TUBES .....(mm)
EFFECTIVE PROJECTED RADIANT SURFACE .....(m²)
TEMP. OF GAS ENTERING S.H. .....(°C)
INSIDE DIAMETER OF WALL TUBES .....(mm)

FURNACE SURFACE .....(m²)
WALL SHIPPED IN PANEL YES b NO b
TUBE MATERIAL .....
FURNACE HEAT RELEASE .....(kJ/m² /h)
TUBE WALL TEMP. .....°C
THICKNESS OF WALL TUBES .....mm

DRUMS

	STEAM	WATER/MUD.
TANGENT & TANGENT DIMENSION, (mm)	.....	.....
OVERALL LENGTH, (mm)	.....	.....
INSIDE DIAMETER, (mm)	.....	.....
VOLUME, (m³)	.....	.....
TUBE SHEET THICKNESS, (mm)	.....	.....
WRAPPER THICKNESS, (mm)	.....	.....
PRESSURE, DESIGN kPa(ga)	.....	.....
PRESSURE, OPERATING kPa(ga)	.....	.....
TEMPERATURE, DESIGN (°C)	.....	.....

MATERIAL .....
LEVEL GAGE TYPE .....

TYPE OF INTERNALS .....
LOCATION ..... No. /UNIT .....

SUPER HEATER

TUBE OUTSIDE DIAMETER .....(mm)
CENTER LINE SPACING .....(mm)
DESIGN PRESSURE ..... kPa(ga)
DIRECTION RADIATION .....(KJ/h)
AVERAGE HEAT TRANSFER RATE AT 100% CAPACITY .....(W/m² °C)
TOTAL SURFACE AREA .....(m²)
MAX. TUBE WALL TEMPERATURE AT 100% CAPACITY .....(°C)
GAS FLOW AREA .....(m²)
FUEL GAS TEMPERATURE .....(°C)
NUMBER OF PARALLEL FLOWS .....
INLET HEADER I/D THICKNESS .....(mm)
HEADER MATERIAL (INLET/OUTLET) .....

TUBE WALL THICKNESS .....(mm)
MATERIAL .....
PRESSURE AT FUEL LOAD ..... kPa(ga) PRESSURE DROP ..... kPa(ga)
HEAT TO SUPERHEATER .....(KJ/h)

HEATING SURFACE .....(m²)

STEAM FLOW AREA .....(m²)
FUEL GAS TEMPERATURE .....kPa(ga)
FOULING FACTOR .....

CORROSION ALLOWANCE .....(mm)

SAFETY VALVES

	Stem Drum	Super Heater
NUMBER OF SAFETY VALVES	.....	.....
NOMINAL DIAMETER OF VALVES	.....(mm)	..... (mm)
CAPACITY OF EACH VALVE	..... (kg/h)	..... (kg/h)
WORKING PRESSURE	..... kPa(ga)	..... kPa(ga)

(to be continued)

APPENDIX A - (continued)

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MECHANICAL DESIGN CONDITIONS
(to be filled by Boiler Manufacturer)

ECONOMIZER

TYPE ..... No. OF TUBES ..... No. OF PASSES .....
TUBE OUTSIDE DIAMETER ..... (mm) TUBE WALL THICKNESS ..... (mm)
CENTER LINE SPACING ..... (mm) MATERIAL ..... FIN DIMENSION ..... (mm)
DESIGN PRESSURE ..... kPa(ga) OPERATING PRESSURE ..... kPa(ga)
PRESSURE DROP ACROSS ECONOMIZER ..... kPa(ga) AVERAGE HEAT TRANSFER RATE AT 100% CAPACITY ..... (W/m² °C)
TOTAL SURFACE AREA ..... (m²)
LONGITUDINAL PITCH OF TUBES ..... (mm) HEATING SURFACE ..... (m²)
BARE TUBE SURFACE ..... (m²) TRANSVERSE PITCH OF TUBES ..... (mm)
MAX. TUBE WALL TEMPERATURE AT 100% CAPACITY ..... (°C) EXTENDED TUBE SURFACE ..... (m²)
FLUE GAS TEMPERATURE ..... (°C) FLUE GAS PRESSURE ..... kPa(ga)
INLET HEADER I/D THICKNESS ..... (mm) OUTLET HEADER I/D THICKNESS ..... (mm)
HEADER MATERIAL (INLET) ..... (OUTLET) .....
CORROSION ALLOWANCE ..... (mm)

BURNERS

a. HEAVY FUEL BURNERS

MANUFACTURER ..... TYPE: STEAM ATOMIZATION SIZE: .....
NUMBER OF BURNERS ..... LOCATION .....
SIZE AND TYPE OF PILOTS ..... MAX. CAPACITY OF EACH BURNER ..... (kg/h)
ATOMIZING STEAM PRESSURE ..... (kPa(ga)
FUEL RETURN PRESSURE (MAX.) ..... (kPa(ga) (MIN.) ..... kPa(ga)
FUEL SUPPLY TEMPERATURE ..... (°C) FUEL SUPPLY PRESSURE ..... kPa(ga)

b. NATURAL GAS BURNERS

MANUFACTURER ..... TYPE: ..... SIZE .....
NUMBER OF BURNERS ..... LOCATION .....
SIZE AND TYPE OF PILOTS .....
MAX. CAPACITY OF EACH BURNER ..... (m^3/h) MIN. FLOW TO EACH BURNER ..... (m^3/h)
PRESSURE (MAX.) ..... kPa(ga) (MIN.) ..... kPa(ga)
TEMPERATURE (MAX.) ..... (°C) (MIN.) ..... (°C)

c. PILOT BURNERS

TYPE ..... NUMBER .....
TYPE OF FUEL (GAS/LIQUID) .....

SOOT BLOWERS

TYPE OF SUPERHEATER SOOT BLOWER .....
No. RETRACTABLE PER BOILER ..... No. ROTARY PER BOILER .....
MATERIAL ..... MANUAL OR AUTOSEQUENTIAL .....
TYPE OF ECONOMIZER SOOT BLOWER .....
No. PER BOILER ..... MATERIAL .....
TYPE OF DRIVE FOR SUPERHEATER SOOT BLOWERS ..... VOLTAGE/AIR PRESSURE .....
TYPE OF DRIVE FOR ECONOMIZER SOOT BLOWERS ..... VOLTAGE/AIR PRESSURE .....
TOTAL STEAM CONSUMPTION ..... (kg/h) DURATION OF BLOWING CYCLE ..... (h)
STEAM SUPPLY PRESSURE TO BLOWERS ..... kPa(ga) STEAM SUPPLY TEMP. TO BLOWERS ..... (°C)

(to be continued)

APPENDIX A - (continued)

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MECHANICAL DESIGN CONDITIONS
(to be filled by Boiler Manufacturer)

FORCED DRAFT FAN

TYPE ..... ARRANGEMENT
TYPE OF ELECTRICAL MOTOR DRIVE .....
TYPE OF TURBINE DRIVE .....
GEAR TYPE .....RATIO .....
TYPE OF COUPLING .....
DESIGN CAPACITY (EACH FAN) .....(m^3/h)
DESIGN INLET TEMPERATURE .....(°C)
MATERIAL OF FAN CASING .....
MATERIAL OF FAN IMPELLER .....
MATERIAL OF FAN SHAFT .....
NUMBER PER UNIT .....
TEST BLOCK ..... 100 .....
TEST BLOCK ..... 100 .....
SERVICE RATING .....
SPEED .....r/min
DESIGN STATIC PRESSURE .....(mm WC)
POWER REQUIRED .....(KW)
THICKNESS OF FAN CASINGS ..... (mm)
THICKNESS OF IMPELLER BLADES ..... (mm)
DIAMETER OF FAN SHAFT ..... (mm)

SILENCERS b YES b NO FILTERS b YES b NO
OUTLET DAMPERS b YES b NO b INLET VALVE CONTROL b YES b NO
BASE PLATE COMMON WITH FAN b SEPARATE b
CASING DESIGNED TO FACILITATE ROTOR REMOVAL WITH MINIMUM DELAY b YES b NO

STEAM COIL AIR PREHEATER

NUMBER .....
MATERIAL OF TUBE .....
STEAM TEMPERATURE .....(°C)
AIR INLET TEMPERATURE .....(°C)
TYPE .....
DESIGN STEAM PRESSURE .....kPa (GA)
STEAM CONSUMPTION (EACH) .....(kg/s)
AIR OUTLET TEMPERATURE ..... °C

ROTARY AIR PREHEATER

INLET GAS TEMPERATURE ..... (°C)
INLET AIR TEMPERATURE ..... (°C)
MATERIAL FOR HOT END (HEATING ELEMENTS) .....
MATERIAL FOR COLD END (HEATING ELEMENTS) .....
MATERIAL OF CASING .....
TYPE OF ROTARY AIR PREHEATER .....
HEATING SURFACE (BOTH SIDES OF PLATES) ..... (m^2)
DEPTH OF HEATING SURFACE HOT END ..... (mm)
ELECTRICAL MOTOR DRIVE POWER ..... (kW)
METHOD OF AIR PREHEATER LUBRICATION .....
No. SOOT BLOWERS .....
GAS PRESSURE LOSS ..... (mm WC)
GAS INLET FLOW .....(kg/h)
AIR INLET FLOW .....(kg/h)
OUTLET GAS TEMPERATURE (UNCORRECTED) ..... (°C)
OUTLET AIR TEMPERATURE ..... (°C)
DIAMETER OF ROTOR ..... (mm)
COLD END ..... (mm)
AUXILIARY DRIVE .....
WATER WASHING FACILITY .....
DRAUGHT LOSS .....(mm WC)
GAS OUTLET FLOW .....(kg/h)
AIR OUTLET FLOW .....(kg/h)

(to be continued)

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MECHANICAL DESIGN CONDITIONS
(to be filled by Boiler Manufacturer)

TABULAR AIR PREHEATER (ALTERNATE)

TYPE .....

	HOT SECTION	COLD SECTION
HEATING SURFACE	..... (m^2)	..... (m^2)
NUMBER OF TUBES	.....	.....
LENGTH OF TUBES	..... (m)	..... (m)
DIAMETER OF TUBES	..... (mm)	..... (mm)
THICKNESS OF TUBES	..... (mm)	..... (mm)
TUBE MATERIAL	.....	.....
NUMBER OF PLATES	.....	.....
PLATE DIMENSION	..... (m × m)	..... (m × m)
NUMBER OF GAS PASSAGES	.....	.....
NUMBER OF AIR PASSAGES	.....	.....
WIDTH OF GAS PASSAGES	..... (mm)	..... (mm)
WIDTH OF AIR PASSAGES	..... (mm)	..... (mm)
GAS LOSS	..... Pa(ga)	..... Pa(ga)
DRAUGHT LOSS	..... Pa(ga)	..... Pa(ga)

DUCT WORK

MATERIAL ..... METAL THICKNESS ..... (mm)
TYPE OF INSULATION ..... THICKNESS OF INSULATION ..... (mm)
TYPE OF EXPANSION JOINTS .....

STACK

NUMBER ..... SELF-SUPP. OR GUYED ..... LOCATION .....
MATERIAL ..... THICKNESS ..... (mm)
INSIDE METAL DIAMETER ..... (mm) HEAT ABOVE GRADE ..... (mm)
LINING MATERIAL ..... THICKNESS ..... (mm)

PLATFORMS

TYPE ..... SIZE .....
LOCATION .....
AIRCRAFT WARNING LIGHTS PER NIOC SP-50-7

WALL INSULATION

TYPE ..... THICKNESS .....

REFRACTORY

TYPE ..... THICKNESS .....

LADDERS

TYPE ..... LOCATION .....
PAINTER'S TROLLEY ..... RAIL ..... S.S. CABLE .....

STAIRWAYS

TYPE ..... LOCATION .....

MASSES (WEIGHT)

DRUM WITH INTERNALS ..... (kg) BOILER STRUCTURE ..... (kg)
BOILER COMPLETE ..... (kg) F.D FAN TURBINE AND BASE ..... (kg)
AIR PREHEATER COMPLETE ..... (kg) MAX. SHIPPING MASS ..... (kg)
MAX. MASS TO BE LIFTED DURING INSTALLATION ..... (kg)
MASSES OF WATER FOR HYDRAULIC TEST (PRESS, PART, CASING INSULATION) ..... (kg)

(to be continued)

APPENDIX A - (continued)

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BOILER PERFORMANCE DATA

A) NATURAL GAS FIRING:

FLOWS	MCR 50%	MCR 75%	MCR 100%
BOILER STEAMING CAPACITY	..... %	..... %	..... %
STEAM LOAD	.....	.....	.....
SUPERHEATER STEAM	.....	.....	..... (tonne/h)
FEED WATER	.....	.....	..... (tonne/h)
STEAM FOR AUXILIARIES	.....	.....	..... (kg/s)
CONTINUOUS BLOWDOWN	.....	.....	..... (kg/s)
INTERMITTENT BLOWDOWN	.....	.....	..... (kg/s)
FUEL CONSUMPTION	.....	.....	..... (Nm^3/h)
AIR AT F.D FAN OUTLET (EACH)	.....	.....	..... (kg/s)
EXCESS AIR (WIND BOX) CO_2 CONTENT	.....	.....	..... %
BOILER WASTE GAS (LEAVING AIR PREHEATER)	.....	.....	..... (kg/s)
WATER AND STEAM TEMPERATURES			
FEED WATER AT ECONOMIZER INLET	.....	.....	..... (°C)
FEED WATER AT ECONOMIZER OUTLET	.....	.....	..... (°C)
SATURATED STEAM AT DRUM	.....	.....	..... (°C)
SUPERHEATED STEAM AT BOILER OUTLET	.....	.....	..... (°C)
SOOT BLOWING STEAM	.....	.....	..... (°C)
WATER AND STEAM PRESSURE			
FEED WATER AT ECONOMIZER INLET	.....	.....	..... kPa(ga)
PRESSURE DROP THROUGH ECONOMIZER	.....	.....	..... kPa(ga)
SATURATED STEAM AT DRUM	.....	.....	..... kPa(ga)
PRESSURE DROP THROUGH SUPERHEATER	.....	.....	..... kPa(ga)
SUPERHEATED STEAM AT BOILER OUTLET	.....	.....	..... kPa(ga)
SOOT BLOWING STEAM	.....	.....	..... kPa(ga)
AIR AND GASES TEMPERATURE			
AMBIENT AIR	.....	.....	..... (°C)
AIR PREHEATER EXIT AIR	.....	.....	..... (°C)
FLUE GASES AT FURNACE OUTLET (SUPER HEAT INLET)	.....	.....	..... (°C)
FLUE GASES AT SUPERHEATER OUTLET	.....	.....	..... (°C)
FLUE GASES AT ECONOMIZER INLET	.....	.....	..... (°C)
FLUE GASES AT ECONOMIZER OUTLET	.....	.....	..... (°C)
FLUE GAS LEAVING AIR PREHEATER	.....	.....	..... (°C)
AIR AND GASES PRESSURE			
AIR LEAVING F.D FAN	.....	.....	..... Pa(ga)
AIR SEALING AIR	.....	.....	..... Pa(ga)
WIND BOX	.....	.....	..... Pa(ga)
FURNACE	.....	.....	..... Pa(ga)
FLUE GASES AT SUPERHEATER OUTLET	.....	.....	..... Pa(ga)
FLUE GASES AT ECONOMIZER OUTLET	.....	.....	..... Pa(ga)
FLUE GASES AT STACK INLET	.....	.....	..... Pa(ga)

(to be continued)

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BOILER PERFORMANCE DATA

HEAT LOSSES BASED ON LHV OF FUEL

LOSS DUE TO DRY GAS	..... %	..... %	..... %
LOSS DUE TO H_2O FROM COMBINATION OF H_2	.....	.....	..... %
LOSS DUE TO RADIATION	.....	.....	..... %
LOSS DUE TO UNBURNED COMBUSTIBLES	.....	.....	..... %
UNACCOUNTED LOSSES AND MAKER'S MARGIN	.....	.....	..... %
TOTAL LOSSES	.....	.....	..... %
EFFICIENCY	.....	.....	..... %

B) FUEL OIL FIRING

FLOWS	MCR 50%	MCR 75%	MCR 100%
BOILER STEAMING CAPACITY	.....	.....	..... %
STEAM LOAD	.....	.....	..... %
SUPERHEATED STEAM	.....	.....	..... (tonne/h)
FEED WATER	.....	.....	..... (tonne/h)
STEAM FOR AUXILIARIES	.....	.....	..... kg/s
CONTINUOUS BLOWDOWN	.....	.....	..... kg/s
INTERMITTENT BLOWDOWN	.....	.....	..... kg/h
FUEL CONSUMPTION	.....	.....	..... kg/s
AIR AT F.D FAN OUTLET (EACH)	.....	.....	..... kg/s
EXCESS AIR (WIND BOX) CO_2 CONTENT	.....	.....	..... %
BOILER WASTE GAS (LEAVING AIR PREHEATER)	.....	.....	..... kg/s

WATER AND STEAM TEMPERATURES

FEED WATER AT ECONOMIZER INLET	.....	.....	..... (°C)
FEED WATER AT ECONOMIZER OUTLET	.....	.....	..... (°C)
SATURATED STEAM AT DRUM	.....	.....	..... (°C)
SUPERHEATER STEAM AT BOILER OUTLET	.....	.....	..... (°C)
SOOT BLOWING STEAM	.....	.....	..... (°C)

WATER AND STEAM PRESSURE

FEED WATER AT ECONOMIZER INLET	.....	.....	..... k Pa(ga)
PRESSURE DROP THROUGH ECONOMIZER	.....	.....	..... kPa(ga)
SATURATED STEAM AT DRUM	.....	.....	..... kPa(ga)
PRESSURE DROP THROUGH SUPERHEATERS	.....	.....	..... kPa(ga)
SUPERHEATED STEAM AT BOILER OUTLET	.....	.....	..... kPa(ga)
SOOT BLOWING STEAM	.....	.....	..... kPa(ga)

AIR AND GASES TEMPERATURE

AMBIENT AIR	.....	.....	..... (°C)
AIR PREHEATER EXIT AIR	.....	.....	..... (°C)
FLUE GASES AT FURNACE OUTLET (SUPER HEAT INLET)	.....	.....	..... (°C)
FLUE GASES AT SUPERHEATER OUTLET	.....	.....	..... (°C)
FLUE GASES AT ECONOMIZER INLET	.....	.....	..... (°C)
FLUE GASES AT ECONOMIZER OUTLET	.....	.....	..... (°C)
FLUE GAS LEAVING AIR PREHEATER	.....	.....	..... (°C)

(to be continued)

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BOILER PERFORMANCE DATA

AIR AND GASES TEMPERATURE

AMBIENT AIR	.....	.....	..... (°C)
AIR PREHEATER EXIT AIR	.....	.....	..... (°C)
FLUE GASES AT FURNACE OUTLET (SUPERHEATER INLET)	.....	.....	..... (°C)
FLUE GASES AT SUPERHEATER OUTLET	.....	.....	..... (°C)
FLUE GASES AT ECONOMIZER INLET	.....	.....	..... (°C)
FLUE GASES AT ECONOMIZER OUTLET	.....	.....	..... (°C)
FLUE GAS LEAVING AIR PREHEATER	.....	.....	..... (°C)

AIR AND GASES PRESSURE

AIR LEAVING F.D FAN	.....	.....	..... Pa(ga)
AIR SEALING AIR	.....	.....	..... Pa(ga)
WIND BOX	.....	.....	..... Pa(ga)
FURNACE	.....	.....	..... Pa(ga)
FLUE GASES AT SUPERHEATER OUTLET	.....	.....	..... Pa(ga)
FLUE GASES AT ECONOMIZER OUTLET	.....	.....	..... Pa(ga)
FLUE GASES AT STACK INLET	.....	.....	..... Pa(ga)

HEAT LOSSES BASED ON LHV OF FUEL

LOSS DUE TO DRY GAS	..... %	..... %	..... %
LOSS DUE TO H_2O FROM COMBINATION OF H_2	.....	.....	..... %
LOSS DUE TO RADIATION	.....	.....	..... %
LOSS DUE TO UNBURNED COMBUSTIBLES	.....	.....	..... %
UNACCOUNTED LOSSES AND MAKER'S MARGIN	.....	.....	..... %
TOTAL LOSSES	.....	.....	..... %
EFFICIENCY	.....	.....	..... %

C) NAFTA FIRING

FLOWS	MCR 50%	MCR 75%	MCR 100%
BOILER STEAMING CAPACITY	.....	.....	..... %
STEAM LOAD	.....	.....	..... %
SUPERHEATED STEAM	.....	.....	..... (tonne/h)
FEED WATER	.....	.....	..... (tonne/h)
STEAM FOR AUXILIARIES	.....	.....	..... kg/s
CONTINUOUS BLOWDOWN	.....	.....	..... kg/s
INTERMITTENT BLOWDOWN	.....	.....	..... kg/h
FUEL CONSUMPTION	.....	.....	..... kg/s
AIR AT F.D FAN OUTLET (EACH)	.....	.....	..... kg/s
EXCESS AIR (WIND BOX) CO_2 CONTENT	.....	.....	..... %
BOILER WASTE GAS (LEAVING AIR PREHEATER)	.....	.....	..... kg/s

(to be continued)

APPENDIX A - (continued)

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BOILER PERFORMANCE DATA

WATER AND STEAM TEMPERATURES

FEED WATER AT ECONOMIZER INLET	.....	.....	..... (°C)
FEED WATER AT ECONOMIZER OUTLET	.....	.....	..... (°C)
SATURATED STEAM AT DRUM	.....	.....	..... (°C)
SUPERHEATED STEAM AT BOILER OUTLET	.....	.....	..... (°C)
SOOT BLOWING STEAM	.....	.....	..... (°C)

WATER AND STEAM PRESSURE

FEED WATER AT ECONOMIZER INLET	.....	.....	..... kPa(ga)
PRESSURE DROP THROUGH ECONOMIZER	.....	.....	..... kPa(ga)
SATURATED STEAM AT DRUM	.....	.....	..... kPa(ga)
PRESSURE DROP THROUGH SUPERHEATER	.....	.....	..... kPa(ga)
SUPERHEATED STEAM AT BOILER OUTLET	.....	.....	..... kPa(ga)
SOOT BLOWING STEAM	.....	.....	..... kPa(ga)

AIR AND GASES TEMPERATURE

AMBIENT AIR	.....	.....	..... (°C)
AIR PREHEATER EXIT AIR	.....	.....	..... (°C)
FLUE GASES AT FURNACE OUTLET (SUPER HEAT INLET)	.....	.....	..... (°C)
FLUE GASES AT SUPERHEATER OUTLET	.....	.....	..... (°C)
FLUE GASES AT ECONOMIZER INLET	.....	.....	..... (°C)
FLUE GASES AT ECONOMIZER OUTLET	.....	.....	..... (°C)
FLUE GAS LEAVING AIR PREHEATER	.....	.....	..... (°C)

AIR AND GASES PRESSURE

AIR LEAVING F.D FAN	.....	.....	..... Pa(ga)
AIR SEALING AIR	.....	.....	..... Pa(ga)
WIND BOX	.....	.....	..... Pa(ga)
FURNACE	.....	.....	..... Pa(ga)
FLUE GASES AT SUPERHEATER OUTLET	.....	.....	..... Pa(ga)
FLUE GASES AT ECONOMIZER OUTLET	.....	.....	..... Pa(ga)
FLUE GASES AT STACK INLET	.....	.....	..... Pa(ga)

HEAT LOSSES BASED ON LCV OF FUEL

LOSS DUE TO DRY GAS	.....	.....	..... %
LOSS DUE TO H_2O FROM COMBINATION OF H_2	.....	.....	..... %
LOSS DUE TO RADIATION	.....	.....	..... %
LOSS DUE TO UNBURNED COMBUSTIBLES	.....	.....	..... %
UNACCOUNTED LOSSES AND MAKER'S MARGIN	.....	.....	..... %
TOTAL LOSSES	.....	.....	..... %
EFFICIENCY	.....	.....	..... %

(to be continued)

APPENDIX A - (continued)

Job No. ..... Item No. .....
Purchaser Order No. .....
Inquiry No. .....

Rev				
DATE				
APPD.				

BOILER CIRCULATION DATA

AVERAGE BOILER CIRCULATION RATIO .....
(BASED ON WEIGHT BASIS OF WATER ENTERING AND STEAM LEAVING)

PERCENTAGE WET BY VOLUME LEAVING FURNACE .....

FOR NATURAL BOILER CIRCULATION

	FRONT WALL	SIDE WALL
MEAN INLET VELOCITY	.....	.....
AVERAGE CIRCULATION RATIO	.....	.....
MIN. CIRCULATION RATIO	.....	.....
AVERAGE PERCENTAGE WET BY VOLUME (EXIT)	.....	.....
MIN. PERCENTAGE WET BY VOLUME (EXIT)	.....	.....

REMARKS: .....

APPENDIX B
TYPICAL DATA SHEET FOR CHEMICAL FEED SYSTEM

NIOC NO.		REV.
NIOC PROJ. NO.	J/V PROJ. NO.	UNIT NO.
J/V NO.		SH OF

Item No.: ..... No. Req'd. ..... Service .....
1 ..... Pump - Item No. .....
2 No. of pumps per unit ..... Mfg'r.* ..... Mfg. Model No.* .....
3 Type: ..... Plunger ..... Diaphragm ..... Direct Acting .....
4 Metering heads: Simplex ..... Duplex ..... Triplex ..... No. Per head .....
5 Liquid handled ..... Stroke adjustment: Manual ..... Automatic .....
6 Maximum capacity, m³/h ..... While running ..... Stopped .....
7 Pressure, discharge, bar(ga) ..... Local ..... Remote .....
8 Suction, bar(ga) ..... Signal: Pneu. ..... Elec. ..... Hyd. .....
9 Temperature °C ..... Capacity adjust: .....
10 Plunger/diaphragm-diameter*/ ..... Materials of construction: .....
11 Stroke, length* ..... Liquid end .....
12 Pump speed, SPM* ..... Valves/seats ..... * Typs .....
13 Connections, suction* ..... Plunger/diaphragm* .....
14 Discharge* ..... Packing/seal* .....
15 Pump relief valve set, bar (ga) ..... Paint: .....
16 Valves replaceable: Yes ..... No ..... (with/without) Piping removed .....
17 Motor drive: AC ..... DC ..... Exp. proof ..... TEFC ..... TENV ..... Other..
18 400 Volts 3 Phase 50 Cycle* ..... HP*(kW) ..... r/min (RPM) .....
19 .....
20 .....
21 ..... Tank-Item No. .....
22 Liquid handled ..... Design press, @ Temp. ..... bar(ga) .....°C
23 Capacity, m³ ..... Freeboard % .... Operating press, @ Temp. ..... bar(ga) .....°C
24 Connections, size: Drain ..... Tank size: ..... mID × mH .....
25 Gauge glass ..... Materials: .....
26 Fill ..... Side ..... Bottom .....
27 Suction ..... Tank legs .....
28 Relief valves ..... Pump platform .....
29 Bottom: Flat ..... Cone ..... Dished ..... Basket .....
30 Top cover: .....
31 Corrosion allowance ..... mm ..... Lining .....
32 Thickness: Side* ..... Bottom ..... Paint .....
33 Basket size, m³ ..... PERF. ..... Seismic zone No. .....
34 .....
35 ..... Mixer-Item No. .....
36 Mfg'r.* ..... Model No.* .....
37 Motor drive: AC ..... DC ..... Exp. proof ..... TEFC ..... TENV ..... Other..
38 ..... Volts ..... Phase ..... Cycle* ..... HP* (kW) ..... r/min (RPM) .....
39 Type mounting bracket ..... Paint: .....
40 Materials of construction wetted parts .....
41 Chemical mixed ..... Liquid ..... Solid .....
42 .....
43 ..... Piping and instruments .....
44 Piping included: Suction ..... Discharge ..... Drain ..... Other .....
45 Line class spec. req'd or state materials .....
46 Instruments included: Relief valve ..... Level gage ..... Pressure gage ..... Other .....
47 Mfg. and type req'd.* .....
48 Remarks:* All blanks to be proposed by Vendor .....
49 .....
50 .....