TECHNICAL SPECIFICATION

WATER-TUBE BOILERS

DEP 30.75.10.30-Gen.

July 1999

DESIGN AND ENGINEERING PRACTICE

PREFACE

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Shell International Oil Products B.V. (SIOP)
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Shell International Exploration and Production B.V. (SIEP)
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Shell International Chemicals B.V. (SIC)

The Hague, The Netherlands,

and other Service Companies.

They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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All administrative queries should be directed to the DEP Administrator in SIOP.

NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

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APPENDICES

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for design, engineering, inspection, site erection, start-up and performance testing of fired industrial type water-tube boiler installations.

CO boilers (in which the remaining carbon monoxide in the regenerator flue gas of a catalytic cracking unit is incinerated) may be an adaptation of a standard industrial type boiler design. In this case, this DEP may be applied with few amendments. However, not all CO boiler designs will be covered by this DEP.

Excluded from the scope of this DEP are heat recovery steam generators downstream of gas turbines (to which DEP 30.75.10.31-Gen. shall apply).

This DEP is a revision of the DEP of the same number dated December 1992. This revision has not been extensive and a summary of the main changes is given in (1.5).

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them (i.e. the distribution code is “F” as described in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants and gas plants. If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny, which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

data/requisition sheets	DEP 30.75.10.93-Gen. (6 sheets), which shall be used by the Principal and the Manufacturer to specify the detailed requirements and proposals for a particular installation.
Fuel	all fuels and combinations of fuels specified by the Principal for firing in the boiler.
maximum continuous rating (MCR)	the steam production under design conditions, measured downstream of the steam main stop/check valve and any de-superheater. It shall be measured upstream of any take-off of auxiliary steam.
peak load	110% of MCR unless otherwise specified on the data/requisition sheets.

1.3.3 Specific definitions

DCS	Distributed Control System
IPF	Instrumented Protective Function (=safeguarding)
TFIT	Trial For Ignition Time

1.4 CROSS-REFERENCES

Where cross references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (7).

1.5 SUMMARY OF MAIN CHANGES SINCE PREVIOUS EDITION

2.2.1	Dew point calculation method in accordance with API 560
2.2.5	Velocities of water/steam are described
2.2.7	Drum sizing aspects detailed
2.2.7, 2.5.4	Better definition of blow down hardware
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2.4.2	Energy criterion for burners removed and more practical approach applied
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Appendix 1	Terminal points better defined

2. DESIGN AND ENGINEERING

2.1 GENERAL

The installation shall comprise the equipment to be listed on a sheet entitled ”Scope of supply”. The limits of supply shall be listed and defined on a sheet entitled ”Terminal points”. For guidance, typical examples of a ”Scope of supply” and ”Terminal points” are given in Appendix 1.

The data/requisition sheets shall be used to exchange information between the Principal and the Manufacturer. The purpose of each of these sheets is described in (6).

All proposed deviations from this DEP shall be listed and that list shall be forwarded with sheet 4 of the data/requisition sheets.

For design, fabrication, inspection and testing, ASME I or BS 1113 shall be followed, as supplemented or amended by this DEP. Other codes may be used if local conditions make this desirable to the Principal; however, only one code shall be applied throughout.

The Manufacturer shall obtain all local code stamps and certificates needed.

The boiler shall be of the water-tube type, for liquid and/or gaseous fuels as specified, with forced-draught burners and natural water circulation.

The boiler shall be suitable for outdoor operation.

The design shall be proven in practice, robust and capable of 2 years' continuous operation, and not less than 4 years between major overhauls.

Safety, ease of operation, inspection, maintenance, repair and cleaning are of major importance.

Before the contract is awarded the Manufacturer shall be prepared to satisfy the Principal that at all loads the circulation of water and steam will be effective and that an even distribution will be achieved of water and steam over the various boiler parts.

The Manufacturer shall give full details of the chemical and physical properties of the construction materials.

There shall be sufficient space and access for inspection, cleaning, removal and maintenance of such parts as tube bundles, headers, retractable burner parts, fixed and retractable soot blowers, valves, pumps, fans, turbines and electric motors.

If there is the danger of freezing during operation or drainage of any part, protection against such freezing shall be provided.

There shall be adequate protection against the hazard of persons touching surfaces hotter than 60 °C. Notwithstanding this safety requirement, energy loss to the environment shall be minimised by appropriate design and insulation.

Proven technology shall be applied for optimising energy conservation and minimising the emission of pollutants to the environment.

2.2 MAJOR HEAT TRANSFER EQUIPMENT

2.2.1 General

All metal surfaces in contact with flue gas shall be at a temperature at least 15 °C above the highest dew point (acid or water as the case may be) which may occur during any of the operating conditions (excluding start-up) in combination with any of the fuels specified on the data/requisition sheets. The dew point calculation method shall be in accordance with API 560.

Tube type and arrangement shall be selected for ease of construction, repair and access.

Convective heat transfer equipment shall have a square or rectangular pitch if fuel oil is to be fired. Soot blowers shall be installed. If fuel gas only is to be fired, triangular pitch may be used. If soot blowers are installed or provided for, tube banks shall be divided into sections which permit effective penetration and cleaning by the steam jets. There shall be no more than 10 tube rows in the direction of the flue gas flow.

2.2.2 Boiler/combustion chamber

The furnace shall be water-cooled to the maximum extent.

Where the boiler floor comprises tubes which have a vertical inclination greater than 30° (e.g. hopper shape typical of top suspended boiler), refractory covering of the floor tubes may not be necessary. Otherwise, the water cooled furnace floor shall be partly or wholly covered by refractory to avoid tube overheating associated with steam/water separation and resultant steam blanketing of the fireside tube surface.

Membrane-type walls shall be used (i.e. constructed from tubes and strips or with extruded fins, each type welded over the whole length). Any attachments to membrane walls shall be made to the strip/fins between tubes and not to the tubes.

If fuel oil or other fouling/sulphur containing fuels are fired, provision shall be made for draining the combustion chamber of “wash-down” water which will be used at shutdowns.

The maximum local heat flux density (heat absorbed per unit surface area) based on the tube surface exposed to the fireside shall be limited to 250 kW/m^2 if the boiler feed water is not fully demineralised. If the boiler feed water is fully demineralised and boiler water will comply with recognised standards for operation at higher heat flux densities, a higher local heat flux density is allowed up to a maximum of 400 kW/m^2. The meaning of recognised standards in this context shall be understood as the established guidelines of boiler user/manufacturer associations, the Manufacturer’s own standards, and applicable national/international standards, of which the most stringent heat flux density limitation shall be applied. As a minimum the water quality shall meet VGB standard R-450-Le.

This DEP imposes no fixed limiting values on volumetric or superficial heat release rates in the furnace as these vary significantly with size and type of equipment. However, the Manufacturer shall take into account the following requirements which will be influenced directly or indirectly by the heat release rate:

- The heat flux density limitation as described above.
- The need to limit the temperature of the flue gases leaving the furnace in order to avoid high temperature corrosion/overheating of the superheater tubes or other components. This temperature limitation will be influenced by the type of fuel fired.
- The requirement to ensure completion of fuel burn-out in the combustion chamber.
- No flame impingement on the tube walls is allowed.
- The requirement to minimise the production of nitrogen oxides in the flue gases (increases with flame temperature) and to minimise the emission of char particulates from fuel oil (increases as temperature and residence time decreases).

The Manufacturer shall optimise the furnace design taking account of the above factors and then state, for the chosen design, the corresponding values of total heat release rate based

on the tube surface exposed to the fireside (kW/m^2) and based on furnace volume (kW/m^3) for the MCR operating condition. This information shall be provided on the data/requisition sheets. For the calculation of the above quantities the following definitions shall be used:

- The furnace outlet is defined as the plane through which the combustion gases leave the furnace. It should be located immediately upstream of and facing the superheater. Furnace outlet temperature and pressure are defined as the average gas temperature and pressure in this plane.
- The furnace volume is that which is enclosed by a geometrical surface comprising the furnace outlet and surfaces laid through the centre lines of those tubes which are exposed to direct radiation, and the surfaces occupied by the burners and refractory.
- The furnace heat transfer surface is the actual tube surface exposed to the fireside (i.e. the half tube round surface), excluding the fins, which encloses the above defined furnace volume but excludes the tube surface covered by refractory or other tubes (as around the burner ports). This surface shall be used for the calculation of average heat flux density.

Flames shall not impinge on walls or any metal part during any operating condition, if such impingement causes deposits on surfaces and/or causes local heat fluxes which are in excess of the maximum allowable value.

Furnace tubes shall be bent around observation ports, burner ports etc., in order to make room for them. However, the use of small headers for this purpose is acceptable provided it can be clearly demonstrated on similar boilers, already in operation, that no adverse effects, such as maldistribution of flow, will occur due to the use and arrangement of such headers. In any case, where such headers are applied, the same tube/circuit shall not be used more than once for the creation of such headers.

Burner lay-out and the path of the flue gas through the boiler shall ensure symmetrical heat flux loading of the furnace walls and all convection coils.

2.2.3 Superheater

The superheater shall have a substantially flat temperature-load characteristic, so that excessive desuperheating will not be necessary.

The steam flow shall be evenly distributed over parallel coils of the superheater(s) throughout the specified operating range. Also, care shall be taken in the design that the flue gas is uniformly distributed over the superheater coils, paying particular attention to the avoidance of flue gas bypassing.

The superheater shall be well supported so as to prevent distortion.

All headers shall be outside the flue gas passage, providing sufficient space for cutting/renewal of tubes without detrimental effects to other boiler parts.

There should be provision for drainage of the superheater where possible. However, superheaters with non-drainable loops are acceptable.

Arrangements shall be made and instructions shall be given, as necessary, to ensure adequate cooling of the superheater during normal start-up.

2.2.4 Steam temperature control

If it is necessary to control the temperature of the superheated steam, this control shall be accomplished by desuperheating, using spray water injection. Spray water shall be turbine condensate, condensed saturated steam from the boiler drum, or other water of equal purity and shall in any case come from a source protected against oxygen ingress.

A full calculation of the maximum superheater tube temperatures shall be provided to the Principal.

2.2.5 Convective evaporator

An even distribution of water, steam, exhaust gas and flue gas over the different boiler parts shall be achieved by applying the following:

- For the horizontal evaporator tubes the water inlet velocity should be at least 0.8 m/s.

For horizontal and vertical tubes:

- To ensure equal distribution over all passes, the design shall be such that 75% of the total pressure drop from drum outlet (inlet downcomer) to drum inlet (riser outlet) is created by the evaporator section.

The velocities of water and steam at the inlet and outlet of the various sections of the evaporator system shall be recorded on the data/requisition sheets.

NOTE: Alternative methods to the above may be applied if reliable operation of the boiler can be demonstrated. The Principal shall be informed about deviations from the above.

For vertical tubes, there should be a physical separation on the flue gas side between risers and downcomers so as to ensure adequate circulation under all operating conditions.

Restriction orifices shall not be used to equalise flow distribution over parallel tubes.

2.2.6 Economiser

The economiser should not generate steam under any condition, since two-phase flow may lead to a mal-distribution of flow or flow/pressure instability in the economiser coils.

NOTE: It is accepted that in some single drum boiler designs a steaming economiser is a normal arrangement and a proven concept.

If an economiser is proposed which does generate steam under certain conditions, then the flow shall be upwards. The Manufacturer shall state in the tender the reasons for the steaming economiser, and provide evidence to the Principal that an examination has been made of the possible consequences of steam generation on pressure drop, flow distribution/stability, stratification of steam/water, tube dry-out/overheating and internal erosion of tube bends from high steam/water mixture velocities for those conditions under which steaming occurs. Further, it shall be explicitly stated that this examination has revealed no condition which will adversely affect the equipment and its operation.

Restriction orifices for equalising flow distribution over parallel tubes shall not be used in any part of the economiser. A non-steaming economiser shall be connected below the water level of the drum.

The steam drum connection for a steaming economiser shall be located lower than the centre line of the drum and upstream of the primary stage steam/water separators.

2.2.7 Drums

The drum design and arrangement shall ensure the required steam and water separation, distribution and circulation in conjunction with the rest of the boiler. Under all conditions the specified steam quality/purity shall be met. If a bi-drum arrangement is applied there shall be no likelihood of a build-up of deposits and ash formation in the chamber above the bottom drum, necessitating an unduly early boiler outage, when burning the specified fuel(s).

In a single-drum boiler the drum shall be outside the flue gas passage.

Drum internals shall be accessible and cleanable and they shall be removable through manholes. Elliptical or circular manholes in accordance with the Manufacturer's standards may be used.

Tube stubs, suitably prepared for welding, shall be provided at the drums if tubes are to be welded at site. Nozzles, stub ends for valves, fittings, mountings, tubes and anything to which drum internals etc. are to be secured shall be shop-welded into place.

The length of the stubs shall be such that welding the tubes to the stubs will have no adverse effects on the drum or stub-to-drum connections.

Downcomers should be unheated so that stable operation is ensured. A stagnant condition in any of the tubes shall not be possible. Downcomers shall be as near to the bottom of the drum as practicable to permit maximum use of drum water content. In order to prevent disturbances in water level in the drum, vortex breakers may be used at the inlets to the downcomers. Also, water velocity in the downcomers should be limited to 1 m/s maximum.

The size of the drum is also determined by the following requirements at MCR capacity, with continuous blow down at its normal value, and no feed water intake (see also Section 3):

- A hold-up time of at least 300 s between normal level (NWL) and low-low trip level (LLWL);
- A hold-up time of at least 60 s between low level (LWL) and low-low trip level (LLWL).

In addition to the above requirements the level difference between both normal-water level and low-water alarm level, and normal-water level and high-water level alarm shall be not less than 150 mm.

The normal water level, the low-low trip level and the maximum trip level shall be indicated by engraved marks both on the drum(s) and on the level gauges.

The supply of feed water to the drum and the separation of steam and water shall occur evenly over the length of the drum.

2.2.8 Air preheater

If an air preheater is proposed, the size of the economiser shall be such that at MCR the economiser water outlet temperature shall be as close as possible to the corresponding saturation temperature in the drum, whilst maintaining a sufficient margin below the saturation temperature to ensure that no steaming can occur at any time in the economiser. In the design of the air heater, account shall be taken of the minimum allowable metal temperature defined in (2.2.1). A steam preheater can be installed to prevent dew point corrosion.

In the air preheater there shall be a complete separation between air and flue gas. An air by-pass shall be provided.

There shall be mechanically interlocked isolating dampers, on the air side, to direct air to the air preheater or air by-pass, as required. In oil fired installations, the air preheater shall be equipped with soot blowers, preferably of the rake type.

2.2.9 Casing

The construction of the combustion chamber and downstream flue gas sections to the stack shall be able to withstand at least the maximum pressure delivered by the forced-draught fan and, if applicable, the maximum draught created by the induced draught fan.

There shall be no restriction to free expansion of refractory and tubes.

The membrane wall and flue gas passes shall be gas-tight.

All sheeting shall be sufficiently stiffened against damage during transport, erection and operation.

2.2.10 Observation and access

Air-cooled observation windows shall be provided and shall afford an unrestricted view of all burners, tips, throats and flames. The windows shall be at least 250 mm by 100 mm and shall also allow observation of all surfaces on the back and side walls and the screen or superheater gas inlet on which flames can impinge; the line of viewing shall be parallel to these surfaces. Windows shall be installed at each side of the boiler front to allow viewing along the side walls.

Air purging shall be provided to keep observation windows sealed, clean and cool. The glasses shall have external covers to prevent cracking by rain ingress and shall be protected on the hot side by pivoting metal plates.

It shall be possible to renew the glasses during operation. Air for any of the above purposes may come from the forced draught fan or from a separate cooling air fan.

There shall be a sufficient number of access and inspection doors and access space for each section or tube bank of the boiler. Access doors shall have a free opening of at least 400 mm x 400 mm.

2.3 AIR AND FLUE GAS SYSTEM

2.3.1 Fans

Unless otherwise specified on the data/requisition sheets, a single forced draught fan is required and the fan shall be capable of supplying at least the total quantity of air required for 20% excess air combustion of the specified fuel at peak load (110 % of MCR) including the air required for auxiliary purposes.

Centrifugal fans, whether for forced or induced draught operation, shall comply with DEP 31.29.47.30-Gen.

Manufacturer shall specifically indicate what allowances have been included in the FD fan's differential head to overcome flue gas fouling.

Principal shall specify on the fan data/requisition sheets what type of driver is required. In the case of a dual drive (turbine/motor) override couplings of the synchronously self shifting type, which can transmit torque in only one direction, shall be applied.

Variable inlet guide vanes or speed control can be used for the control of the combustion air, and the air control damper shall be equipped with a maximum and minimum mechanical stop. The positioner shall be pneumatically controlled with a lock-up device.

Manual operation shall also be possible. A clear identification of the position of the vanes shall be given. Lubrication facilities shall be provided on the vane adjusting mechanism to ensure that the mechanism cannot jam.

A venturi tube shall be provided in the air intake (see Standard Drawing S 24.002).

2.3.2 Ducting

All ducting, including bends, shall be gas-tight and smooth and bends shall, if necessary, have guide vanes.

Ducting shall be sufficiently stiffened against vibration and distortion. Pipe and duct supports, expansion joints, brackets, base plates, foundation bolts, nuts, packing etc. shall be provided as far as required. Also where required, access doors with a free opening of at least 400 mm x 400 mm shall be provided. It shall be possible to drain all ducts.

2.3.2.1 Air ducting and wind box

The air ducting and wind box shall have a plate thickness of not less than 5 mm.

The combustion air shall be distributed evenly over the burners in operation irrespective of the number of fans in use.

If the air is preheated the hot air ducting shall be insulated on the outside, see also (2.6.4). Expansion joints should be in accordance with S24.404. The vendor shall provide evidence that the air is distributed evenly to the air preheater. This is specified as follows:

- the average velocity lies within 5% of the average inlet velocity to the entire air preheater;
- the ratio between the highest and lowest local air velocity is less than 1.1.

2.3.2.2 Flue gas ducting

Flue gas ducting shall comprise:

- complete ducting from boiler to terminal point or stack;
- also, if applicable, ducting from boiler to separate economiser or air preheater.

The flue gas ducting shall have a plate thickness of not less than 6 mm. Expansion joints in the flue gas ducts may be of the steel-bellows or fabric type. Either type shall be fitted with inner sleeves to protect against the build up of deposits in the bellows. Steel bellows shall be insulated on the outside to avoid low temperature corrosion.

The ducts shall be refractory lined or, if approved by the Principal, externally insulated.

If the supply does not include flue gas ducts, the Manufacturer shall give sufficient operational information to enable the Principal to design the ducting from the boiler to the stack.

2.3.3 Dampers

Dampers shall be designed sufficiently robust to ensure reliable operation. Special attention shall be given to the prevention of vibration, distortion or deterioration, and to greasing. The shafts shall extend through the duct walls to accommodate bearings external to the walls. They shall be efficiently sealed to prevent leakage. Each shaft shall be marked to indicate its blade position.

If the boiler does not have a separate stack, there shall be a damper in each flue gas duct, complete with all necessary linkages. The damper shall be easily accessible for manual operation and shall have a position indicator, clearly visible from ground level. It shall be possible to lock the damper in the open position during normal operation, and it shall tend to open by gravity. In addition, there shall be a sliding plate, located as close as possible to the stack and in accordance with Standard Drawing S 24.303.

2.3.4 Stack

If the stack is not included in the order, the Manufacturer shall provide information to enable the Principal to design the stack. Unless otherwise specified in the "Scope of supply", stacks shall be in accordance with DEP 34.24.26.31-Gen. or DEP 34.24.27.31-Gen.

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

2.4 FUEL SYSTEM

It shall be possible to obtain peak load with all burners in operation and with such fuel as specified by the Principal.

The Principal shall state on the data/requisition sheets whether it shall be necessary to operate the boiler continuously at MCR with any one burner out of operation and with which fuel.

With the mode of firing proposed it shall be clearly demonstrated on similar boilers in operation:

- that combustion is safe and stable at all loads and load fluctuations;
- that there is no possibility of unburned fuel collecting in burner wind boxes or ducts;
- that handling and operation of the burners is easy and safe;
- that there is no flame impingement on side and rear walls, nor superheater tubes.

2.4.1 Burners

The burner installation shall be suitable for automatic start-up with provision for one or more flame detectors per burner, depending on the fuels fired, and with provision for automatic isolation of air flow to individual burners.

Where the Principal has indicated that both gaseous and liquid fuels may be fired, it shall be understood that this requires the capability of firing in the dual fuel mode, i.e. firing of both fuels simultaneously on all burners, unless the Principal indicates otherwise.

Reliable operation of the burners, without risk of harmful flame impingement, flame carry-over or flame instability is essential. There shall be no excessive vibration of part or the whole of the boiler. This requirement shall apply with any specified fuel, over the whole range of automatic control, without the need for manual adjustment of the air register.

Burners shall be of a design which is compatible with the state of the art for minimising NOx and solids emissions. The Manufacturer shall state the expected NOx and solids emissions for the specified fuels and design operating loads. This information shall be supported by appropriate measured emissions data from burner tests and/or experience with plants already in operation. Note that emission limits specified by the Principal may result in restrictions on burner heat release rate in the combustion chamber.

For residual oil fuels, steam atomisation of the fuel is required as this generally offers better fuel burnout and a turndown of around 5:1. Atomising steam pressure shall be higher than controlled fuel pressure.

Steam used for purging and cleaning of burners shall come from a steam system, the pressure of which is always higher than the maximum possible fuel pressure at the location of purging.

Adjustment of the air register settings shall be possible during start-up so as to obtain good combustion and a proper flame form. Under normal operating conditions, the air registers should have only two possible positions, i.e. “normal firing“ or “closed“. If light-up is not possible with the degree of opening necessary for normal operation, a third register position, i.e. “light-up“, is allowed. All positions shall be clearly indicated. The burner Manufacturer shall provide a burner protocol indicating all burner dimensions, adjustments and air register settings. In order to maintain correct air/fuel ratio on remaining operational burners in the event of an individual burner trip, provision for automatic closing off of the air supply to the tripped burner shall be made.

Provision shall be made for the installation of flame supervision equipment. The positioning of the nozzles for this equipment shall be such that good flame discrimination is obtained.

A fixed ignition burner shall be provided (see 2.4.2).

The flames shall not be blown off on any fuel, in the case of minimum load on the burner and the maximum air flow that can arrive at the burner. Such a situation, for example, can be caused by a trip of one of the fuels when the system is on high load and dual fuel firing. It

shall be possible to remove each individual liquid fuel gun during operation, e.g. for atomiser cleaning.

There shall be a safety shut-off device for each burner such that the burner gun can be removed only when the burner is isolated from the fuel and atomising steam supply.

Where initial and/or normal start up requires a different size of liquid fuel atomiser to that used in normal operation, a complete set of these atomisers shall be provided.

The width of the burner platforms shall be at least that necessary for unobstructed removal of a burner plus 1 000 mm working clearance.

Burners and associated instrumentation, if provided, shall be able to withstand the maximum fuel system pressure, gas or oil, as specified by the Principal.

Provision shall be made for supporting/storing spare oil guns. A facility has to be provided to enable disassembly of atomisers.

2.4.2 Ignition

Each burner shall be provided with its own safeguarded ignition burner suitable for pressurised combustion chambers. The ignition burner shall be designed to have only one fixed position in the main burner. The Principal shall specify if these units are to be fed from an independent fuel supply system such as a battery of propane cylinders located at ground level.

Ignition burners shall be of a type approved by the Principal.

The ignition of main burners is governed by a criterion based on a maximum allowable energy input during the ignition period. This, in turn, fixes the maximum time allowed for burner ignition when the fuel rate to the burner at start-up is known. This period is defined as the trial for ignition time (TFIT).

The burner control and management system shall be designed so that during a start-up 20% of the MCR fuel input is introduced into the boiler for a period not exceeding 5 s. If no flame is detected within this period, the fuel is shutoff.

2.4.3 Boiler front piping

Piping shall not obstruct access doors, observation windows, or burners.

It shall be possible to remove oil and gas burners or gas lances without having to dismantle the piping.

Steel piping is preferred, however the use of flexible hoses for liquid fuel, main burner gas and steam is acceptable, but requires approval by the Principal. Flexible hoses may be used on ignition burners.

2.5 BOILER MOUNTINGS

2.5.1 Safety valves

The safety valve(s) at the superheater outlet shall always open before and close after the safety valve(s) on the drum open and close respectively.

The superheater safety valve(s) shall be of such capacity that the superheater cannot be overheated when the drum valve(s) are blowing, even under the condition that the superheater outlet is closed when the boiler is being fired at MCR on manual firing control.

The set pressures of the boiler drum and superheater safety valves shall take into account the pressure drop between the drum and the superheater outlet at peak steam flow, plus an additional pressure drop allowance for long term fouling of the superheater.

The rating and setting of safety valves shall be in accordance with the ASME Boiler and Pressure Vessel Code Section I.

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

Note: If approved by the Principal, air assisted safety valves with triple steam pressure sensors may be used in special cases.

All safety valves shall have flanged connections. They shall be rated for the requirements of the service but in any case shall have inlet and outlet ratings of at least ANS class 300 RF and ANS 150 RF respectively.

Welded connections shall not be used. Vertical outlets, at least 2 000 mm high, shall be provided for safety valves. All valve outlets shall be adequately supported to withstand the reaction forces generated whilst the valve is discharging. They shall have safe drainage facilities which shall prevent the accumulation or freezing of water in the outlets.

For noise limitations applicable to safety valves, see 2.10.

2.5.2 Water level gauges

At least two independent water level gauges, one installed at each end of the drum, shall be provided. The installation shall comply with the requirements of ASME Boiler and Pressure Vessel Code Section I or BS 1113 as a minimum. Where these codes permit the use of alternative types of water level gauge to those in which the water level is observed directly, such application of alternative types shall be subject to the approval of the Principal.

Water level shall be easily visible from the operating platform either by use of drum gauge image transmission system or by remote level indicator.

At least 4 level transmitters shall be installed for drum level control and IPF.

2.5.3 Main steam and water valves

The feed water stop and check valves shall be close to the economiser inlet or to the drum, as applicable.

The steam stop/check valve shall be close to the superheater outlet.

2.5.4 Blow down systems

There shall be facilities for continuous blow down from the steam/water drum and for intermittent blow down from the bottom drum and bottom headers, these blow down lines being connected to a common blow down vessel.

The continuous system shall be designed for the maximum continuous blow down specified on the data/requisition sheets. At this rate there shall be no interference with the normal water circulation in the boiler or drum level control, or other adverse effects.

The intermittent system shall ensure that the boiler can be kept free of sludge during operation.

Both continuous and intermittent blow down valves shall be remotely operated from the

control room. The valves shall be equipped with a proximity switch to detect the closed position. Blow down pipe sizing shall comply with ASME B31.1. The conductivity meter sample connection shall have an independent nozzle (not connected to blow down lines). A common blow down vessel shall be installed.

In addition, a start-up blow down from the steam drum shall be provided in order to limit the water volume surge in the steam drum during boiler start-up to an acceptable level. This blow down shall have its own blow down line to the blow down vessel.

Each system shall have two valves in series, one block valve located at the drum or bottom header and one special blow down valve located at ground level.

2.5.5 Start-up vent

Unless otherwise stated, a start-up vent and silencer system with two valves shall be provided to ensure adequate flow through the superheater during start-up and when steam is not being delivered from the boiler. The start-up vent must have facilities for remote control from a control room. The silencer shall have safe drainage facilities which shall prevent accumulation or freezing of water.

For noise limitations applicable to this vent, see 2.10.

2.5.6 Soot blowers

Soot blowers shall be provided unless the fuel is specified to be gas.

Soot blowing shall not damage the tubes.

The cleaning equipment shall include all piping, valves, drains, drives, operating platforms and other parts. Facilities shall be provided for warming up the lines up to the soot blower operating valve. Steam lines shall be inclined so that they can de-water during heating up. Sealing and purging air from the FD fan shall be provided as necessary. A dedicated seal/purge air fan shall be installed, if it cannot be assured that seal/purge air is available under all boiler loads when air is provided by the FD fan.

The type of soot blower, e.g. retractable, fixed etc., shall be selected to suit the flue gas temperature conditions at the soot blower location. Steam for soot blowing shall preferably be taken from the MP steam main, but in any case downstream of all boiler control elements.

The capacity and lay-out of the soot blowers shall be such that during an 8 000-hour operating period the efficiency of the boiler at MCR, with any of the specified fuels or fuel combinations, shall not drop by more than 3% and that the guaranteed MCR and steam temperature shall be maintained.

A PLC shall be included for automatic operation from a central room. Non-safety related functionality for automatic operation of soot blowers should be resident in the DCS.

It shall be possible locally to stop and retract each soot blower.

2.5.7 Boiler water and steam sampling

Sampling of boiler water and steam shall be in accordance with ASTM D 3370 and ASTM D 1066 respectively. Nozzles, valves, pipes, fittings and coolers suitable for these sampling methods shall be provided. The piping material for the steam sampling line shall be ASTM A 312, TP 316, and be self-draining to avoid the risk of stress corrosion cracking. The piping material for the water sampling line upstream of the isolating valve closest to the drum, and for this isolating valve, shall be carbon steel to avoid stress corrosion cracking.

2.6 MATERIALS, FABRICATION AND STRUCTURES

2.6.1 Tubes and pipework

All tubing and piping, flanges and fittings shall comply with DEP 31.38.01.11-Gen. and DEP 31.38.01.12-Gen.

Electric-resistance-welded (ERW) tubing or piping with the water-wall weld on the casing side may be used for pressures up to 45 bar (abs) up to a maximum of 100 mm nominal size, and up to a maximum wall thickness of 5 mm, provided it complies with DEP 30.10.02.11-Gen. ERW tubing or piping for higher pressures may be used only with the approval of the Principal. In all other cases, seamless tubes or piping shall be used.

Attention is drawn to the provision of proper drainage/blow drying facilities which may be required to protect against corrosion during shut down periods. The Manufacturer shall state clearly any special provisions required.

Pipe, tube and return bend materials shall be selected for the service requirements and in accordance with ASTM or British Standards (or other standards if approved by the Principal). The type and material specifications of the tubing and piping shall be stated by the Manufacturer on the data/requisition sheets.

If boiler, economiser and superheater tubes/pipes are bent, the resulting thickness of the tube wall at the thinnest part shall not be less than the design value required according to the strength calculation, with the corrosion allowance added thereto.

Bending of tubes/pipes shall be in accordance with DEP 31.38.01.31-Gen.

Extended surface tubing may be applied to convective heat transfer surfaces where this is judged to be advantageous to the overall boiler design and takes appropriate account of the fouling nature of the flue gases. Where finned tubes are applied, the fins shall be fully welded to the tube and be sufficiently rigid to withstand mechanical cleaning. Minimum fin thicknesses of 1.5 mm and 3.0 mm shall be applied for clean gas and fuel oil firing respectively. The minimum fin pitch shall be 5.0 mm for clean gas firing and 12.5 mm for fuel oil firing. For dual-fuel fired installations the limitations for fuel oil firing shall govern. In all cases, the application and type of finned tubing shall be subject to the approval of the Principal.

2.6.2 Welding

Joints shall be made by welding wherever possible, unless otherwise specified.

All tube ends and pipework shall be suitably prepared for welding where welding is required.

The welding of all parts which are covered by the ASME Boiler and Pressure Vessel Code Section I shall comply with this code and any additional requirements of DEP 30.10.60.18-Gen. (e.g. post weld heat treatment of 1¼ Cr-½ Mo tubes is required).

For welding details not available in ASME Boiler and Pressure Vessel Code Section I or other selected code (see 2.1), DEP 31.24.49.31-Gen. shall be followed.

All welded connections to the steam and water drums shall be of the full-penetration type. The connections shall be of the set-on or set-through type, so as to obtain the minimum weld volume.

All welding shall be done by qualified welders. Qualification tests for welders and welding procedures shall comply with ASME Boiler and Pressure Vessel Code Section IX or other code stated by the Principal.

2.6.3 Steel structures

Supporting steel structures, platforms, stairs, ladders and railings shall be in accordance with DEP 34.00.01.30-Gen. and DEP 34.28.00.31-Gen. Handrailing shall be in accordance with Standard Drawing S 28.006. The steel structure design shall take into account the support requirements for all hydrostatic testing (including during manufacture) as well as for transportation and erection.

Further to the requirements of the above specifications, stairs and platforms shall provide easy access to all valves, gauges, instrument fittings, observation points and access doors, and for all other operational purposes. Ladders may be used only for providing extra means of escape. All stairs, platforms and walkways shall be adequately safeguarded with hand railing and toe plates.

All main platforms shall be provided with an emergency means of escape leading to ground level.

All bolts should have metric threads.

2.6.4 Refractories and insulation

Insulating refractory concrete shall be in accordance with DEP 64.24.32.30-Gen. Refractory bricks shall be in accordance with DEP 44.24.90.31-Gen. Insulation shall be in accordance with DEP 30.46.00.31-Gen. The Manufacturer shall give in the tender full, detailed specifications of the refractory and insulating materials to be used.

Burner throats should be constructed of preformed bricks. Alternatives are subject to approval by the Principal.

External insulation shall be covered with aluminium, or galvanised/aluminised steel sheeting, whichever is specified, installed in such a way that the insulation remains perfectly dry and free from ingress of water, and has sufficient allowance for expansion.

Manholes, access doors etc. shall have their own separate insulation or refractory so that they can be opened without damage to insulation or refractory.

2.7 PRESERVATION AND INITIAL PREPARATION

Painting, both at works and on site, shall be in accordance with DEP 30.48.00.31-Gen. Any case not covered therein shall be discussed with the Principal.

Galvanising shall be in accordance with ASTM A 123 or BS 729.

NOTE: Galvanising shall not be used on the water or steam side of tubes or piping.

The superheater shall be freed from mill scale before departure from the Manufacturer's works as the superheater will only be steam blown during commissioning of the boiler. All boxes, vessels, tubes and internal connecting lines shall be cleaned prior to departure from the works. At that time all openings shall be closed to prevent foreign matter from entering during transport or erection. Chemical cleaning of the boiler at site is covered in (5.1).

2.8 ELECTRICAL INSTALLATIONS

Electrical installations and lighting shall comply with DEP 33.64.10.10-Gen.

2.9 CHEMICAL DOSING INSTALLATION

An installation suitable for dosing the necessary chemicals for the boiler shall be provided unless specified otherwise by the Principal.

This may comprise, for example:

- a dosing installation for continuous alkalinity control by means of NaOH;
- a dosing installation for phosphates;
- dosing installations for hydrazine/sulphite/morpholine, or other chemicals.

If hydrazine is used, a fully closed dosing system shall be applied for operator protection.

Each dosing installation shall be provided with a dosing pump complete with installed spare. The stroke of the pumps shall be adjustable during operation and standstill. If the dosing rate is constant over long periods of time, a locally adjustable stroke is sufficient. If the dosing rate requires automatic adjustment in ratio with the water consumption, automatic facilities are required.
Dosing pumps shall be in accordance with DEP 31.29.12.30-Gen.

Chemicals shall preferably be injected at the suction side of the feed water pump. If boiler feed water is used for desuperheating, chemicals shall be injected downstream of the desuperheating water take-off.

The above installations shall be complete with lines, valves, pumps, vessels, mixers, mountings, heaters, if necessary, and arrangements to avoid health and safety hazards.

2.10 NOISE LIMITATIONS

2.10.1 General

EEMUA 140 shall apply with regard to definitions, notations, measuring equipment and procedures, test reporting, calculation methods and procedures.

2.10.2 Noise limits

The maximum allowable sound pressure level shall not exceed 85 dB(A) in the work area, i.e. any position accessible to personnel not less than 1 m from equipment surfaces.

The above limit may be adapted by limits given in the noise limitation data sheet, DEP 31.10.00.94-Gen., which forms part of the requisition.

The requirements apply in the absence of reverberation and background noise from equipment other than the water-tube boiler installation, for all operating conditions between minimum flow and MCR.

If the equipment produces impulsive and/or narrow band noise, the noise limits shall be 5 dB(A) lower than the values stated above or in the requisition.

For safety valves which discharge under emergency conditions only, the above limitations are relaxed so that the noise level in the work area shall never be greater than 120 dB(A) when they are discharging.

For start-up, shut-down and testing situations which are to be considered as normal operation, a relaxation is accepted. In such situations, the equivalent sound pressure level over an 8-hour period shall not exceed 85 dB(A) in the work area. However, the maximum level shall not exceed 95 dB(A).

2.10.3 Noise abatement

Excessive equipment noise should be eliminated by low noise design. Where other noise control measures such as acoustic insulation or acoustic enclosures are required, they shall be designed to allow operational or routine maintenance activities. Where enclosures are proposed, prior approval of the Principal shall be obtained regarding construction, materials and safety requirements.

Acoustic insulation of pipes, valves and flanges shall be in accordance with DEP 31.46.00.31-Gen.

3. INSTRUMENTATION FOR IPF AND CONTROL

The Manufacturer shall include in the tender schematic diagrams for automatic control and IPF of the boiler. Diagram symbols shall conform with DEP 32.10.03.10-Gen. Functional Logic Diagrams (FLDs) shall be complete, comprehensible and consistent. If the Manufacturer is not using his own standard, reference is made to IEC 60617-12.

The automatic control diagrams should follow the principles shown in the relevant Standard Drawing S 75.004 and include closed-loop oxygen control. The Manufacturer shall also include any additions deemed necessary for satisfactory operation of the boiler under the conditions specified in the data/requisition sheets.

The IPF (in accordance with DEP 32.80.10.10-Gen.) and control of the firing system shall be in accordance with the following DEPs, whichever is applicable:

- DEP 32.24.20.40-Gen. for tangentially gas-fired CO boilers;
- DEP 32.24.20.38-Gen. for automatically started, forced draught, multi-burner furnaces and boilers;
- DEP 32.24.20.30-Gen. for a single burner furnace.

The diagrams etc. shall also include the additional requirements, if any, specified in national or local regulations. In case of conflict between such regulations and the requirements specified above, this shall be stated by the Manufacturer in the tender.

Requirements for flow meters shall be in accordance with DEP 32.31.00.32-Gen.

For the instrumentation, as appropriate, and process connections for instrumentation, DEP 32.31.09.31-Gen. shall apply.

Whether or not the instrumentation is supplied with the boiler installation, all the necessary instrument process connections shall be provided by the Manufacturer. Their construction, accessibility etc. shall be in accordance with DEP 32.31.00.32-Gen.

The Manufacturer shall be responsible for the correct input data for the sizing calculations for flow measuring elements and control valves. The methods of selection and sizing of flow meters and control valves shall be approved by the Principal in writing. Reference is made to DEP 32.36.01.17-Gen.

4. QUALITY ASSURANCE AND INSPECTION

4.1 QUALITY ASSURANCE

The Manufacturer shall implement a quality management system in accordance with ISO 9001, or alternative standard if approved by the Principal.

The Manufacturer shall prepare a quality plan no later than four weeks after the order date. The quality plan shall demonstrate compliance with this DEP and shall be submitted to the Contractor for approval.

The Contractor shall indicate hold or witness points (if any) on the quality plan.

The final quality plan shall be subject to the approval of the Principal.

The Contractor may conduct quality audits at any stage throughout the duration of the work to evaluate the degree of compliance with the quality plan.

4.2 INSPECTION AND TESTING

4.2.1 General

The Manufacturer shall perform inspection and tests in the shop as described in the quality plan.

If the Contractor has specified any hold or witness points, the Manufacturer shall give the Contractor all reasonable facilities and access for satisfying himself that the equipment is being manufactured in accordance with this DEP.

Except as approved by the Contractor all equipment shall be presented for inspection in an unpainted state. All closures for shop testing shall be provided by the Manufacturer.

4.2.2 Specific

- The components of the electrical auxiliaries and the control systems shall each be given standard factory tests. Each section shall be functionally tested after assembly.
- Gas tightness shall be verified visually using a smoke bomb or a soap test at the maximum discharge pressure of the forced-draught fan, up to the sliding damper or a blanking plate in the flue gas duct (see 2.2.9).
- Refractory materials shall be tested in accordance with DEP 64.24.32.30-Gen.
- The Manufacturer shall submit inspection certificates in accordance with ISO 10474 type 3.1.B for tubing, piping and pressure vessels.
- The Manufacturer shall submit pressure test certificates for the safety valves and the pressure vessels themselves.
- The above certificates shall satisfy the applicable code requirements and shall be available at site before the initial firing of the boiler.

5. ERECTION, CLEANING, START-UP AND PERFORMANCE TESTING

5.1 MECHANICAL ERECTION

Mechanical erection shall include any applicable tests and services such as cleaning, chemical cleaning, drying out, setting of safety valves etc. as may be required to prepare for start-up. Mechanical erection shall be carried out by the Manufacturer, or under his supervision, as specified on the data/requisition sheets.

The installation of rotating equipment shall be in accordance with DEP 31.29.00.10-Gen.

Where applicable, the refractories shall be kept free from freezing before initial start-up.

The boiler and ducting shall be mounted in such a way that free expansion is possible so that no undue stresses are caused to adjoining structures, equipment and foundations.

After completion of erection but before the drum internals are installed, all extraneous material shall be removed from the boiler, superheater, and economiser. The internal surfaces shall then be chemically cleaned in accordance with DEP 70.10.80.11-Gen.

In the event that the boiler, after erection, will be standing idle for a period before being brought into service, steps shall be taken to store it in a way that will avoid corrosion or other deterioration before eventual start up. Reference is made to DEP 70.10.70.11-Gen.

Whether acid cleaning is proposed or not, suitable connections on the boiler such as nozzles etc. shall be provided if an acid cleaning process is desired at a future date. All equipment necessary for the pre-start-up chemical cleaning, such as pump, tanks, heaters, valves, piping and chemicals shall be supplied by the Contractor, see DEP 70.10.80.11-Gen.

5.2 START-UP

After completion of mechanical erection and pre-start-up tests of control and IPF the boiler will be put into operation by the Principal under supervision of and, if required, with the assistance of the Manufacturer.

The Manufacturer shall advise the Principal of the correct methods of start-up, operation, shutdown, emergency procedure, off-load preservation, chemical cleaning and maintenance.

5.3 PERFORMANCE/ACCEPTANCE TESTS

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

At least the following tests shall be carried out using the fuel specified by the Principal:

- at peak load for 2 hours;
- at 100% of MCR for 8 hours;
- at minimum load on automatic control - for 8 hours;
- any additional performance test, as specified on the data/requisition sheets;
- tests for automatic control and load response;
- a test at 100% MCR with one burner out of operation, if specified on the data/requisition sheets;
- tests for operation of the IPF system.

The tests shall be done by the Principal in the presence of the Manufacturer, who shall give assistance if necessary.

Unless otherwise specified, the plant instruments may be used for the performance tests after agreement has been reached between the Principal and the Manufacturer on the

calibration of the plant instruments.

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

Methods for the determination of steam quality shall be agreed between Principal and Manufacturer.

Efficiency tests and calculations shall be carried out according to the "Losses Method" described in ASME PTC 4.1.

Flow metering shall be in accordance with DEP 32.37.00.33-Gen.

Whoever supplies the instrumentation and control system, the boiler Manufacturer shall remain responsible for the boiler performance guarantees, on the basis that he agrees with the principles of the instrumentation and control system which will be applied.

6. DOCUMENTATION

6.1 GENERAL

The English language shall be used throughout unless otherwise specified. However, descriptions on drawings may be in other languages, provided English translations are clearly given. All documents shall also be made available electronically to the maximum extent.

S.I. units shall be used throughout.

The Manufacturer shall provide all drawings, design details, operation and maintenance manuals, and other information necessary for the design assessment, erection, operation and maintenance of the installation. All information, especially the manuals for operation and maintenance, shall be clear and not open to misinterpretation and shall apply specifically to the installation supplied.

6.2 DATA/REQUISITION SHEETS AND DOCUMENTATION REQUIRED AT THE TENDERING STAGE.

The data/requisition sheets (DEP 30.75.10.93-Gen.) shall be used to exchange information between the Principal and the Manufacturer.

Where the sheets show alternatives, those items which are not applicable shall be crossed out.

Alternative data shall be provided for each type of fuel, as necessary.

6.2.1 Data/requisition sheets 1, 2, and 3

Sheets 1, 2 and 3 shall be completed by the Principal. These sheets describe, in conjunction with this DEP, the extent of the project and contain data provided by the Principal.

Battery limit conditions for all items mentioned under the heading "Utilities" will normally be indicated on the flow scheme and on the proposed control schemes.

Where necessary, additional information on existing equipment will be given by the Principal, e.g. blowdown line system, vents and drains, chemical dosing system and feed pumps.

Information on rotating equipment (blowers, fans, pumps, turbines etc.) shall be submitted via the relevant rotating equipment data sheets:

Centrifugal pump datasheets DEP 31.29.02.93 sheets 1,2,3. Refer to DEP 31.29.02.30.

Mechanical seal datasheet DEP 31.29.00.94.

Reciprocating pumps DEP 31.29.12.93 sheets 1,2. Refer to DEP 31.29.12.30.

Rotary pumps DEP 31.29.22.93 sheets 1,2

Fan datasheets DEP 31.29.42.93 sheets 1,2,3. Refer to DEP 31.29.47.30.

General purpose steam turbines DEP 31.29.61.95 sheets 1, 2. Refer to DEP 31.29.60.30.

6.2.2 Data/requisition sheet 4

Sheet 4 shall be completed by the prospective Manufacturer at the tendering stage and is intended to provide the minimum information required by the Principal to enable pre-selection of the tenders.

The following drawings and information shall be submitted with sheet 4:

a) Drawings of:

- dimensioned general arrangement, front and side elevations, of complete installation showing boiler, burners, galleries and ladders, ducting, fan and stack;
- dimensioned front and side sectional elevation of boiler, showing drum, casing, furnace, burners, access and observation ports, soot blowers and all tube banks. The furnace in particular shall be fully dimensioned including burner centre lines.

b) Description of:

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

c) The capital costs of:

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

d) Period of delivery:

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

e) Lists of:

- reference boilers of the same type, including location, capacity, superheated steam pressure and temperature and fuels fired, and if possible, feed water quality;
- any deviations from the requirements of this DEP;
- sub-suppliers;
- all instruments needed and their location (local, local panel, control room);
- the scope definition split between the Manufacturer and Principal for the Instrumentation part.

  The scope definition should address at least the following issues:

  1. Hardware scope split.
  2. Responsibility split as regards functionality, operating and control concept, performance, operating spectrum and integrity.
  3. Data interchange.
  4. Integration with Principal's systems such as Instrument Engineering database tools, control and IPS systems and maintenance management systems.

- major shipping weights and dimensions;
- provisions made for safety and emergencies.

6.2.3 Data/requisition sheets 5 and 6

Sheets 5 and 6 shall be completed by selected Manufacturers to provide detailed information for final selection by the Principal. Sheet 4 shall also be updated, if necessary.

The following information shall be submitted together with sheets 5 and 6:

- details of the furnace wall construction showing tubes, insulation and casing;
- burner details;
- flame pattern;
- dimensioned details of drums and internals;
- boiler support and expansion details;
- tube bank support details;
- diagram showing superheater materials and corresponding metal temperatures at MCR and peak load;
- burner characteristics;
- list of vents, stop and check valves, showing sizes, capacities and Manufacturers;
- list of refractories and insulation materials, showing type, location, protection, fastening and surface temperature;
- dosing pump characteristics.

The Manufacturer shall submit guaranteed sound power levels and/or sound pressure levels of the equipment, together with any other relevant information as requested in the equipment noise limitation sheet DEP 31.10.00.94-Gen., in the silencer data/requisition sheet DEP 31.10.00.95-Gen., and in the acoustic enclosure data/requisition sheet DEP 31.10.00.96-Gen.

6.3 DOCUMENTATION AND INFORMATION REQUIRED AFTER CONTRACT AWARD

The following shall be submitted after the contract has been awarded:

- operating manual describing normal operation, hot stand-by, shut-down procedures etc.;
- one copy of operating and maintenance manual (or more if the Principal so specifies);
- detailed calculations for tube dimensions and materials for drum and major heat transfer equipment;
- all necessary information on mass, moments, location of foundation bolts etc. for the design of the foundation. The Manufacturer shall approve the foundation drawings;
- resistance characteristics on the air and the flue gas side over the whole installation;
- characteristic of the combustion air flow-metering Venturi;
- list of Manufacturers of all major equipment, tubes and tube fittings;
- list of all spare parts, including list of initial spare parts necessary for start-up and first year of operation, with detailed prices and time of delivery;
- list of all tools necessary for operation, maintenance, inspection and cleaning insofar as not normally found in a refinery workshop;
- the mass of:

  boiler empty;
  boiler full (hydraulic test conditions);
  boiler full (working conditions);

- engineering drawings:

  - List of instrumentation drawings;
  - Instrument data sheets of the Principal. On these data sheets the information to be provided by Manufacturer is indicated;
  - PEFS;
  - System control diagrams, IPF system and sequence control narratives, giving

detailed requirements of integrated control loops e.g. air/fuel control;

- Logic diagrams showing IPF system and shut-down requirements and (separate) start/stop sequence logic;
- List of alarm trip and timer settings;
- Utility consumption data: power supply, instrument air, demin. water, nitrogen, service/cooling water;
- Calculations for flow measurements, control valves, noise, restriction orifices and de-pressurising systems;
- Hazardous area certifications as applicable;
- Analyser drawings.

7. REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Requisition binder	DEP 30.10.01.10-Gen.
Metallic materials - Selected standards	DEP 30.10.02.11-Gen.
Welding of metals	DEP 30.10.60.18-Gen.
Thermal insulation for hot services	DEP 30.46.00.31-Gen.
Painting and coating of new equipment	DEP 30.48.00.31-Gen.
Gas turbine heat recovery steam generators	DEP 30.75.10.31-Gen.
Shop fabrication of heater piping	DEP 31.24.49.31-Gen.
Installation of rotating equipment	DEP 31.29.00.10-Gen.
Centrifugal pumps (amendments/supplements to API Std 610)	DEP 31.29.02.30-Gen.
Reciprocating positive displacement pumps and metering pumps	DEP 31.29.12.30-Gen.
Centrifugal fans	DEP 31.29.47.30-Gen.
General-purpose steam turbines	DEP 31.29.60.30-Gen.
General-purpose steam turbines	DEP 31.29.61.95-Gen.
Piping - general requirements	DEP 31.38.01.11-Gen.
SIOP piping classes	DEP 31.38.01 12-Gen.
Shop and field fabrication of piping	DEP 31.38.01.31-Gen.
Acoustic insulation for piping	DEP 31.46.00.31-Gen.
Instrumentation symbols and identification on process engineering flow schemes	DEP 32.10.03.10-Gen.
Control system and instrumented protective functions for fired equipment - System for a single-burner furnace (S 24.024 and S 24.026)	DEP 32.24.20.30-Gen
Control system and instrumented protective functions for fire equipment - System for an automatically-started, forced draught, multi-burner furnace or boiler (S24.030 or S 24.034)	DEP 32.24.20.38-Gen.
Control system and instrument protective functions for fired equipment - System for a tangentially gas-fired CO boiler (S 24.036)	DEP 32.24.20.40-Gen
Instruments for measurement and control	DEP 32.31.00.32-Gen.
Instrumentation for equipment packages	DEP 32.31.09.31-Gen.
Control valves - selection, sizing and specification	DEP 32.36.01.17-Gen.
Classification and implementation of instrumented protective functions	DEP 32.80.10.10-Gen.
Electrical engineering guidelines	DEP 33.64.10.10-Gen.
Minimum requirements for structural design and	DEP 34.00.01.30-Gen.

engineering	
Steel stacks	DEP 34.24.26.31-Gen.
Reinforced concrete stacks	DEP 34.24.27.31-Gen.
Steel structures	DEP 34.28.00.31-Gen.
Refractory bricks and shapes	DEP 44.24.90.31-Gen.
Insulating and dense refractory concrete linings	DEP 64.24.32.30-Gen.
The preservation of old and new equipment and piping standing idle	DEP 70.10.70.11-Gen.
Cleaning of equipment	DEP 70.10.80.11-Gen.

DATA/REQUISITION SHEETS

Data/requisition sheet for water tube boilers	DEP 30.75.10.93-Gen.
Data/requisition sheet for equipment noise limitation	DEP 31.10.00.94-Gen.
Data/requisition sheet for vent/blowdown/air flow/inline silencers	DEP 31.10.00.95-Gen.
Data/requisition sheet for rotating equipment acoustic enclosures	DEP 31.10.00.96-Gen.
Data/requisition sheet for Mechanical seal for centrifugal/rotary pumps	DEP 31.29.00.94-Gen.
Data/requisition sheet for Centrifugal pumps	DEP 31.29.02.93-Gen.
Data/requisition sheet for Reciprocating pumps	DEP 31.29.12.93-Gen.
Data/requisition sheet for Rotary pumps	DEP 31.29.22.93-Gen.
Data/requisition sheet for Rotary-type compressors and fans	DEP 31.29.42.93-Gen.
Data/requisition sheet for General-purpose steam turbines	DEP 31.29.61.95-Gen.

STANDARD DRAWINGS

Typical arrangement for air flow measurement in suction of FD fans	S 24.002
Sliding plate in flue duct	S 24.303
Flexible flanged connection for hot air duct	S 24.404
Hand railing, type "A"	S 28.006
Typical control scheme of water/steam side for steam boiler	S 75.004

AMERICAN STANDARDS

ASME boiler and pressure vessel code:	ASME B31.1
Section I -Power Boilers	ASME I
Section IX- Qualification standard for welding and brazing procedures, welders, brazers, and welding and brazing operators	ASME IX
ASME Performance Test Code - Steam-Generating Units	ASME PTC 4.1

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345 East 47th Street
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Standard specification for zinc (hot-dip galvanised) coatings on iron and steel products	ASTM A 123
Standard specification for seamless and welded austenitic stainless steel pipes	ASTM A 312
Standard practice for sampling steam	ASTM D 1066
Standard practices for sampling water from closed conduits	ASTM D 3370

Issued by:
American Society for Testing and Materials,
1916 Race St.,
Philadelphia Pa 19103,
USA

BRITISH STANDARDS

Hot dip galvanised coatings on iron and steel articles	BS 729
Design and manufacture of water-tube steam generating plant (including superheaters, reheaters and steel tube economizers)	BS 1113

Issued by:
British Standards Institution
389 Chiswick High Road
London W4 4AL
UK

Noise Procedure Specification	EEMUA 140

Issued by:
Engineering Equipment and Materials Users Association
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GERMAN STANDARDS

Guideline for Boiler Feedwater, Boiler Water and Steam of Steam Generators with a Permissible Operating Pressure of >68 bar — VGB R-450-Le

Issued by:
VGB-Kraftwerkstechnik GmbH
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D-45136 Essen
Germany

INTERNATIONAL STANDARDS

Graphical symbols for diagrams — IEC 60617-12

- Part 12 Binary logic elements third edition

Central Office of the IEC
3, Rue de Varembé
CH 1211 Geneva 20
Switzerland.

Copies can also be obtained from national standards organizations.

Quality systems – Model for quality assurance in design, development, production, installation and servicing — ISO 9001

Steel and steel structures - Inspection documents — ISO 10474

Issued by:
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CH-1211 Geneva 20
Switzerland.

Copies can also be obtained from national standards organizations.

APPENDIX 1 SCOPE OF SUPPLY AND TERMINAL POINTS

A list entitled “Scope of supply” and a list entitled “Terminal points” shall be provided by the Principal. These lists refer to the individual requirements of each installation. To assist in the compilation of these lists, typical examples are given below.

A sketch may also be found useful in defining the “Terminal points” (e.g. fuel line terminal points), in which case such a sketch should be attached to the “Terminal points” list.

1. General

The work to be performed under the terms of this Specification includes design, engineering, manufacturing, testing and supply, and supervision and assistance during erection, (pre-)commissioning, start-up and performance testing of the boiler packages.

2. Manufacturer's equipment and material supply

The extent of supply of the packages shall be as noted below, but the Manufacturer shall include in the scope of work any additional equipment considered necessary, or as required, or defined in any code, standard or specification noted herein, including this Specification, consistent with good engineering practice or required for safe operation of the boilers.

The following list shall, therefore, not be considered as limiting but is intended to reflect the Company's minimum requirements:

- Evaporator, steam drum (including internals), superheater(s), economiser, downcomers/risers, headers/manifolds and all other internal boiler pipe work and valves.
- Spray attemporator (de-superheater) system(s) for main steam temperature control including integral piping, spray water control station.
- Main steam control and water valves, stop valves and vent valves.
- Boiler structure, frames and supports with platforms, stairs and ladders giving access to all valves, mountings, fittings and instrumentation.
- Burners for fuel gas complete with flame detectors, ignition burners, igniters plus panels, all piping, measuring devices, manual and automatic shut off valves and control valves but **excluding** a fuel gas knock out drum.
- Insulation/refractory.
- Observation windows, access and inspection doors.
- Main steam stop double-block-and-bleed valve (one to be electrically operated) and main steam non-return valve, including hand wheel for positive closure.
- Silencers, where needed to comply with noise regulations as stated in DEPs and local legislation.
- Stack (depending on proposed boiler type).
- Auxiliary firing system, including control and tight shut off valves.
- All ducting and ducting supports required to be installed within the plot space limits as indicated in the drawings.
- All lighting fixtures (normal and emergency) including connection boxes.
- All process and utilities connections.
- All field instrumentation required to monitor, control and safeguard a boiler. This includes instrumentation for combustion, drum level, feed water supply, boiler feed water quality, steam supply and temperature.
- All local reading instruments.
- All local instrumentation cabling including junction boxes.

- Insulation at works of equipment and piping plus weatherproof casing.
- All painting at works.
- The flue gas duct shall be equipped with several DN 100 nozzles with blind flanges to facilitate emission measurements.
- An in-situ type oxygen analyser in the flue gas duct.
- All safety relief valves.
- All electrical equipment including motors, terminal boxes, RCUs and safety switches.
- All local electric cabling including junction boxes.
- All earthing facilities including earthing pits.
- All special tools and equipment required for operation and maintenance, other than those ordinarily found in a mechanical workshop.
- Sample coolers for boiler water, saturated steam and superheated steam.
- An electrically operated steam blow off, including a silencer, for start-up and hot stand-by purposes.
- Common blow down vessel with atmospheric vent and residual air-cooled blow down cooler (cooling down to 80 °C).

3. Tie-in points of equipment supply for a boiler package

In the following paragraphs typical tie-in points are given as an example only.

HP/MP steam

Up to and including the flow measurement downstream of the motor operated TSO steam valve.

Boiler feed water

Up to and including the flow measurement upstream of the boiler feed water control valve (stream number 4 on drawing T-2.944.428-C, Appendix 5).

Continuous and intermittent blow down

Up to and including block valves of the intermittent and the continuous blow down lines. Inlet block valves of the blow down vessel. Discharge block valve of the residual blow down cooler.

Fuel oil/gas

Up to and including the block valve upstream of the fuel gas control and IPF skid.

Drains

Up to and including discharges at sewer points.

Cooling water

Cooling water will only be required for the sample coolers, and the Company will provide the cooling water supply.

Instrument air

Up to and including the block valve in the common supply line to each boiler (9 bar (abs)) 900 kPa, 50 °C).

Plant air

Up to and including the block valve in the common supply line to each boiler.

Nitrogen

Up to and including the block valve in the common supply line to each boiler.

Electrical

Up to and including:

- terminal box of HV motor;
- terminal box of LV motor;
- safety switches of MOV;
- junction box of ignition control panel;
- connection box of lighting fixture;
- connection box of power receptacle;
- earth pit.

Instrumentation

- Instrument cabling up to including the junction boxes.

4. Manufacturer's Services

Manufacturer shall provide following services:

- Design and engineering of boiler related instrumentation. This design and engineering shall be in accordance with the specified DEPs and standards.
- The scope for design and engineering of instrumentation is not limited to those instruments which will be installed on equipment/piping within Manufacturer's scope of supply but is extended to the following items:
    1. the fuel gas supply and control system starting at the tie-in point.
    2. the combustion control system (taking into account section 3).
    3. the burner management/IPF system (taking into account the guidelines given in section 3).
    4. the feed water supply and control system, including drum level control.
    5. the injection water system including the steam temperature control system.