NEERA BHIMA SAHAKARI SAKHAR KARKHANA LTD., (NBSSKL)

Shahajinagar, A/p. Redni
Tal.Indapur & Dist. Pune,
Maharashtra - 413114, India

Contact Person	D.N Markad
Phone	02111-270200/270650
Fax	02111-270555

INCINERATION (SPENT WASH) BOILER FOR DISTILLERY PROJECT

AT

NEERA BHIMA SAHAKARI SAKHAR KARKHANA LTD., (NBSSKL)

ENQUIRY NO.: - 2021/BOILER/001

FOR

SPENT WASH FIRED BOILER AND AUXILIARIES

VOLUME II

July- 2021

CONSULTANTS

VASANTDADA SUGAR INSTITUTE,
Manjari (Bk), Tal- Haveli, Pune

VOLUME-II

TECHNICAL SPECIFICATION AND SCOPE OF WORK FOR SPENT WASH FIRED BOILER WITH AUXILIARIES

FOR

SPENT WASH TREATMENT PROJECT

CONTENTS

1.0 SCOPE OF WORK, EXCLUSIONS AND TERMINAL POINTS

1.1 General

This specification covers the design, manufacture, delivery installation and commissioning at site, of one (1) No. steam generator for meeting the steam and power requirements of the distillery complex. The steam generator shall be designed to generate 110% MCR capacity under the following fuel firing combinations.

Distillery Slop + Indian coal / Imported Coal /Bagasse /Biogas.
And also 100% Indian coal, 100% Imported coal, 100% Bagasse.

The capacity of the boiler shall be 38TPH. The boiler shall be designed to operate with the feed water inlet temperature of 150°c. (Inlet to Economizer, inlet to deaerator 90°c). The boiler steam outlet parameters shall be 46 ata and 400 $\pm$ 5°c at the main steam stop valve outlet. The fuel firing system shall be travelling grate technology with variable frequency drive and planetary gear box.

Supplies and services shall be rendered in conformity with proven engineering principles, taking into account the current state-of-art technology. The requirements of the contract must be fulfilled in its entirety.

The supplies and services within the scope shall be rendered inclusive of all appliances and interconnecting arrangements with other supplies, necessary for installation of all accessories, needed for proper and reliable continuous operation and for satisfactory maintenance and repair.

As far as the scope of execution of supplies and services is concerned, the supplies and services as contained in drawings, but not in specification and vice versa, shall be deemed to be contained in both. Contradictions between drawings and specifications if any shall be brought to the attention of the **PURCHASER / CONSULTANT** by the **SUPPLIER** and the correct requirement shall be obtained.

The scope of supply and services shall include all necessary work and supply of equipment and material whether mentioned in these specifications or not, but which are necessary for the satisfactory, reliable and safe operation and maintenance of the plant and required for achieving guaranteed performance of the plant. Any equipment, device or material even if not included in the original bid but found necessary for the safe and satisfactory functioning of the units under the bid shall be supplied, erected and commissioned by the **SUPPLIER** at **no extra cost** to the **PURCHASER** as though such

equipment, material or work were originally specified and formed part of the scope of work.

1.2 Codes and Standards

The design, manufacture, testing and performance of the Boiler and Accessories shall comply with the requirements of applicable Indian / British / American / DIN Standards, such as the following, and those standards specified therein, in so far as they apply.

a.	Indian Boiler Regulations (IBR)	
b.	IS 800	Code of practice for Constructions in Steel
	IS 875	Code of practice for Design loads for buildings structures.
c.	IS 1893	Criteria for Earthquake Resistant – Design of Structures
d.	IS 2825	Code for unfired pressure vessels
e.	ASME Section I	Rules for construction of power boilers
f.	ASME Section IX	Welding & Brazing Qualifications
g.	ASME PTC 4	Steam Generating Units
h.	ASME PTC 4.3	Air Heaters
i.	ASME PTC 19.11	Water and Steam in the Power Cycle (Purity and Quality, Leak detection and Measurement)
j.	ASME Section I	Safety Valves
k.	API RP 520	Relief Valves
l.	ASME B 31.1	Code for Power piping

1.3 Design and Construction - General

The boiler shall be designed and constructed according to the latest edition, and including all the latest amendments of Indian Boiler Regulations (IBR).

The material and the design of pressure parts including pipes shall be approved by the Chief Inspector of Boilers and shall be inspected and certified by inspecting authorities approved by Indian Boiler Regulation, during manufacturing / fabrication, construction and erection. The **SUPPLIER** shall submit to the **PURCHASER / CONSULTANT** and the Chief Inspector of Boilers, the calculations and other documents for all pressure parts including pipes showing that the requirements of IBR have been entirely fulfilled.

The proposed Steam Generator shall be designed and supplied as per the performance design criteria, material specification and other stipulations detailed out in this section of the specification.

1.4 Type of Steam Generator and Auxiliaries

- The boiler shall be suitable for outdoor installation. The boiler shall be mounted on a steel structure from the ground level. Civil work shall be provided for mounting of boiler above FFL +300mm. The boiler steel structure columns shall be mounted from the ground level at +300 mm. The platform level of boiler shall be 5 mtr.

- The draft system of the boiler shall be balanced.

- The boiler shall be designed with natural circulation.

- The boiler furnace shall be Water cooled membrane walls.

- Two stage super heater with inter stage attemperator.

- Economizer as the heat recovery system.

- 2 X 120 % Motor driven Boiler feed pumps

- Deaerator and Deaerated water storage tank 40-minute and feed water tank of min. 45 m3 capacity on same platform.

1.5 Boiler Parameters

1.5.1	Net Steam Output at the Boiler Main Steam Stop Valve (Kg/Hr)	38000	Kg/hr

Peak generation 110% of MCR for half an hour continuous duration, for 2 times in every 8 hrs. per shift.

1.5.2	Superheated Steam Pressure at Main Steam Stop Valve Outlet (kg/cm2)	46.0
1.5.3	Superheated Steam Temperature at Main Steam Stop Valve Outlet (Deg.C)	400 ± 5
1.5.4	Feed Water Temperature at Economizer Inlet (°C)	150

The Net capacity of the boiler excludes, soot blowing and any other auxiliary steam requirements. The steam required for the deaerator and SCAPH, under the normal operation, will be supplied from turbine exhaust and SUPPLIER shall provide the necessary piping for the same. Further SUPPLIER shall include a separate PRDS in his scope for meeting the distillery process, startup requirement of steam for the deaerator & SCAPH.

The flue gas temperature leaving the boiler to stack shall be chosen such that maximum economically possible efficiency is achieved but the temperature shall be sufficiently higher to prevent dew point considering the fuel characteristics. Provisions shall be made in the design to get the optimum temperatures both under slop + Coal /bagasse firing and standalone coal/bagasse firing system. Temp. of flue gas leaving the boiler to stack not more than 180^0C.

1.6 Scope of Work

1.6.1 General

The scope of work covered under this specification includes but not limited to the following:

1.6.2 Supply

Design, engineering, fabrication, manufacture, assembly, shop testing and inspection at manufacturing works and supply erection & commissioning at site for the complete boiler & auxiliaries including 2 year operational spares list.

1.6.3 Scope of Services

Inspection and expediting, handling, packing, forwarding, transporting obtaining statutory approvals and documentation. All IBR formalities such as Inspection at manufacturer end, ground inspection at site, Hydro test approval and Provisional approval etc. is in scope of SUPPLIER

1.6.4 Training of **PURCHASER's** personnel at works and at site.

1.7 Scope of Supply and Services of Basic Equipment

This section details out the scope of supply and services as indicated. Components and services not specifically mentioned here but necessary to complete the stipulated work in all respects, regardless of any omission in this specifications or drawings, is deemed to have been included in this section.

All materials supplied under this contract shall be new and unused. (CHINA made material shall not be accepted/ considered).

1.8 Scope of Supply

1.8.1 Mechanical

One (1) No. Steam generator unit comprising of,

- Steam drum of fusion welded construction provided with necessary nozzles and with dished ends on both side with manways. Steam drum internals comprising of scrubbers and demister.
- Complete water-cooled furnace system with membrane wall construction and with all required piping, headers etc.
- Evaporators tubes with complete manifolds, pipings & headers
- Complete superheater system with two stage superheater with all required piping, headers etc.
- Single stage Desuperheater system comprising of the, fixed orifice type attemperator and other accessories including spray water piping for final steam temperature control at 400 $\pm$ 5 deg C between 70-100% MCR for slop + coal firing+ bagasse firing.
- Forced flow section of economizer complete with manifolds, coil supports, casing & insulation. Feed check valve at economizer inlet piping
- Steam Coil Air Preheater (SCAPH) to preheat the combustion air complete with casing and support.
- Insulation with aluminum cladding for pipes, ducting, headers, inner and outer casing with all fixing material for boiler

Sample coolers with complete SS coils, sampling piping and cooling water piping. The coils / jacket containing cooling water shall be of carbon steel. SWAS package consists of the pH, conductivity & silica with sampling system and complete calibrations to monitor the

quality of boiler drum water, feed water, blow-down, saturated steam, super-heated steam and makeup water.

- Suitable Arrangement for furnace zone cleaning & nos. of electrically operated retractable steam soot blowers for superheater zone, evaporator bank zone & economizer zone, air heater zone complete with other accessories, valves/fittings. Sequential operation of soot blowers will be realized in PLC and shall be hook up with boiler DCS system. The motorized with integral bypass drain valve to be provided.

- Boiler refractory, insulation and inner and outer casing with all fixing material for the boiler, piping, ducting, equipment etc.

- Insulation with all the fixing materials and outer casing for piping, valves, fittings and equipment, etc.

- Concentrated spent wash tank which shall have a capacity of 100 m^3 with SS 304 construction including floor coil heating arrangement and all other accessories

- Coal Handling & bagasse handling system

General: -

Bagasse handling and feeding system includes**.**

i) Bagasse Handling System from Existing Sugar Plant Bagasse Yard to New Proposed Incineration Boiler (Tentative Layout provided for reference)

ii) Bagasse elevator/BC1

iii) Return Bagasse Carrier/BC2

iv) Main Bagasse carrier

v) Bagasse silo for Minimum 8 minutes Holding Time

vi) Fuel feeder discharge chutes upto furnace.

vii) Minimum Three Feeders with variable frequency drive for bagasse feeding

viii) Pneumatic distributor for bagasse feeding with rotary damper for controlling fuel.

ix) Secondary air system.

x) Inspection cum fire doors for furnace.

The details of Bagasse Handling System shall be as follows:

The capacity of Bagasse handling system shall be **20 TPH** & for entire Bagasse requirement for 24 hours MCR capacity of the boiler.

The full proof system is complete as considering all the designed parameter such as location; mean barometric pressure, wind velocity, Relative humidity etc.
The conveying system shall have zero speed switch, pull cord, belt sway.
System designed shall be as per IS 11592 (Belts, Pulleys, Idlers etc.) and structural material as per IS standards.
One No. Bagasse Handling system will be provided suitable for 38 TPH boiler from Existing Bagasse yard with details as below.

Bagasse Elevator/BC1

1 No. Bagasse Elevator (Slat type)/BC1 of 20 TPH capacity shall be provided to convey the bagasse from existing boiler bagasse yard to proposed spent wash boiler MBC. The length of the Elevator shall be as per layout.

Return Bagasse carrier (RBC)/BC2

1No.Return Bagasse carrier (Slat type)/BC2 of 20 TPH capacity shall be provided to convey the excess bagasse from the proposed main bagasse carrier (MBC) to storage yard. The length of the conveyor shall be as per layout.

Main Bagasse Carrier (MBC)

1 No. Main bagasse carrier (rake type) of 20 TPH capacity shall be provided which receives bagasse from BC1 and feed into the respective bagasse silos of the spent wash incinerator. The length shall be as per layout.

Construction Details of Main Bagasse Carrier, Elevator & Return Bagasse Carrier

Bagasse carrier shall be of double trough design and return type self-discharge. Bagasse carrier (both side loaded) all steel construction of min. 1000 mm effective width inside sprocket. It should be able to carry about 20 tones Bagasse per hour, driven by T.E.F.C electric motor of suitable BHP at 1440 rpm through helical gear box to give a linear speed of 25 meters/minute. It shall have two strands of chains of 150mm pitch. The breaking strength of chains shall be minimum 40000Kgs.

The Bagasse carrier shall have 6 mm thick side and bottom mild steel plates over the entire length to be supported on steel channel columns, provided with rigid base plate. The columns should be adequately braced. The conveyor shall be complete with all structure and feeding chute to boilers etc. and will have arrangement to feed Bagasse to the boilers. The individual chutes to boiler should have slide operated diagonally cut doors operable from the working platform of the

boilers having double pinion and rake type arrangement and stair case from boiler platform.

Idler sprockets having machine cut teeth shall be provided wherever there is change in direction. Approach from the ground shall be provided to attend to drive of this conveyor. Horizontal feeding portion of RBC shall be 12m in length and not more than 300 mm below the ground level. Mild steel guards shall be provided over the horizontal feeding portion to ensure safety of workmen.

The return Bagasse carrier shall have self-tightening arrangements can deliver the Bagasse to MBC as well as collect the excess bagasse from MBC and deliver it to yard. A horizontal 750mm wide gangway with hand railing shall be provided along whole length of the Bagasse carrier with access staircase from the ground at the drive end and from MBC platform. Level of MBC & RBC shall be suitable for feeding bagasse to the boiler. The bagasse carrier shall have runners of angle iron/channel with 8m thick spring steel wear plate.

Discharge Hood & Chutes.

Bagasse carrier shall be provided with discharge / receiving chutes for the flow of material.

Supporting Structure.

The complete supporting structure required for equipment will be in scope of supply. All RCC foundation required for columns and support shall be provided by the **PURCHASER**.
Near the boiler house, Slat conveyor should not be supported on the boiler house columns/structures. However, any intermediate short columns required for this purpose will be responsibility of the BIDDER. If columns and beams of the boiler house are not suitably placed for this purpose, then separate columns & beams wherever required shall be provided by the BIDDER during contract stage without commercial implication.

All supporting structures shall be designed for a wind speed in line with IS.

Bagasse carrier shall have maintenance platforms, landings, handrails and toe plates. The floors and landings shall be complete with hand railing made from 32 NB MS pipe construction (horizontal & vertical) & 25 NB MS pipe construction (middle) and vertical pipes @ every 1 meter intervals, toe plates (min 100 x 6 mm MS flats) all around the floor and gratings M. S. fabricated dip galvanized as per our drg. The steps for staircase shall be fabricated from MS flats.

Motors

All motors to be of squirrel cage induction type and shall be selected for voltage & frequency variation +/ - 10 % and + /- 5 % respectively with combined variation of 10% with temperature rise not exceeding limits of class 'B' insulation over an ambient of 50 Deg C. However, motors shall have class 'F' insulation only. All motors to be of TEFC enclosure with IP 55 protection. Motors shall be of 'Energy Efficient' Type (IE3).

There shall be a minimum 25% (for chain conveyor) & 15% (for other equipment) margin to the selected motor rating over the calculated power requirement at the motor output.

ii) **Coal handling system includes**

The capacity of coal handling system shall be 12 TPH
The full proof system is complete as considering all the designed parameter such as location; mean barometric pressure, wind velocity, Relative humidity etc.
System designed shall be as per IS 11592 (Belts, Pulleys, Idlers etc.) and structural material as per IS standards.

SCOPE OF WORK: -

The coal handling system includes conveyors, feeding grizzly hopper, 1 x 100% crusher,1 x 100% post screen, vibratory feeders, over band magnetic separators, metal detector, safety switches, Dust suppression / dust extraction system, online belt weighing etc.
The coal handling system tentative belt lengths shall be as under – Raw coal conveyor (BC-1) for carrying inlet coal to coal feeder, coal conveyor (BC-2) for carrying from coal feeder to coal crusher house, coal conveyor (BC- 3) for carrying sized coal from coal crusher house to junction tower JT2 & from where it will have supplied to coal bunker top via a horizontal belt weigher. The coal reject form coal crusher house to supply belt conveyer (BC-2), shall be transferred by separate belt conveyer (BC-4) at JT1.The belt width shall be 800mm.The belt conveyor angle shall not exceed 17 deg.

DESCRIPTION: -

Indian /Imported coal will be received in the raw coal yard by trucks. It is expected that the size of ROM coal will be 150-200mm. Hence suitable grizzle of 150mm size has been envisaged. Coal from grizzly hopper will be fed to the crusher for required sizing it up to minus 18 mm. The crushed coal will be fed again to post screen to screen required sizing. The accepts from post screen would be fed to the product conveyor to take it further to fuel storage bunkers. The rejects from the post screen will be recycled back to the crusher using

a belt conveyor (BC-4) to feed to supply belt. Shuttle conveyors/Divergent chute shall be considered to distribute the coal uniformly.

COAL HANDLING OTHER REQUIREMENTS: -

Coal bunker shall be with SS 304 lining of 1.6 mm thickness (1/3rd conical portion of bunker) with 16 hours' storage during spent wash + Indian / Imported coal combination firing Coal bunker shall be provided with level switches for the high, low and very low levels. The level switches shall be of non-contact (Radio Frequency) type.

The shuttle conveyor shall have suitable bellow and chute arrangement to feed the fuels to any of the partition of the bunker. The coal crusher and screen house shall be with concrete floor up to crusher level (RCC scope – purchaser) and above this a house shall be constructed of structural steel having roof and side cladding sheets. Side cladding shall be provided from the first slab level till the roof to avoid flying of prepared fine coal.
All the equipment's shall normally handle fuel continuously at the rated capacity as indicated above. Bulk density of imported (or Indian coal) shall be considered as 1000 kg / m^3 for purpose of structural design and loading data. For volume calculation, bulk density of coal shall be considered 800 kg/m^3. All the equipment shall be suitable for handling damp and sticky coal during monsoon with moisture of 30% and fines up to 40%

On – line coal weighing arrangement (load cells) shall be installed for sized coal conveyor between the junction tower JT2 to coal bunker tower for measurement of the coal inlet to the coal bunker. Metal detector with magnetic separator shall be installed on the raw coal conveyor (BC-1) for screening out metal parts entering the feeding system. The complete coal conveying belt system shall be with hood / cover made from GI sheets with easy- accessibility arrangement.

COAL HANDLING TECHNICAL SPECIFICATIONS: -

BELT CONVEYOR: -
All the equipment's shall be of heavy duty construction and suitable for outdoor installation and to work under extremely dusty environment.
Safety switches shall be provided on one side of the conveyor. The belt conveyors shall be provided with cross over facility to approach all the towers. Side cladding is up to drive platform, maintenance trolley beam, approach for the take up etc. as required shall be provided for all transfer towers.

Design capacity of the belt conveyors for coal handling shall be considered 20% more than the rated capacity. The structure shall be designed for 15T capacity.
Belt sag between two idlers shall not exceed 2 %.

Hold back arrangement to be provided for all inclined conveyors.

BELTING:-
Nylon / Nylon FR grade belting shall be provided. The rating of the belt should be such that the maximum tension induced in the belt should not exceed 80% of the maximum recommended belt tension. The rating and duty conditions shall be decided on the maximum tension anticipated in the belt maximum belt width for adequate load support, min. belt width for adequate troughing.

VIBRATORY FEEDER:-
The vibratory feeder shall be dual motor brute force type with suspended spring mounting. It shall be designed for a maximum lump size as indicated elsewhere in the bid. The frequency of vibration shall be around 3000 (Cycle per Minute) CPM and amplitude of around 1.5 mm maximum. The intel of the feeder shall be fitted with rod gate for isolation.

CRUSHER:-
The crusher shall be bulk head impactor / hammer mill type. The product size from the coal crusher shall be suitable for the boiler. The crusher shall be designed for continuous heavy duty operation. The crusher shall be complete with lubrication system. The crusher shall be designed in such a way that it shall not generate more than 10% fines (below – 1mm) Heavy duty ball or roller bearing shall be preferably used and the minimum calculated life shall be 25,000 hrs. Labyrinth seals shall be provided for the bearings. Journal type bearing if used shall have replaceable liners or shells. The inlet chute to crusher shall be designed in such a way that while running, the material will not be rejected out due to the motion of crusher.
Bearing lubrication system and cooling system, if required, shall be selected for the applicable services conditions and shall be capable of operating continuously with the temperature at any bearing housing not exceeding 80 deg.C or ambient temperature plus 40deg.C whichever is lower. Bearing housing shall be effectively sealed against any ingress of water or dust.

SHAFT :-
Shaft shall be designed to take care of the shock loading of the equipment. The material shall be Forged steel.

VIBRATORY SCREEN:-

The screen shall be high tensile wire mesh.

The vibrating screen shall be a totally enclosed type. The static enclosure shall be completely sealed and shall be provided with access doors from accessing the screen mesh, bearings. A dust hood shall be strategically provided for the dust extraction.

Drive :- The exciter shaft with unbalanced massed by means of V- belt drive.

Screen box – It shall be of structure connected with high tensile bolts. The slope shall be in the conveying direction. The angle of slope shall be suitable fixed and indicate the same in the offer. The vibrating system of screen shall supported by rubber hollow springs and screen be covered with fast fixture.

MAGNETIC IRON SEPARATOR :-

Over band magnetic separator with chute and hopper to remove magnetic material shall be considered.

DUST EXTRACTION AND DUST SUPPRESSION SYSTEM

Dust suppression system shall be effected through properly designed mist – nozzles mounted / fixed on a ring header around the round hopper area. Dust excretion shall be applicable at all discharged points. Vibrating screen shall totally enclosed type with dust hoods connected to the dust extraction system. Dust extraction system filter bags shall be having anti adhesive and anti-static. Dust collection bags shall be of conventional cage type only. Cartridge type bags are not acceptable at all.

Volume calculations for the bag filter sizing shall be subject to consultant approval.

COAL HANDLING TECHNICAL REQUIREMENTS: -

Pulleys – All pulleys to be adequately sized and statically balanced. The pulleys shall conform to IS 8531

Material of construction
Hub – Forged steel as per IS- 2004
MS rounds – IS – 2062 Gr. A
Shaft – C 45 alloy steel.

Double row spherical rollers bearings shall be with an adapter sleeve. Lubrication through nipples labyrinth seals. The bearing life minimum 25,000 hr.

Rubber lagging shall be done for all drums; with natural rubber (12mm thick). The depth of grove shall be 6 mm.

IDLERS :-

Material – MS ERW rollers and MS bars for shafts.

Sealing - Double labyrinth seal on external side and contact nylon seal on it or the outer side of roller face, an additional water proof neoprene contact lip seal shall be provided.
Antifriction long lubricated ball bearings.
Maximum spacing interval for idlers shall be specified clearly.
Impact idlers shall be provided to cover complete feed area.

SHORT SUPPORTS:-
Short supports wherever applicable shall be considered at 3000 mm space.

CHUTES AND LUNERS:-

Feed and discharge chutes shall be of MS plate with wear resistant stainless steel plate.

DISCHARGE CHUTE:-

Properly designed hood with liners for effective de-dusting and dust tight flexible rubber access door shall be provided. The height of discharge hood shall be 1500 mm from belt top. Required vent connection for hood with flange shall be included.

DECK PLATE / SEAL PLATE:-

Deck plate shall be 3.15 mm MS sheet. Deck plate shall be considered for the 5 m at head end and tail end of all conveyors.
3.15 mm thick seal plate to be provided below conveyor belt at the road crossing as well as other conveyor crossings.

LOCAL CONVEYING:-

Belt conveyors suitable for installation in open area shall be provided with a local covering so that the belting (conveying and return) can be protected from rain. Hood shall be provided for covering belt and shall be 24 SWG minimum GI sheets with inspection door every 10m intervals. Hood shall be fixed with the help of bolts on the gallery members.

BELT SCRAPERS :-

Belt scraper shall be HOSCH design with primary and secondary scraper for external & V- plough for internal and diagonal internal for reversible conveyor.
The location of these scrapers should be such that inspection / adjustment / replacement of these scrapers are possible while the conveyor is running.

GEAR BOX :-
Planetary gear box shall be provided.
The rating of gear box shall be based on service factor of 2.0.

COUPLINGS :-

Pin bush type / Tyre type coupling on input side & geared coupling on output side shall be considered.

SAFETY DEVICES: -
All belts shall be interlocked as per sequence.
Pull Cord switch shall - At 30 m interval on one side (2 Nos. minimum) should be provided, pull cord switch shall be complete with wire – rope, Supports, fasteners etc.

Zero speed Switch – At tail pulley on one side (1 No.)
Belt Sway Switch – At 30m interval (2 No. minimum)

Each of the above safety devices to be supplied with 2 NO + 2 NC potential contacts for alarm, tripping and interlocking purpose. The aux. contact shall be for minimum 5A at 220 V. Zero speed switch shall be provided with initial line. The power supply for zero speed switches shall be 220 V AC.

CONTROL: -

The system shall be operated through Boiler DCS as well as from local push button station, and shall be start / automatically as per coal bunker level or bagasse silo level.

1.8.1.12 Travelling grate type technology with variable frequency drive and planetary gear box.

Travelling Grate Furnace

Travelling Grate Assembly with mechanical variable speed drive.
Front ash hopper with plate valve for ash discharge.
Riddling hopper with plate valve for ash discharge.
The firing system shall consist of a spreader stoker with continuous ash discharge traveling grate with variable speed drive. Pull chord switches shall be provided in the travelling grate to trip the grate drive motor in case of the breakage of the grate bars

1.8.1.13 Furnace draft system comprising of,

- 1 x 120% Radial backward curved simply supported Forced draft (FD) and fans with variable frequency drives with star

delta arrangement for by-pass & running) directly and pneumatic power cylinder operated control mechanism through IGV, necessary base plates, foundation bolts, coupling, etc

- 1 x 110% Radial backward curved simply supported ID fans with variable frequency drives with star–delta arrangement for by pass & direct run and pneumatic power cylinder operated control mechanism through MLD, necessary base plates, foundation bolts, couplings etc -

- Manual isolation damper at FD fan outlet & ID fan outlet.

1.8.1.14 All air and flue gas ducting with required stiffeners, expansion joints, guide vanes for bends, dampers, insulation, cladding, supports, etc.

1.8.1.15 HP and LP dosing system piping from dosing skid to steam drum and Dearator respectively. HP and LP dilution water piping from transfer pumps to respective dosing tank

1.8.1.16 Blow down tank drain headers, drain and vent piping, etc.

1.8.1.17 Dearator with deaerated water tank and feed water tank (2 x 120% capacity transfer pumps), with required piping, valves fittings, pressure and level control stations, overflow, vents and drains, supports and operating platform with ladders. Spray cum tray type Dearator with Deaerated water tank and feed water tank of 40 minutes storage of MCR generation capacity from LWL to NWL with required piping, valves, fittings, platform, ladders, control and instrumentation, steam nozzle, water inlet / outlet nozzles, Dearator steam pressure control valve and Dearator level control valve. Material of trays will be of stainless steel

1.8.1.18 **Boiler Feed Pumps**: -

2 x 120% capacity boiler feed pumps (multistage, centrifugal, ring section type) 45 M3 capacity for variable frequency drive with star delta arrangement for bypass & direct runs the motors and accessories viz., base plates, coupling, coupling guard, ARC valves, piping, suction strainer, suction manifolds, balancing leak off lines, foundation bolts, mechanical seals and lift off device. Motorized isolation valves at boiler feed pump discharge.

1.8.1.19 Complete boiler integral piping consisting of all the interconnecting piping between the economizer inlet stop valve and the super heater outlet header, valves, fittings, drains, vents and safety valve exhaust piping, startup vent with motorized isolation valve and pressure

reducing valve with diffuser & silencer, super heater safety valve with silencer and exhaust piping, blow down systems etc., all as required.

1.8.1.20 Boiler external piping with valves, fittings, hangers, supports, on-line instrument, insulation, cladding, etc. as required.

- The material of the main steam piping will be SA 106 Gr. B. The main steam piping shall be provided with warm up vent line with silencer. Main steam piping from superheater outlet header upto common steam distribution header (CSDH) CSDH is scope of supply. Motorized main steam stop valve with motorized bypass valve and motorised isolation valve before pneumatically operated start up vent valve. Manual drain valves in main stream line.

  CSDH with following Nipple

  - One number for steam inlet with motorized valve with integral starter.
  - One number for steam outlet with motorized valve with integral starter to TG set.
  - One number for steam outlet with motorized valve with integral starter for PRDs of 38 TPH capacity including deaerator steam.
  - One spare nipple

- Steam piping from Turbine Extraction to Dearator for normal operation with motorized valve with integral starter.
- Steam for Dearator (for Startup operation) through startup PRDs with motorized valve with integral starter.
- Steam piping from Main steam line to soot blowing system with motorized valve with integral starter.
- A 45/5.5 ata Dearator steam pressure reducing station with upstream piping and downstream piping upto the battery limit, including control valves and safety valves, with motorized valve with integral starter.
- Auxiliary steam piping to Dearator with motorized valve with integral starter.
- Steam piping to SCAPH from the Dearator steam line and condensate piping from SCAPH to feed water tank with Manual isolation valve shall be provided.
- Feed water piping from deaerated water storage tank to feed pump suction and from feed pump discharge with motorized valve with integral starter to economizer through the boiler feed control station.

- Minimum recirculation piping, balance leak off piping shall be individually taken from each pump and connected to the Dearator tank.
- HP and LP chemical dosing system (mounted on individual skids) with SS mixing tanks, motorised agitators, plunger type pumps, SS piping, valves and fittings.

- Spray water piping for PRDS 45/5.5 ata for Dearator, with all valves, including control valves and desuperheaters. For Other auxiliary PRDS, stub at BFP discharge header with motorized valve /integral starter.

- Cooling water supply and return piping from terminal point near boiler to all equipment's within the boiler island requiring cooling water supply.

- Two air compressors, air dryer, air receiver, with auto moisture drain with suitable capacity for instrument air is in the scope of supply near boiler to all equipment within the boiler island, requiring instrument air.

.

- Service air piping from terminal point near boiler to all equipment within the boiler island.

- Primarily Motorized Isolation valves shall be provided in the Main steam line, etc. The motorized valves open / close time shall be suitable for the application.

- Target plates and temporary piping as required for steam blowing, including the motor operated isolation valve with quick closing and opening time. (The temporary piping and the valve shall be taken back by the **SUPPLIER**)
- Temporary piping for chemical cleaning.
- Boiler filling line from terminal point to the water wall drain header.
- HP & LP dosing system dilution water line from terminal point to tank.
- Raw water quenching line for IBD tank.

1.8.1.21 Complete boiler mountings and fittings including safety valves, three (3) Nos. gauge glasses of port/ transparent type, one hydrate electronic water level indicator etc.

1.8.1.22 Boiler buckstays, tie connectors, corner connectors, stiffeners, channels .

1.8.1.23 Boiler rough mountings including access / inspection doors, peepholes with frames and fittings.

1.8.1.24 Air pollution control system comprising of one no. ESP/Bag filter with minimum 4 fields (space for one field for future expansion) & all its accessories to be provided. The ESP/Bag filter will be designed to

provide an outlet dust concentration level of 30 mg/NM^3 with the boiler operating with spent wash, and coal /bagasse as a fuel.

1.8.1.25 ESP / Bag filter will be complete with required stairways, walkways, handrails, housing, expansion joints, mineral wool insulation with 24 SWG plain aluminum cladding, inlet/outlet funnels, gas distribution screens, collecting electrode system, emitting electrode system, hoppers, hopper heater, hopper level indicators, rapping mechanism, T-R sets, lifting / handling arrangement for T-R sets, control panel and associated cabling, mechanical and electrical interlock system.

1.8.1.26 Suitable operating mechanism for ESP, complete in all respect with access for operation for all manual and power cylinder operated dampers

Ash hoppers with manually operated slide gate for boiler bottom ash and rotary air lock valve for boiler SH zone, evaporator zone, economizer & all hoppers of ESP. SUPPLIER to provide individual hopper per module for convection zone banks (SH, Evaporator & economizer banks). The MOC of the bottom ash hopper, boiler second pass hopper & SH zone hoppers shall be SS304 and MOC for evaporator, economizer and ESP hoppers shall be carbon steel.

1.8.1.27 For all manual and power cylinder operated dampers, suitable operating mechanism complete in all respects with access for manual operation shall be provided.

1.8.1.28 Chimney connecting flanges, counter flange, near chimney and all fasteners for the connections.

1.8.1.29 Chemicals for chemical cleaning, as required.

1.8.1.30 First fill of lubricants and chemicals, for all equipment.

1.8.1.31 Rain water down pipes.

1.8.1.32 Support and suspension steel, access platforms for all equipment, piping, ducting etc.

1.8.1.33 Foundation bolts, structural steels and anchor bolts and channels for columns, bought out items like fans, pumps, etc. and for all other equipment & supports.

1.8.1.34 Canopy over boiler, coal bunker and side sheeting of GI sheets up to drum operating floor level from boiler top and extended up to top of the coal bunker for weather protection

1.8.1.35 Galleries, ladders, platform and stairways for access to the essential levels of the steam generator and auxiliaries. Platform, walkway, stair tread, gratings and handrails are of mild steel construction. Handrail material should be 'B' class pipe. One number staircase from ground level to steam drum operating floor level

1.8.1.36 The Deaerator with Deaerator water storage tank, DM water storage tank and feed water tank will be located near the boiler on separate structure which shall be provided. The Boiler feed pumps will be located below the Deaerator as per NPSH is required.

Feed water tank capacity – 45 m3 and Deaerator tank capacity shall be minimum 40 Min. storage is required.

DM water storage tank capacity: - storage is required. (Tank capacity – 75 m^3)

Deaeration capacity of the deaerator shall be 110% of MCR of boiler. Deaerator storage capacity is minimum 40 minute at MCR of boiler

1.8.1.37 Counter flanges for all inlet and outlet connections from and to the **SUPPLIER**'s battery limit, including gaskets, bolts and nuts.

1.8.1.38 Two (2) coats of primer paint prior to dispatch for all items and supply of paints for final application

1.8.1.39 One number mechanical ash handling system complete with discharge hoppers, necessary conveyors up to the inlet of storage silo and accessories suitable sized for all firing conditions

1.8.1.40 TECHINICAL SPECICATION FOR ASH HANDLING PLANT

GENERAL :-

1) The grate / bottom ash generated by the combustion of fuel shall be mechanical transported through submerge belt conveyor to a point outside the boiler area and be loaded directly on to ash trucks / trailer.
2) The bottom / furnace ash shall be suitably wetted in the water trough of submerged belt conveyor to reduce the temperature of the ash to a temperature which can be comfortably handled by the belt (at about 300 deg.C). Suitable water piping shall be made for water make – up to the trough.
3) A mechanical type fly ash handling system (As per Vendor standard) proposed for the removal of fly ash collected at the bottom hoppers of Economizer, Air heater and Bag filter/ESP hopper zones.

   (Each ash hopper shall be separate screw conveyor and each screw conveyor outlet one common ash belt conveyor upto SS 304 ash silo)

   Note: ESP/Bag filter ash handling system should be a separate screw conveyor with one another common ash belt conveyor up to another ash silo.

4) The ash silo shall be in SS 304 construction with staging & structure. The disposal of ash for the silos shall be through trucks. The ash silo shall be provided with a motorized rotary air lock valve at the bottom which will discharge the ash to the conditioner. The ash conditioner shall have necessary water spray arrangement to prevent dust generation at the time of unloading. The ash conditioner below the ash silo shall be a twin screw replaceable paddle type. The ash silo shall have a bypass chute with a rotary air lock feeder and a mechanized telescopic unloading below the feeder for dry disposal of ash.
5) The ash handling system shall be operated / monitored through the central DCS.

6) The ash handling system shall be design for handle ash at rate of minimum 7.0 Tones per hour.
7) If required suitable capacity air compressor for ash handling shall be in scope of supplier.

1.8.1.41 H P piping from Boiler steam stop valve to CSDH Header is to be provided by BIDDER as per the std piping layout with Isolation valve, NRV valve, drains, traps, supports, structure as required.

1.8.1.42 DCS Based Control and Operating system is to be supplied.

1.8.1.43 Fire detection and Protection System is to be supplied.

1.8.2 Electrical

1.8.2.1 Drive motors for all auxiliaries covered under the scope. The motors for Boiler Feed Pumps, ID Fans, FD, SA Fans, and fuel feeders to be VFD duty. All VFD panels and motors are in the scope of supply. The VFD rating shall be 1.2 times the Motor current rating.

1.8.2.2 Following Electricals for ESP shall be included in the scope of supply: (Alternatively Bag Filters also considered.)

Motor Control Centre and all control panels of ESP, viz. TR Set Control Panel, Rapper Controller and Rapper Distribution / Temperature Scanners / timers (as applicable). Rapper Controller may be part of TR Set Control Panel or can be housed in a separate panel.

Local Push Button Stations with supports structures.

The supply, laying and termination of the following cables, with accessories [Distances of Control Room (where control panels shall be installed), MCC Panel Room (where MCC shall be installed) and first column of ESP shall up to ESP

- All power cable between PCC & MCC and motors, heaters, transformers and other loads. The incomer power cable for MCC shall be in **BIDDER**'s scope. The changeover switch of suitable capacity is to be provided to Feed Pump for emergency purpose.
- All control cables between MCC and LPBS.
- All power, control and special cables between MCC / control panels of ESP

Prefabricated GI cable trays with support for all the above cables in the scope.

Complete earthing as per IS 3043 for ESP and its auxiliaries up to ground level. This shall also include the earthing of outdoor cable trays, all motors and other equipments in scope. Earth pits shall be in **PURCHASER**'s scope. Separate earthing for MCC , VFD and Motors is to be provided. (Only earth pit civil work is in the purchaser's scope)

Complete lightning protection with necessary horizontal roof conductors, vertical down conductor's top to ground level shall be in **suppliers** scope.

1.8.2.3 Following Electricals for Boiler shall be included in the scope of supply:

Prefabricated GI cable trays with support for the following cables within Boiler from its first column:

- For laying of power cable between Boiler PCC & MCC and motors / boiler loads, as applicable.
- Motor 1.5kW to 18.5kW copper cable
- DOL starter upto 18.5kW copper cable
- Star Delta starter upto 30kW copper cable
- Star Delta starter upto 45kW Aluminum cable
- Earthing would be pipe and pipe size 80mm dia x 4mtr long
- For laying of control cables between Boiler MCC and LPBS.
- Complete illumination system of power house and boiler and its auxiliaries.
- Lighting should be LED type

Cable tray supports for laying of cable trays for ESP System loads.

Complete earthing as per IS 3043 for boiler and its auxiliaries above and below ground level. This shall also include the earthing of outdoor cable trays, all motors and other equipments in scope.

Complete lightning and its protection with necessary horizontal roof conductors, vertical down conductors up to ground level.
Earth pits only civil work shall be in **PURCHASER**'s scope

Complete electrical engineering of the Boiler and ESP System systems, as below:

- Single line diagram of boiler and ESP feeders.
- Control schematic diagrams for different types of feeders including VFDs.
- Cable schedule for complete power, control and special cables.
- Interconnection chart for control cables.
- Cable tray and trench layout.
- Earthing layout drawings.
- Bill of materials for power, control and special cables, local push button stations with support structures, earthing conductors and cable trays with structures.
- All flange type motors should be foot cum flange mounted.
- All motors body should be C I casing, fan should be with key and casting MOC
- All equipment starter should be operated through DCS
- All PCC feeders and MCC incoming feeders having multifunction meters, make Conserve 6400/Rish delta energy

- PCC incomer separate analog meter, volt meter, multifunction mete, PF and frequency meter

1.8.3 Control and Instrumentation

1.8.3.1 Supply of all field instruments (transmitters, local temperature gauges, local pressure gauges, thermocouples, flow nozzles / Orifice plates, etc.) that are required for the monitoring / control of the various parameters for the operation of boiler / auxiliaries.

1.8.3.2 Supply of all the final control elements (on/off valves, control valves, power cylinders, I/P converters, etc.) taking into account the precision of control.

1.8.3.3 Supply of all the field instruments such as temperature switches, pressure switches, flow switches, level switches, limit switches, etc. for the purpose of safety interlock and start/stop operation.

1.8.3.4 Supply of all the instrument / power / control cable and accessories like cable trays, conduits, supports etc., from the individual field instrument / control element / motorized valves / any other panel supplied by the **SUPPLIER** to the I/O rack and laying and termination of the same.

1.8.3.5 Submission of all the control schemes & interlock / start/ stop procedure in the form of logic diagram so that the same will be incorporated in the Distributed Control System. DCS along with UPS is also in **SUPPLIER** Scope.

1.8.3.6 Submission of input and output list for the various analog and digital signals.

1.8.4 Civil

1.8.4.1 All foundation bolts within the scope of supply.

1.8.4.2 Supply of all support structures for mounting the base channels of all Electrical and Instrumentation panels, included in the scope.

1.9 Consumables

Specifications including brand names and quantities of all consumable materials such as lubricants, flushing oil, hydraulic fluids etc., required for startup, initial filling, commissioning and performance tests and yearly requirements of the same for normal operation are to be submitted by the **SUPPLIER**.

However, supply of all consumables required for start-up, commissioning, initial filling and performance tests is included in the scope and shall be supplied by the successful **SUPPLIER** at appropriate time.

Power, water and fuel requirements for the start-up, commissioning, and performance test shall be provided by the **PURCHASER**.

Paints for the completion of final painting.

1.10 **Spare Parts**

A minimum requirement of spare parts sufficient for two years of normal trouble free operation shall be as given in Annexure-1.1 at the end of this section.

1.11 Special Maintenance Tools and Tackles

One set of special tools and tackles required for erection, operation and maintenance, inspection and repair of the equipment / systems, neatly packed in steel boxes complete with instructions for the Steam Generator and all other Auxiliary Equipment covered in this scope of work. The Annexure-1.2 enclosed to this section gives the list of special tools and tackles required and the **SUPPLIER** shall include the same in his offer.

1.12 Terminal Points

1.12.1 Mechanical

Steam

Main steam	:	Up to CSDH header (includes CSDH header with supports)
5.5 ata steam PRDS for process & deaerator	:	At Turbine outlet line flange with valves
Steam for deaerator & SCAPH (From turbine)	:	At respective inlet flanges with valves
Feed water for initial Filling (only DM water) & Dilution water for dosing	:	At the first row of boiler column
Condensate & Make up water	:	At the inlet of feed water level control station
Feed water Storage tank maintenance drain		:The height of feed water storage tank shall be decided as per NPSH required.
feed water storage tank overflow & local drain	:	Shall be connected to DM water storage tank.
Deaerated water storage tank overflow & local drain	:	Shall be connected to DM water storage tank and local drain is connected to IBD tank.
Spray Water to PRDS		at the outlet of stub of size 25 NB on the BFP discharge header
Coal	:	At inlet of grizzly hopper. (Inlet of Coal handling System)

Bagasse		From bagasse yard.
Concentrated Spent wash (slop)	:	At the inlet flange of the tank with suction valve.
Cooling water	:	At first column of the boiler
Raw water	:	At first column the boiler
Blow down drains	:	Upto nearest surface drain / trench
All high pressure drains	:	To be taken to a common header and one line further to IBD tank
Safety valve exhaust and vents	:	To atmosphere at safe elevation 1 m above with silencer
Combustion air	:	Inlet to suction filter of FD fan
Instrument air	:	At in let of Air compressor
Service air	:	At one point near the boiler
Flue gas	:	Inlet of chimney
Instrument and other line drains	:	Nearest drain trench
Bed Ash	:	At the outlet of manual slide gate valve & RAV at an Elevation of 2.75 M at ash Silo inlet.
Fly ash	:	At the outlet of RAV for boiler second pass Hoppers, third pass hoppers & ESP hoppers. (ESP hoppers shall be at an elevation of 2.75m) at ash Silo inlet.

1.12.2 Electrical

Electric Power for Boiler Auxiliaries.	:	From PCC at power house
Electric Power for ESP Auxiliaries.	:	From PCC at power house.
Lightning System for Boiler	:	From the MCC of Boiler (Earth pits in **PURCHASER**'s scope).
Lightning Protection System for ESP	:	From MCC of Boiler (Earth pits in **PURCHASER**'s scope).
Earthing Protection System for Boiler	:	At bottom of pit.

1.12.3 Control and Instrumentation

1.12.4 Terminal point for the **SUPPLIER** will be upto and including DCS, including the supply, laying, glanding and termination of cables.

Cabling includes all inter-panel cabling from field devices, VFD / ESP / motorized valve / any other panel supplied by the SUPPLIER, to the DCS.

It is the responsibility of the **SUPPLIER** to further take these output signals from DCS for actuating the final control elements and motorized valves pertaining to Boiler and its auxiliaries. **DCS shall be within 30 m from the boiler**.

1.12.5 CIVIL – up to 300mm FFL, required foundation layout drawing.

1.13 Exclusions

1.13.1 Mechanical

1. Steam and water piping beyond terminal points.
2. All air / water / steam piping and vessels other than required within the scope of work.
3. Lubricants and chemicals (other than that for flushing use and for the initial fill)
4. Fire detection and Protection System.
5. Chimney and Aviation lights.
6. Air conditioning and ventilation plant other than tender document scope.
7. Coal storage yard

1.13.2 Electrical

1. All power and distribution transformers.
2. Earth pits civil work only.

1.13.3 Control & Instrumentation

The control room with air conditioners.

1.13.4.1 Civil

Design and Construction of buildings, foundations for all the equipment, trenches, chimney and other civil works.

Soil investigation.

1.14 Performance Test

After completion of erection, the boiler plant shall be trial operated and performance tested as detailed in the relevant sections of the specifications.

The performance test shall be carried out, on the boiler, as per ASME PTC 4.

Spent wash + Indian Coal/ Imported coal/ Bagasse with 50% moisture. (in combination) shall be used as the fuel for the guarantee performance test. The **SUPPLIER** may also note that the performance parameters guaranteed shall be considered in the bid evaluation.

2.0 DESIGN BASIS, SITE DATA AND FUEL DATA

2.1 General

The new Distillery Plant will be designed with one (1) boiler and One (1) Turbo generator for meeting the steam and power requirements of the distillery , The boiler and Turbo generator steam cycle will be designed with One (1) Deaerator. The steam requirements for the Deaerator will be taken from the turbine. This specification covers the requirements for the Steam generator and Auxiliaries. The Steam generator and the Auxiliary Equipment covered under this specification shall be designed to achieve the objective of supplying uninterrupted steam to the turbine.

2.1.1 The generated power from this Turbo generator will be fed to the Distillery and incineration plant

2.1.2 The steam generator should be suitable for continuous duty during its operation between two consecutive cleaning and the design should maximize the period of operation between two consecutive cleaning. The base fuel for the steam generator will be distillery slop/spent wash and the supplementary/support fuel shall be Indian Coal/Imported coal/bagasse. The design shall be such that the base fuel quantity indicated in this section will be consumed totally and the total generation in the boiler will be made up by supplementing coal. It is expected that the slop will be concentrated to 60% w/w solids content and the ultimate analysis of the concentrated slop is given in this section. Indian Coal /Imported coal/bagasse should be used as standalone fuels without the base fuel, to generate the MCR steam output of the boiler, under contingent operating conditions.

The steam generator will be supported on steel structures and the structures shall be raised from +300 mm from the finished floor level. The steam generator will be designed taking into consideration all possible operating conditions and, assuring continuous, stable and reliable operation. Safety and reliability shall be the two paramount considerations in the design of the steam generator

2.1.3 The boiler capacity is worked out to be 38 TPH. This is based on a total process steam flow of 28.00 TPH with 28.00 TPH of steam condensate from process at 90 Deg.C. The boiler sizing includes the steam requirements for the deaerator and any other slop heating. All the distillery process steam and the heating steam will be taken from the extraction/exhaust of the turbine. Even during solo coal/bagasse firing condition, net steam available for process shall be 28.00 TPH.

2.2 Performance Parameters

The following shall be the design parameters of the boiler:

Particular	Units	Value
The net capacity of boiler to meet the steam demand at MCR operation of the Plant exclusive of all the internal steam requirements of the boiler. (eg. Soot blowers, Deaerator, SCAPH etc.)		
- For Slop + Indian coal /Imported coal/bagasse	T/HR	38
- For Indian coal firing/bagasse firing	T/HR	38
Peak Generation capacity as Percentage of MCR, under any of the fuel combinations given above	%	110
The steam pressure at the Main Steam stop valve outlet from minimum load upto MCR.	Ata	46
The pressure drop on Main steam line between boiler MSSV out-let & turbine inlet nozzle shall be	Kg/Sq.Cm	Maximum 1kg/cm^2
The steam temperature at the Main steam stop valve outlet at MCR	Deg.C	400 ± 5
The steam temperature shall be maintained constant at the Main Steam stop valve outlet at any load between		
Slop + Indian Coal /Imported coal /bagasse Firing Indian coal/Imported coal /bagasse Firing	% MCR % MCR.	70 to 100 60 to 100
The minimum continuous load shall be		
Slop + Indian Coal/bagasse firing	% MCR	50
Indian coal/bagasse firing	% MCR	30
The steam sample taken under steady state conditions at the main steam stop valve inlet shall not exceed the following.		
- specific conductivity measured at 25 Deg. C.	µ S/cm	0.200
- Silica (SiO_2)	ppm	0.020
The maximum value of excess air, to be measure at the economizer outlet, shall be, at MCR		SUPPLIER to Indicate
At steady state operation the difference in temperature between the ambient and the outside surface of insulation with a wind velocity of 1 m/sec shall be	Deg.C	20

The maximum noise pressure level at 3.0 m distance for the boiler and any associated equipment within 1 m distance will be equal to or less than;	dB(A)	85
Start-up Vent Capacity	% MCR	30
Ambient Conditions to be used in the Design		As per site data, given in project information
The flue gas temperature at the stack inlet **shall not be more than**	Deg.C	
Under slop + Suppementary fuel firing		180
Boiler feed water temperature at the inlet to the Economiser shall not be less than (Heated in the deaerator) (Under slop + Supplementary fuel firing)	Deg.C	150
Allowable maximum dust content in flue gases leaving the dust collection system (Firing any Fuel and With the respective design excess air)	mg/n.cu.m	50
Code of Design and construction		IBR

2.3 Site Data

1. Plant Location : Neera Bhima SSK Ltd.,
Shajinagar, Redni
Tal. Indapur & Dist. Pune,
Maharashtra - 413114, India

Contact Person D.N Markad
Phone 02111-270200/270650
Fax 02111-270555

2. Nearest Railway Station: , Pune.

3. Nearest Airport : Pune

4. Port of disembarkation: Nil

5. Ambient Temp(deg C)
Maximum/ Minimum : 43 / 20
Performance Design : 35 Electrical Design 50

6. Relative Humidity %
Maximum / Minimum : 86 / 61
Design : 70

7. Rainfall (Annual Avg.): 700 mm

8. Altitude : 120 M above M.S.L

9. Seismic condition : As per IS :1893

10. Wind
A. Direction : North East –South West.
B. Design Wind Velocity: As per IS :875

11. Climatic Condition : Tropical, dry and arid.

12. Soil Bearing Capacity : 25 MT/Sq.M@1.0 M Depth.

2.4 Fuel Data

Distillery Slop (@52% concentration)

FUEL		Spentwash (60%)	Indian Coal	Imported Coal	Bagasse
Carbon	%	19.26	39.9	52.64	23.50
Hydrogen	%	1.86	2.48	3.51	3.25
Oxygen	%	12.57	6.76	5.91	21.75
Nitrogen	%	1.60	0.67	0.95	00.00
Sulfur	%	0.54	0.38	1.00	00,00
H2 O	%	48.00	10	26	50.00
Mineral matter	%	16.17	39.81		1.50
TOTAL	%	100	100.00	100.00	100.00
GCV	Kcal/Kg	1517	3800	5400	2272

- **The quantity of slop available for use in the boiler will be 5 - 10 TPH with a solids concentration of 60%.**
- **Supplier to design boiler such that it can be operated from 48%-60% solid concentration with marginal increase in Bagasse/coal quantity.**
- **Boiler should be designed such that the furnace temperature shall be maintained between 950-1000 Deg C to have complete combustion.**

2.5 Utilities Data

Refer Project Information.

2.6 Deaerator Design Basis

2.6.1 The Deaerator shall be sized by the **SUPPLIER**. The Design and the steam requirements for the Deaerator shall be on the following basis.

-	Operating pressure	Kg/Sq.Cm (g)	3.50
-	Outlet water temperature	Deg.C	150
-	Design pressure	Kg/Sq.Cm(g)	5.5 & Full vacuum
-	Design Temperature	Deg.C	200
-	Hydro test pressure	Kg/Sq.Cm(g)	7.25
-	Dissolved O_2 in the outlet Water without chemical dosing	ppm (Max.)	0.007
-	Process Condensate quantity / temperature (Under Normal Operating conditions)	(TPH/Deg.C)	8/90

The makeup water temperature may be taken as 35 Deg.C.

45 / 5.5 ata for Distillery process PRDS

- Pressure (ata) @ downstream of PRDS	5.5
- Temperature (°C) @ downstream of PRDS	160.0
Quantity Requirements	28.00 TPH

3. DETAILED TECHNICAL SPECIFICATION FOR MECHANICAL EQUIPMENT AND COMPONENTS

3.0 General

This Section gives the detailed requirements of the various mechanical equipment and systems covered in this specification.

3.0.1 The steam generator, all associated piping and systems shall be designed, manufactured, inspected, tested, erected and commissioned to well establish engineering practices and safety codes.

3.0.2 Basically the boiler shall be a radiant furnace, single / Bi-Drum, natural circulation, outdoor type with two stage harp type superheater. The boiler shall be designed with water cooled membrane / fin welded walls. The refractory work as required for the efficient combustion of the fuel shall be provided and the design and application shall be with adequate reinforcement to ensure that premature spalling of the refractory work is eliminated. The material of the refractory shall be suitable for the application.

3.0.3 **A minimum of two hand holes for the purpose of cleaning and inspection shall be provided, for each of the headers either on the end covers or on the body of the headers.**

3.0.4 The drive motor rating for all pumps and fans shall be at least fifteen percent (15%) higher than the maximum Kilowatt rating of the respective driven equipment. For boiler feed pumps refer the margin requirement in the respective specification.

3.0.5 The boilers shall be bottom supported with adequate provisions for the thermal expansion of the boilers in all directions. The supports and thermal expansion guides (could be common for wind and seismic load transfers) shall be suitably located so as to direct the thermal expansion in the pre-determined directions.

3.1 Pressure Parts

The complete system of boiler pressure parts, covering

- Boiler Drum(s)
- Furnace water wall & other circulating system components
- Boiler bank /evaporator system
- Superheater system
- Economizer system

together with all required headers, integral piping, interconnecting piping, valves, fittings, supports, etc. are to be provided.

The complete of pressure parts tubing, piping and headers shall be **of seamless construction**, as per reputed international material specifications and bought from renowned Suppliers. The thickness of pressure parts and materials to be used shall meet the requirements of the **INDIAN BOILER REGULATIONS (IBR)** in all aspects of design, fabrication, heat treatment and inspection. Notwithstanding the approval and inspection by the Inspector of Boilers, the **PURCHASER / CONSULTANT** reserves their right to review the documents and inspect the components during manufacture and testing.

The Circulating system essentially comprising of the drums, water walls, furnace tubes, boiler banks, down comers and relief tubes shall be designed to provide an adequate circulation ratio in the system and to prevent DNB. The down comers and the relief tubes shall be sized and routed to offer minimum pressure drop and to help in improving the circulation ratio.

The minimum tube thickness for the various pressure part heat transfer surfaces required to be provided shall be as per Annexure-3.1.

It may be noted that the requirements indicated are the minimum and shall be exclusive of the negative tolerances applicable to the relevant standards.

3.1.1 Steam & Water Drum

The boiler shall be provided with single steam drum design and the drums shall be of fusion welded type. The drums shall be provided with Torrispherical / Semi-Ellipsoidal dished ends fitted with oblong manways at either end. If circular manways are used the minimum clear diameter shall be 400 mm. The manway doors shall be arranged to open inwards and shall be self sealing under internal pressure. The drum shell, dished ends and the manway doors shall conform to SA 516 Gr. 70 or equivalent material specification. Alloy steel materials could be used for the drums, provided the selected material specification for the drums should have been in use for a considerably long period, and the manufacturer should have first hand experience in the fabrication of the selected material. The steam drum shall be liberally sized to assure low steam space loading, with adequate space to accommodate the internals..

The steam drum shall be provided with internals of proven design, shall be bolted type, and of size that will enable removal through the manways. The system of internals consisting of the primary and secondary separators shall ensure steam of highest purity with dissolved silica carry over limited to a maximum of 0.02 ppm, at all loads of the boiler

The necessary nozzle connections for the following, but not limited to, steam outlets, safety valves, feed water inlets, continuous blowdown, level indicators, chemical feeding, vents and drains, nitrogen blanketing with cap, sampling connections, downcomers shall be provided on the drums as applicable. All nozzle connections on the drums shall be of welded type and the feed water inlet shall be provided with a suitably designed thermal sleeve. All nozzle openings shall be adequately compensated as per applicable codes and the relevant calculations shall be submitted during contract engineering stage.

3.1.2 Furnace - Water Wall System

The Furnace envelope shall be constructed of fully water cooled membrane panels and adequately supported. The design shall be such as to prevent distortion of steel work due to thermal expansion. The construction shall be fully gas pressure tight, and the furnace shall be strengthened by providing buckstays and tie-bar system. The buckstay system shall be adequately designed to stiffen the furnace walls against the internal and external pressures and also to transfer the wind and seismic loading from the boiler envelope to the boiler structures through suitably designed guides. The minimum design pressure for the buckstay system shall be $\pm$ 400 mm WC, with the buckstay members reaching 60% of the yield strength or as permitted by IS: 800 (specifically for compressive loading) of the buckstay material. The furnace shall be sized adequately to give enough residence time for the fuel to get fully combusted.

Necessary provisions shall be made in the furnace for admitting the required quantity of over fire air at various levels.

The furnace EPRS should be so selected to give acceptable furnace outlet temperatures, not exceeding 680 Deg.C in case of clean condition for combination (Slop + Coal/bagasse) firing and 720 Deg.C in case of solo coal/bagasse is firing condition. The furnace design shall incorporate necessary manholes, peep holes, openings for the fuel distributors, ignition / reflection arch and refractory covering in the lower furnace area if required. The lower furnace area shall be built of refractory bricks or of refractory lining on water walls as required for the combustion of the fuel. The refractory material shall be Phoscast 90 XR, Phoscast 60XR, Inculcast with SS anchors in order to withstand the heat and prevent erosion.. In addition, considering the nature of the fuel, any area of the furnace where there is a possibility of preferential corrosion shall be protected with suitable refractory material. Adequate number of openings, covered with flanges, shall be made in the furnace roof for introducing the rope supports for a sky-climber, to be procured by the **PURCHASER** at a later date.

Adequate number of inlet and outlet headers, with the necessary stubs, commensurate with the arrangement of the furnace shall be provided. Each of the headers shall have at least two numbers of hand holes for inspection and cleaning, as detailed elsewhere in this specifications. The down comers supply pipes and relief tube sizing shall be based on the circulation calculations. Riddling hopper shall be provided for Travelling grate type system and bed ash drains shall be provided for deep fluidized bubbling bed system. MOC of the riddling hopper and second pass hopper shall be SS409.

3.1.3 Screen Tubes

Suitable number of screen tubes shall be provided by the SUPPLIER at the entry of third pass of boiler. The minimum clear gap between the screen tubes and the Superheater modules should be between 900 -950 mm for easy removal of tubes/modules in case of failure.

3.1.4 Convection Evaporator Section

If a convection evaporator bank is required, the same shall be of the harpes type rigid design. The evaporator design shall be of vertical tubes with individual header and minimum clear gap between two (2) consecutive modules should be in the range of 650-700 mm for easy removal of the tubes/assemblies in case of any failure.There shall be adequate approach space to the tubes of the bank for maintenance. The gas flow **arrangement shall be a single pass gas flow across the bank tubes, without the use of baffles.** The gas inlet to the bank and the outlet ducting from the bank shall be so arranged as to give effective utilization of the provided heat transfer area in the bank. An arrangement resulting in stagnant gas zones and unworkable flow arrangements will not be accepted.

The evaporator section shall be provided with minimum 4 numbers of soot blowers and mechanical rapping system to minimize ash bridging. The flue gas velocity in the bank area shall be restricted 4 m/s Dedicated hoppers shall be provided for individual module so as to prevent gas from following the least resistant path. MOC of the hopper shall be carbon steel with refractory lining.

3.1.5 Superheater System

The superheater shall be of convection type arranged to give a minimum metal temperature. The superheater pressure drop, the inlet and outlet header sizing, arrangement and sizing of their respective inlet and take off connections shall be so as to give minimum unbalance and the tube element material selection shall be based on the actual metal temperature calculations.

The transverse tube spacing of the superheater shall be suitable designed to minimize bridging and tube erosion and shall be suitable for proper on-load cleaning by means of soot blowers & Mechanical Rapping system. Suitable spacers shall be provided both along and transverse to the gas flow directions. The superheater section design shall be of vertical tubes with individual header and minimum clear gap between two (2) consecutive modules should be between 650-700 mm for easy removal of the tubes/assemblies in case of any failure

The spacer design shall take into consideration the expected maximum metal temperature of the spacers and the ability of the spacers to permit the differential thermal expansion between the elements wherever applicable. The spacer system shall also provide rigidity to the assemblies during the transportation and erection. Moreover it should be ensured that the spacer arrangement does not promote ash build up in the superheater area.. The flue gas velocity in the bank should be restricted to 4m/s.

The SH system shall be complete with required seamless pipe headers, inter connecting piping, vents, drains, supports, tube spacers, valves, fittings, etc. The headers shall be complete with necessary inlet and outlet connections to receive the connecting tubes / pipes and element tubing. The sealing at the superheater tube penetrations with the roof or the wall shall be 100% leak tight and the arrangement shall be approved by the **PURCHASER / CONSULTANT**. The unheated terminal portion of the superheater tubes shall be designed with adequate flexibility against thermal expansion differentials. The outlet header shall be suitably supported and anchored such that the piping forces and moments incident to the steam piping will not cause excessive stresses in the element tubes. Dedicated hoppers shall be provided for individual module so as to prevent gas from following the least resistant path. MOC of the hopper shall be SS409 with refractory lining.

The SH section shall be provided with minimum 4 number of soot blowers and mechanical rapping system to minimize ash bridging

3.1.6 Attemperator System

The interstage attemperator system to control the temperature of the final superheater outlet steam temperature within the specified value shall be provided in between the two stages of the superheater. The interstage attemperator shall be of the spray type, using the boiler feed water tapped off at the outlet of the boiler feed water pumps, to control the final steam temperature as specified in Section 2..

3.1.7 Economiser

The Economiser shall be located downstream of the convection heat transfer section. The design shall be of bare tube construction with inline, counter flow, and drainable arrangement. The economiser shall be designed for an inlet feed water temperature of 150 Deg.C. The coil arrangement shall take care of proper calculated end gaps to avert gas bypassing and the consequent erosion of the element tubes. No gas side or waterside bypass arrangement shall be provided. The transverse tube spacing of the economiser suitably designed to minimize bridging and tube erosion and shall be suitable for proper on-load cleaning by means of soot blowers & Mechanical Rapping system. **The number of parallel paths shall be so chosen to give a water side velocity of a minimum of 0.4 meter per Sec.**

The flue gas velocity over the economiser tubes shall be limited to a maximum of 5 metres/sec. Suitable number of sonic horn blowers blowers and mechanical rapping system shall be located in the economiser for effective cleaning of the heat transfer areas. For the purpose of maintenance and for accommodating the sonic horn blowers the economiser may be divided into suitable number of banks. Broadly the economizer tube height shall be about 4900 mm with the minimum interbank gap at about 900 mm.

The economiser shall be complete with seamless inlet / outlet / intermediate headers with drains and vents, coil supports, supporting structures for the complete economiser, interconnecting piping for the inlet and the outlet, access galleries and stairs, etc.

The Economiser casing shall be 6mm thick, mild steel plate suitably stiffened / reinforced. Erosion protection covers should be provided for the economizer coils on the top side of the tubes in each bank. The bank design shall be such that minimum clear gap between two (2) consecutive modules should not be less than 900 mm for easy removal of the tubes/assemblies in case of any failure.

Also, cassette baffles should be provided for all the economizer coil bends.

The economiser gas path shall be of the pressure tight construction with the proper design of the seals at the tube penetrations with the casing. The inlet and the outlet headers are adequately supported and anchored to take care of the loading from the connected piping.

The boiler shall be provided with one Feed check valve in the feed water piping close to the inlet of the economiser.

3.2 Air Heater

A steam coil air heater to heat the FD outlet air to a minimum of 100 Deg.C shall be added in the FD air outlet ducting upstream of the air-

heater. This steam coil heater will be operated almost continuously to prevent the moisture condensation in the tubes and the consequent corrosion. Steam at 6 ata and at saturation temperature will be supplied at the inlet of the steam air heater. Sufficient straight length shall be provided in the air duct for installing Steam coil air pre heater at the air heater air inlet side. The condensate from the steam coil heaters will be taken to the condensate receiving tank.

The steam coil airheater shall be of finned tube construction with the steam on the tube side and air flowing over the tubes. The tubes shall be of carbon steel material with carbon steel fins/aluminium LL fins. In case of carbon steel tubes with carbon steel fins the tube and fins shall be hot dip galvanized to eliminate the possibility of corrosion of the tube/fins. In case of LL fin construction the LL fins shall have sufficient overlap to cover the tubes completely and thus prevent any corrosion of the tubes. The tubes shall be expanded and welded to tubes sheets on either side. Semi circular headers with end covers will be welded to the tube sheets to form the inlet and outlet headers. The headers will be provided with nozzles for supplying steam and draining the condensate. The finned tube bundle shall be covered with casing and end flanges shall be provided for connecting to the ducting. The condensate from the steam airheater shall be piped to the dearator and complete drainage should be ensured. If drainage to deaerator is not possible due to reasons of inadequate pressure differential alternate arrangement of drainage of the condensate shall be made. The casing of Air Heater shall be 6 mm thick

3.2 Steam and Water Sampling System

Provision for sampling the various streams shall be made as required below. The parameters to be analyzed are given for information. The required sampling lines, sample coolers, valves, fittings, cooling water lines from the battery limits, drain trays and drain piping upto the nearest trench shall be in the scope of the **SUPPLIER**.

The sampling and parameters to be analyzed will be as given below

Sl. No	Sample	Parameters to analyzed
1	Feed Water	pH, Hydrazine, conductivity
2	Boiler Water	pH, Conductivity, silica
2	Blow down Water	pH, conductivity & residual phosphate
3	Saturated Steam	Silica, Conductivity
4	Superheated Steam	Conductivity, Silica
5	Exhaust Condensate	pH, Conductivity
6	Make up water	pH, Conductivity

3.3 Soot Blowing System

Soot blowers:

The boiler shall be provided with a complete system of soot blowers to effectively dislodge deposits from the heat transfer areas. The soot blowers could be of type using steam as the blowing medium, depending on the nature of the deposits and the requirements.

Steam Soot Blowers:

The soot blowers shall be motor operated and with steam, taken from the outlet of Superheater First stage, as the cleaning medium. The required pressure reducing station with pressure controller and pneumatically operated control valve and downstream safety valve shall be provided. Considering the nature of the deposits, it is preferable to go in for the maximum possible blowing pressure for steam. The isolating valve upstream of the pressure reducing valve shall be a motor operated valve. The supply shall include all piping, fittings, valves, traps etc.
In the zones where the gas temperature exceeds 700 Deg.C only long retractable soot blowers shall be given. For the blowers located in zones where the gas temperature exceeds 700 Deg.C, the lance material shall be a minimum of stainless steel type 304 (for necessary part only as per soot blower vendor suggestion).
All soot blowers shall be provided with poppet valves at the inlet of the soot blowers and group isolation valves. The soot blowing system shall be suitable for the automatic sequential operation from the plant **DCS**.

Wherever the furnace width exceeds 6.1 meters or as recommended by the soot blower manufacturer, a single long retractable type soot blowers on one end of the furnace side wall is not acceptable, as the long lance tube is susceptible for damage. There shall be two soot blowers, one on either side wall of the boiler at each location, such that both the blowers put together cover the entire furnace width of the boiler.

The number of long retractable and rotary soot blowers shall be decided based on the manufacturer's, recommended cleaning radius and full coverage of the pressure part sections to be cleaned.

3.4 Fuel Firing System

The fuel firing system for the boiler shall be of traveling grate type. The boiler is to be designed for firing the individual fuels and fuel combinations as specified in Section 2 of this Bid documents. The fuel

firing system should be such that the furnace temperature is maintained in the range of 950-1000 Deg C. **The SUPPLIER in his offer should give a detailed write up and sketches / drawings on the fuel firing system inclusive of the feeding, distribution and fuel feed control**. The boiler should be designed for minimum NCV of 1750 Kcal/kg of combination fuel.

SUPPLIER to submit his credentials to PURCHASER/CONSULTANNT showing minimum three (3) nos of working installations with this fuel firing type and are operating trouble free for past 1 year.

SUPPLIER to the boiler Travelling grate type suitably to prevent corrosion and maintain furnace temperature of 950-1000 Deg C. The travelling grate type system shall of catenary design with length of cast of 300mm or less. The MOC of the casting shall be alloy steel to prevent corrosion of the grate.

The layout of the fuel feeding systems shall be such that each system is easily approachable and maintainable. All nozzles, feeders and distributors shall have independent drive arrangement. The arrangement and the details of the fuel firing system, inclusive of the feeding, distribution and fuel feed control for coal shall be approved by the **PURCHASER / CONSULTANT**.

3.4.1 Distillery slop feeding system

The distillery slop at a range 48 to 60 % solids concentration will be made available from the concentration plant at the inlet of storage tank. The slop will be pumped by slop feed pumps to the slop spray nozzles located in the furnace through a suitable flow meter. The flow to the spray nozzles shall be automatically and shall be controlled through DCS according to Boiler pressure and load condition. The Bypass provision has been provided in case of failure of automation system and the excess slop pumped to the nozzles shall be returned through the return slop line to the storage tank. Reasonable information shall be furnished on the spray nozzle size and location for the **PURCHASER/CONSULTANT** to get satisfied on the workability of the arrangement.

The Boiler and the spent wash feeding system shall be designed for firing spent wash with 48% to 60% solids. SUPPLIER to submit the data of 1 working installations where the boiler has been operated for this range of solid concentration.

3.5 Coal feeding system

3.5.1 The Coal from the crusher house will be delivered to the Coal bunker in the boiler house. The bunker shall have a minimum capacity of 75

Cu.M water volume with outlet slide gate shall be motorized operated and the **SUPPLIER** shall choose the appropriate bunker configuration and location to suit the Coal feeding system. However, part of the conveyor load shall be taken on the first row of the boiler columns. The bunker shall have suitable lining, inserting system, emergency bunker evacuation chute, isolation gates, manholes, etc. The 1/3rd of conical portion of the bunker shall be lined with 1.6mm of stainless steel (SS 304) material. The **SUPPLIER** shall furnish the method of fixing the liner to the bunker for **PURCHASER / CONSULTANT** approval during detailed engineering stage. The thickness of the bunker plates shall be a minimum of 8 mm and the top deck plate of the bunker shall be a minimum of 6mm. The coal feeding shall be automatically and shall be controlled through DCS according to Boiler pressure and load condition.

3.5.2 The extraction feeders shall be of proven design with variable frequency drive. The feeders shall be easily approachable for maintenance with adequate provision for on line observation of the operation of the feeders. The sizing the feeders and other feeding equipment, shall be done considering the firing of coal. The density of the Coal shall be taken as 1100 Kg/M^3 and moisture of 30%. For this project, there shall be minimum three (3) nos. of feeders.

3.5.3 The distributor could be mechanical or pneumatic. There shall be provision to vary the length and the angle of throw. The parts facing the furnace radiation shall be of stainless steel, minimum of type 304 or suitable and proven heat resistant material. If the design does not envisage any distributor, the **SUPPLIER** shall clearly explain the arrangement envisaged for spreading and controlling the Coal over the grate. Expansion bellows, if used in the fuel feeding chute (feeder to the distributor) for accommodating the differential expansion between the furnace and the chutes **shall not be non-metallic type**. Coal spreader Plummer block bearing shall be provided with cooling jacket arrangement. Centralized lubrication system shall be provided for the spreaders.

3.6 Draft System

The draft system for the boiler shall be suitable of producing a balanced draft with sub-atmospheric pressure conditions in the furnace.

There shall be, one x 120% capacity Induced Draft Fans, one x 120% capacity Forced Draft Fans and One x 120% capacity Secondary Air Fans making up the complete draft system for the boiler.

The nomenclatures of Induced draft, forced draft, Secondary air may be changed to suit the SUPPLIER'S system of referring the fans depending on the SUPPLEIR'S design.

If any additional fans are required depending on the type of the boiler, the same shall be included in the scope of the SUPPLIER. The requirements for the additional fan(s) shall be similar to the following specifications.

3.6.1 General requirements

All the fans shall be suitable for outdoor installation. The **SUPPLIER** shall furnish the complete data, and all the characteristic curves for all the fans. The fan efficiencies both at design and MCR operating conditions shall be clearly brought out in the data sheets. The fan impellers shall be dynamically balanced at the fan manufacturer's works.

The fans shall be basically sized using the following margins over the calculated values of the flow volume and the pressure using the maximum continuous rating condition during spent wash + coal firing condition. During solo coal firing condition, the margin on flow and head for all fans shall be minimum 10%.

Required Fan Margins:

Fan	Margin on Volume	Margin on Pressure
Secondary air fan	10 %	15 %
Forced draft fan	15 %	20 %
Induced draft fan	20%	25%

The casing of all fans shall be split for the easy handling of the rotor without disturbing the connected ducting. The duct routing to and from the fans shall also be done to enable the rotor and motor removal without calling for cutting the ducting and structural members. Sufficient bracing and reinforcement shall be employed to withstand imposed pressures without vibration or distortion during operation for the life of the fan. Casing shall be fitted with drains of atleast 40 NB diameter pipes and positioned at the bottom of the casing and inlet boxes. Access doors shall be provided for entry into the fan housing and inlet boxes.

The rotor shall be of all welded construction utilizing ASTM specification materials suitable for the application. The rotor shaft shall be forged and annealed. For ID fan, cooling discs shall be provided on either side of the rotor to minimize the conduction of heat to the bearings through the shaft.

Fans shall be equipped with anti-friction spherical roller bearings supported on heavy steel fabricated pedestals independent of the fan housing. Bearing pedestals shall be furnished with sole plates for proper location of the bearing pedestal. The bearings shall be

lubricated with grease. The vibration displacement at the bearings at full speed with a clean rotor shall not exceed the limits as per Vendor standards.

The coupling will be of flexible type. The fan half of the coupling should be mounted in the manufacturer's shop. A suitably designed coupling guard shall be furnished by the fan manufacturer. This guard shall comply with OSHA requirements. The coupling shall be attached to the shaft by either keying or by having a shrink fit.

3.6.2 Forced Draft Fan

The forced draft fan shall be a variable speed, horizontal, radial, backward curved and electric motor driven. Primarily the fan control shall be with the variable frequency drive (VFD), but however the fans will also be provided with inlet guide vane operation in case the VFD fails. The inlet guide vane opening shall be manually controlled from the control room through pneumatically operated power cylinder incorporating suitable linkages. IGV / damper operating links/drives should be mounted outside to the extent possible to avoid settlement of dust on links. The fan shall be direct driven with the maximum speed not exceeding 1500 RPM and shall be supplied complete with motor, common base plate for fan and motor, coupling, etc. The fan suction shall be provided with rigid bird and trash screen assembly and shall have suitable arrangement to prevent rain water directly entering the fan. FD fans shall also be provided with silencer. Flow measurement device shall be provided for measuring the air flow to the furnace. The fan design temperature shall be a minimum of 40 Deg.C. VFD motor and Panels to be included in scope.

3.6.3 Induced Draft Fan

The Induced draft fan shall be horizontal, radial, with backward curved blades. Primarily the fan control shall be with the variable frequency drive (VFD), but however the fans will also be provided with inlet damper operation in case the VFD fails. The damper shall be manually controlled from the control room, through pneumatically operated power cylinder incorporating suitable linkages. IGV/ damper operating links/drives should be mounted outside to the extent possible to avoid settlement of dust or links. The fan speed shall not exceed 980 RPM. The fan shall be supplied complete with motor, common base plate for motor and fan, coupling, etc. The fan shaft shall be of simply supported design. The impeller shall be **hard faced** to avoid erosion of the impeller blades. The fan mechanical design temperature shall be not less than 250°C and hot gas temperature shall not exceed 190 deg °C. VFD Motor and Panels to be included.

3.7 Ducting and Sealing System

All ducts shall be rectangular in cross section and will be of welded construction, properly stiffened and reinforced. All the air ducts shall be fabricated from steel plates of minimum 4mm thick, and all flue ducts shall be of minimum 5mm thick. The duct plate material shall conform to IS 2062. Carbon steel plates shall not be used for ducting system if the operating temperature of flue gas exceeds 427°C. The duct corners shall be stitch welded internally and full welded on the outside.

All ducts, exceeding 600 mm width or depth, shall be suitably stiffened and reinforced on the outside and designed to withstand the pressures encountered, but however the minimum design pressure for the ducts shall be $\pm$ 400 mm wc. The stiffening shall be with Indian standard section conforming to the applicable Bureau of Indian standards.

The internal struts wherever required for the ducts shall be of tubular (ERW) construction. The ducting system shall be complete with all required expansion joints, mating flanges, dampers, supports, access doors / man hole doors, platforms, insulation etc. The top of the ducts and / or the outer cladding shall be cambered to facilitate drainage of water. The man hole / access doors provided in the ducting shall be of hinged type.

The routing of the ducts shall be compact with due considerations for the draft losses and flexibility. Inner radius of the bends shall not be less than 500 mm and in cases where the inner radius is less than 500 mm suitable guide vanes shall be provided.

Ducts will be sized considering a maximum velocity of 20 m/sec for hot air and flue gases and 16 m/sec for cold air during solo firing condition. For combination firing condition, the maximum velocities shall be 14 m/sec for cold air and 18 m/sec for hot air and flue gas. The duct design consideration shall include the operating internal pressure, medium temperature, dead loads, ash loads, live loads, seismic loads, expansion joint reactions etc.

The ducting expansion joints are provided to take care of the duct expansions and shall be of saw tooth square corner type. The number of expansion joints required shall depend on the ducting thermal movement considerations. All expansion joints in the flue gas and air ducting shall be of **MS. Non-metallic joints are not acceptable.** For the critical ducting sections, to be identified by the **PURCHASER / CONSULTANT**'s after the submission of the ducting layout drawing, the **SUPPLIER** shall provide the calculations for the flexibility analysis and the expansion bellow selection for approval.

The ducts shall be supported adequately, either from the ground or from the boiler structural steel works depending on the location of the ducting support. The ducting system, consisting of the ducts, dampers and expansion joints shall be analyzed as a single unit and the locations of the expansion joints, supports and restraints shall be finalized based on the ducting flexibility analysis calculations.

Dampers, in the ducting system, shall be provided as called, for the proper operation of the boiler. All dampers shall be of the `louvre' or butterfly type with the necessary frames, shafts, blades, bearings, linkages, seals etc. The main frame of the dampers shall be of sturdy construction capable of withstanding the loads imposed by the adjacent ducting system. The blades shall be made of 3 mm thick steel plate and shall be formed to aerofoil shape and bent to provide adequate stiffness and rigidity and uniform Contact edge for sealing. The blades shall be welded to tubular shafts with adequate rigidity to limit deflection. The tubular shafts shall be welded with stub shafts at both the ends to fit into stuffing boxes and anti-friction bearings housed in the frame. All the blades in the damper shall be linked by linkages capable of transmitting the full torque for driving the blades.

The unburnts in the ash and the low ash fusion temperature of the slop ash, causes serious problems at the ash collection points in case of any air ingress into the system. The burning of the unburnt fuel at ash collection points, quite common in bio-mass firing, locally increases the gas temperature and softens the ash. This soft or molten ash causes fouling in the heat transfer areas, the seriousness of which is dependent on the extent of the secondary combustion. This ash agglomeration at the ash collection points and fouling on the heat transfer areas reduces the period of operation of the boiler between cleaning cycles. It is extremely important that adequate care is taken in sealing to potential leakage areas to prevent ingress of atmospheric air into the system. The offer shall highlight how the design takes care of the above points. The sealing design shall be done in such a way that the start up and shutdown cycles and the thermal stresses developed during the operation do not cause any air leakages into the system during the plant operation. After the mechanical erection is completed, the boiler shall be adequately leak tested.

3.8 Chemical Dosing System

The boiler shall be provided with a tri-sodium phosphate based High pressure (HP) dosing system and oxygen scavangers & ammonia based Low Pressure (LP) dosing system. The HP dosing system shall be connected to the steam drum and shall add the chemical to the boiler water to take care of the ingress of the hardness salts and to

increase the boiler water pH. The LP dosing shall be connected to the deaerator tank to scavenge the last traces of oxygen and to increase the feed water pH.

The HP dosing pumps, 2 x 100 % (1 working & 1 standby) shall be of simplex reciprocating plunger type stroke adjustable while the pumps in operation or stationery for the 0 – 100 % capacity range. For the LP dosing pumps, (1 working & 1 standby) simplex reciprocating plunger type pumps shall be provided. The pumps shall be designed according to Hydraulic Institute Standard. The wetted part of the pumps shall be of stainless steel SS 316.

HP dosing system sizing shall be with One percent (1%) concentration of Tri-sodium-Phosphate. The tank usable volume shall be on 24 hours basis and on a residual phosphate level of 7 ppm in the boiler water. LP dosing system sizing shall be with 0.1% concentration. The tank usable volume shall be on 24 hours basis and on a residual hydrazine level of 0.02 ppm in the feed water. However, the mechanical design and material selection shall be based on 10 % concentration of the chemicals for both dosing systems.

Each dosing system shall include a stainless steel mixing tank with an electric motor driven agitator. The tanks shall be provided with dished ends at the bottom and flat covers at the top. The top cover will be provided with an observation door with swivel bolts and wing nuts.

The HP and LP dosing systems shall be **mounted on individual skids** with their respective tank, pumps along with all required piping, valves, fittings, relief valves, supports etc.

The design margin for the calculation of rated flow shall be 10 % of maximum flow.

The design margin for the calculation of the rated head of the dosing pumps shall be 5% of its maximum discharge pressure requirements, to be calculated, as given below.

HP dosing pump

THE MAXIMUM DISCHARGE PRESSURE:
MAXIMUM SET PRESSURE OF DRUM SAFETY VALVE + LINE LOSSES + STATICHEAD

LP dosing pump

THE MAXIMUM DISCHARGE PRESSURE:
DEAERATOR SAFETY VALVE SET PRESSURE + LINE LOSSES + STATICHEAD

Relief valve set pressure shall be minimum 25% more than the maximum discharge pressure of the pump.

The complete piping for both the HP and LP dosing system from the skid to the respective admission points to the boiler water circuit shall be of stainless steel 304. All fasteners in the dosing skid shall be of stainless steel material. The minimum pipe size in the dosing system shall be NB25.

The following gives the other requirements of HP and LP dosing system:

8) Approved make of components for HP and LP dosing system equipment shall be as given below:

Sl. No.	Particulars	Approved make
1	Pump-plunger type	Metachem / Veekay pumps / Asia LMI.
2	PRV	Metachem / Veekay pumps / BHEL / Audco / Fisher Xemox.
3	Pressure gauges	Waree / H. Guru / GIC / AN Instruments.
4	Level gauge	V-Automat / Technomatc / Levcon / Chemtrols
5	Drive motors	Siemens / NGEF / CGL / Kirloskar / ABB / Bharat Bijilee / Alstom.
6	Strainers	Triveni equipments / Bhatia / Filtration engineer / Strainwell / Sungov.
7	Valves	BDK / KSB / Audco / BHEL / Steel strong / Valtech.

3.9 Blow Down Tank

One Continuous Blow down (CBD) tank shall be provided for the boiler. The CBD will also act as the intermittent blowdown tank and the flash steam from the outlet shall be connected to deaerator tank.

The tank design, material selection and manufacturing shall be as per the requirements of the IBR. The end covers shall be semi ellipsoidal / torrispherical dished ends and flat end covers will not be accepted. The blow down tank shall be provided with a siphon break to prevent the water getting drained completely from the tank due to the siphon effect.

The drains from different pressures shall be connected to blow down tanks through an individual manifolds.

The tank shall be sized for 3 % blow down of MCR condition. The diameter of the tank shall be sized as per supplier standard.

3.10 Feed water tank (Condensate water receiving tank)

Horizontal, cylindrical, closed tank in carbon steel construction with dished ends for receiving condensates and DM water for supply to the de-aerator through transfer pumps. Net capacity of tank shall be suitable up to overflow level. Adequate vapour space shall be provided above the overflow level.

3.11 Condensate water transfer pump

Two transfer pumps of 45 M^3 /Hr each and 100 MLC head. (1 W +1 S) shall pump water from boiler feed water tank to deaerator to maintain 4 bar(g) pressure at the nozzles of deaerator.
Pumps shall be provided with individual strainer in the suction line, control valve, non-return valve, pressure gauges etc. Pumps shall be equipped with hot water stuffing box with water-cooling system.

3.12 Dearator and Deaerated water storage tank

One (1) Dearator of dearating capacity equal to Twenty percent (20 %) higher than the gross MCR steam generation capacity of the boiler with a deaerated water storage tank of net useful capacity (normal water level to Low water level) equivalent to forty minutes (40 minutes) of MCR generation capacity of the boiler shall be provided. The material of the dearator, dearated water storage tank shall be SA 516 Gr.70 / IS:2002 Gr.2. The design of the dearator and dearated water storage tank shall be as per ASME Section VIII and wherever applicable the minimum statutory requirements of IBR shall be met with. The Dearator and the Dearated water storage tanks shall be designed as per IBR code.

The dearator shall be of either spray-cum-tray type or spray type with counter current flow of steam and water. The material of trays shall be stainless steel, conforming to a minimum of AISI 304. The dearator and the storage tank shall be complete with all the fittings and mountings like vents, controlled vent, drains, gauge glasses, pressure indicators, relief valve, steam and water inlet and outlet nozzles, overflow nozzle etc. The size of the overflow nozzle shall be minimum one size higher than the inlet pipe size. If one or more inlet nozzles are provided, the size shall be one size higher than the maximum inlet size. Operating platform and ladder shall be provided for the dearator and dearated water storage tank.

The dearation steam almost at the saturation temperature shall be supplied at the inlet of the dearator. Condensate from process and

make up water will be let into the dearator spray head. Level transmitters shall be provided for the entire range of the tank (i.e) Low water level to High high water level. The tappings for the level gauges, level switches and level transmitters shall be taken directly from the dearator water storage tank.

The design parameters shall be as per the Dearator Design Basis under Section 2 of this specification.

Spargers shall also be provided for deaerating steam and pegging steam line.

A vent loss of 2% of the steam supplied to the dearator is acceptable. If the vent loss is more than 2% the SUPPLIER shall provide then a vent condenser, designed suitably as per HEI/TEMA. The **SUPPLIER** shall submit the calculations and the vent condenser drawing for approval to the **CONSULTANTS**.

The saddle support for the dearated water storage tank shall be calculated as per BS 5500 : 1994 G.3.3. Stainless steel plates of 3.15 mm thick shall be provided on the dearaor saddle bottom and PTFE sheet resting on carbon steel plates embedded on the foundation.

3.13 Boiler Feed Water Pumps

Two (2) Nos. of 120 % capacity boiler feed water pumps with LT motor suitable for the application shall be provided to supply feed water to the boiler.

The feed water pump will take suction from the dearator.

One out of the two feed water pumps shall be capable of meeting the peak generating capacity of the boiler and the blow down requirements of the boiler under peak generation. The peak generation capability of the boiler shall be 110% of the MCR capacity of the boiler. The design margin for the calculation of the rated pump capacity shall be 10 % of the feed water requirements for the peak load operation of the boiler with 3 % blow down.

The design margin for the calculation of the rated head of the pumps shall be 5% of its maximum discharge pressure requirements, to be calculated, as given below.

THE MAXIMUM DISCHARGE PRESSURE:

MAXIMUM SET PRESSURE OF DRUM SAFETY VALVE + ECONOMISER PRESSURE DROP +LINE LOSSES including flow meter Pressure drop + FCV PRESSURE DROP + STATIC HEAD + pressure drop in ARC valve

The pressure drops and losses indicated above shall be calculated under boiler peak load steam generation.

While calculating the total dynamic head of the pump, credit can be taken for the net suction head. However, no credit shall be taken for the operating pressure of deaerated water storage tank.

The drive motor rating for pumps shall be selected based on the maximum of the following:

- 10% margin on the Bkw at rated operating conditions
- 5 % margin on the maximum Bkw with rated impeller

The maximum temperature of the feed water at the BFP suction will be 155^0C and the Pumps are to be selected to handle this temperature of feed water.

The discharge flange rating shall be class 600 or 900 depending upon the actual pump shutoff head. The design pressure of the boiler feed pump discharge shall be the cold shutoff pressure of the boiler feed pumps.

The pump shall be single suction, multi stage centrifugal type with drive motor of suitable rating, coupling, common base frame, foundation bolts etc.

The pump shall be with Mechanical Seal.

The pump Bearing shall have water cooling system with flow indicator.

The following instruments shall be provided in each of the BFP local gauge panel:

Pressure gauges for pump suction, discharge and balancing leakoff

Temperature gauges for pump suction and discharge

The material of construction for the pump shall be as per approved vendor's standard to suit the application.

The feed pumps shall be provided with suitable recirculation and balance leak off arrangement. Recirculation flow under low load conditions shall be automatically controlled. The minimum stable flow of the boiler feed pump shall be as low as possible, so as to operate the boiler feed pumps continuously at low loads. The **SUPPLIER** shall furnish minimum flow thermal and minimum flow stable along with characteristics curves of pump along with the offer. The automatic reciruclation valve shall be sized for the higher of the minimum flow thermal and minimum flow stable values.

Pressure transmitter shall be provided in the individual discharge piping of the boiler feed pump upstream of the ARC valve.

The size of ARC valve shall be equal to the BFP discharge flange size.

Removable conical type suction strainers, with free flow area equal to four (4) times the flow area of the pipe shall be provided. Pressure drop in the strainers shall be limited to a maximum of 0.1 kgf/Sq.cm at the design flow in clean conditions and to a maximum of 0.15 kgf/Sq.cm at 50% clogged conditions at design flow. The strainer shall be made of stainless steel 304 material. The size of the conical strainer shall be equal to the suction pipe size and not the pump suction flange size.

The feed water pump performance test shall confirm to the requirements of Hydraulic Institute standards.

Impeller Diameter

The impeller diameter shall be selected as per vendor standard considering the rated parameters.

The pumps shall be capable of operating at rated parameters and at minimum load for temperature range of ambient to maximum operating temperature. It is also to be ensured during selection of drive motors for the pumps.

3.13.1 The boiler feed pumps shall have the following characteristics

Head - Flow Characteristic Curve

This should be a stable curve with the head continuously increasing from maximum flow condition to zero flow condition with a maximum head being at closed delivery valve (zero flow). Both flat curve as well as heavily drooping curves are not acceptable. Maximum run-out flow should atleast be 130% of duty point flow. Specified normal pump capacity shall be less than rated capacity and these two points shall lie to the left of capacity at Best Efficiency Point (BEP).

Closed Valves (Shut Off Head)

The shut off head should be at least 1.1 times the duty point head (at MCR) and should not be more than 1.2 times the duty point head (at MCR).

Power Characteristics

The power curve should be of non-overloading type with the maximum power occurring at or near duty point or towards maximum runout flow. Deeply formed 'S' shaped power curve should as far as possible be avoided.

NPSHR Characteristics

At rated capacity, margins between required and available NPSH shall be at least 1.0 M, under strainer 50% clogged conditions.

NPSHR curve should be a continuously rising one in the range of operation, from the minimum flow in the range to the maximum flow in the range. A bowl shaped NPSHR curve in the operating range is unacceptable. Required NPSH values shall not exceed available values over the entire range from minimum to rated flow.

Efficiency Vs Flow Characteristics

The efficiency curve should be fairly flat in the range of ± 1% of the BEP flow. The duty point of the equipment should preferably lie in this flat region, but not at a flow higher than the BEP flow.

Pumps operating in parallel shall have equal head rises from normal capacity to shut-off of atleast 10%.

3.14 Boiler Integral Piping

The boiler integral piping consist of all the interconnecting piping between the economiser inlet stop valve and the main steam stop valve on the superheater outlet piping. The number off, size and the arrangement of these integral piping shall be based on the permissible pressure drops in these pipes and the distribution required in the respective headers of the various sections of the boiler. These piping shall be properly supported and provided with the required tapping, stubs and thermowells for measurements.

3.15 Boiler External Piping

Boiler external piping with valves, fittings, hangers, supports, on-line instrument, insulation, casing, etc. as required.

The external piping in the scope of the SUPPLIER shall be as per Clause 1.8.1.21 of Section 1 of this Volume of the Bid Documents.

3.16 Piping, Valves and Specialties

3.16.1 General

The scope of work covered by this specification includes design, engineering, supply, fabrication, delivery, unloading, handling at site, erection, cleaning, testing, painting and commissioning of all piping

system complete with accessories within the terminal points indicated elsewhere in the specification. The piping provided shall be complete in all respects including valves, specialties, supports, thermal insulation etc. as required.

3.16.2 Scope of Supply

For all the piping systems included in **SUPPLIER'S** scope of supply shall include but not limited to:

a. Pipes, Tubes, Headers and Manifolds.

b. Bends, Elbows, Returns, Tees, Laterals, Crosses, Reduces, Caps and Closures, Full & Half Couplings, Plugs, Sleeves & Saddles, Stubs & Bosses, Reinforcement pads, Unions, Weldolets, Sockolets, Threadolets and other similar fittings.

c. Valves

d. Flanges, Gaskets and Fasteners.

e. Complete assemblies of supports, anchors, guides, restraints etc, including welded attachments etc.

f. Auxiliary Steel, as required for Hangers, Supports, Guides, Restraints, Anchors etc.

g. All Paints, Varnishes, Primers, Thinners and other Painting Materials.

h. Weather hoods for Pipes, Crossing Ceilings and Walls.

i. All instrument impulse piping and fittings upto the last root valve

j. In case of temperature measurement points, **SUPPLIER'S** scope includes the supply of thermowell stubs with plugs.

SUPPLIER shall supply all necessary drains and vents including anti-flash funnels as required for the safe and effective draining / venting of the piping systems. It must be noted that the flow diagrams may not indicate all the drains and vents that would be required. It is **SUPPLIER**'s responsibility to identify the requirements of drains and vent whether the same have been shown in the flow diagrams or not and supply the necessary pipe work, fittings, hangers and supports etc. The drains and vents indicated on the flow diagrams shall however be regarded as minimum requirements. The drains and vents shall be led upto the nearest floor drain in case of cold water

systems and upto the flash tank in case of steam and hot water systems, all as erected by the **PURCHASER**.

Wherever uninsulated pipes cross walls or roofs, the necessary weather hoods shall be supplied by the **SUPPLIER** as directed by **PURCHASER**. Where required, **SUPPLIER** shall make openings in floors, gratings etc. for routing the pipes and provide proper finishing after piping is erected.

3.16.3 Scope of Erection

Where **SUPPLIER**'s scope ends adjacent to equipment or piping installed by others, the final joint shall be made by the **SUPPLIER**. If at his terminal connections or at connections to online specialities, the same shall be erected by the **SUPPLIER**. Necessary gaskets and fasteners are included in **SUPPLIER**'s scope of supply.

SUPPLIER shall erect all instruments impulse piping and fittings from the tap-off point of the last root valve including the root valve as per the requirements of the flow diagrams.

SUPPLIER shall also install small accessory piping and any specialties furnished with or for equipment such as relief valves, built-in-bypasses etc in his scope of supply..

SUPPLIER shall install thermowells to be supplied by **PURCHASER** prior to hydrotesting of the piping systems. In the event of non-availability of thermowell in time, **SUPPLIER** shall provide necessary plugs to carry out the hydraulic testing of the piping systems.

SUPPLIER shall thoroughly inspect and clean all valves and specialties before erection on the pipe lines.

SUPPLIER shall carry out blue matching of all high pressure flanges (greater than ASME 300 lbs rating or equivalent) erected by him. Any defects in the surfaces of flanges shall be rectified by him by lapping as directed by the **PURCHASER**.

SUPPLIER shall check all fabricated components reaching site from his own works or components supplied by other Contractors / Vendors and ensure that they correspond dimensionally to the fabrication drawings / layout drawings. In the case of any defect in the piping components supplied by his works, he shall take necessary steps to rectify the defective components. In the case of components supplied by others, he shall notify **PURCHASER** immediately of the defects observed in order that timely action can be taken or the corrective measures to be adopted well in advance of erection.

SUPPLIER shall provide all machinery, equipment, tools, tackles for transportation, handling, fabrication and erection.

SUPPLIER shall provide all equipment and material, temporary piping, tools & tackles for cleaning, fluishing, blowing out and testing of piping system.

SUPPLIER shall provide all Scaffolding material.

3.16.4 Design Requirements

The equipment and work under this specification shall conform to the following standards / codes:

a. Indian Boiler Regulations.

b. Applicable Standards for Structural Steel.

i. IS:800 Codes of Practice for use of Structural Steel in general Building Construction.

ii. IS:2062Gr.A Structural Steel (Fusion Welding Quality)

c. American National Standard ASME code for “Power Piping" - ASME B 31.1 and all other associated ASME Standards.

d. American Society of Testing and Materials (ASTM) Specifications.

e. American Society of Mechanical Engineers (ASME) Codes.

The piping shall be arranged to provide clearance for the removal of equipment requiring maintenance and for easy access to valves and other piping accessories required for operation and maintenance.

Piping shall generally be routed above ground but where specifically indicated / approved by the **CONSULTANT**, the pipes may be arranged in trenches or buried. Pipes at working temperatures above the ambient shall however not be buried.

Wherever pipes are to be bent, the bends shall be free from wrinkles and bulges. The bends shall be made by cold bending.

Overhead piping shall have a minimum vertical clearance of 2.3 meters above walkways and working areas and 6 meters above roadways unless otherwise approved by the **CONSULTANT**.

Drains shall be provided at all low points and vent at all high points as per actual layout regardless of whether the same have been shown

in the flow diagrams are not. Pipelines shall be sloped towards the drain points.

Provision shall be made while preparing piping layout to accept control valves, flow measuring elements and any other on line specialty or equipment supplied by others. Sufficient upstream and down stream lengths shall be provided for flow measuring devices, control valves, desuperheaters and other specialties as required by the Suppliers.

At all screwed valves and screwed connections on equipment, unions shall be provide to facilitate disassembly. Likewise, unions shall also be provided at suitable points on straight lengths of screwed pipelines.

All local instruments shall be located on pipelines as to render them observable from the nearest available platforms and accessible for maintenance.

Piping with operating temperatures above or below the ambient shall be routed so as to provide adequate flexibility for the pipes.

Tap-off on main lines for field routed pipework, if not indicated on **PURCHASER**'s layout drawings, shall be suitably located by **SUPPLIER** to suit the layout evolved by him.

All steam tracer lines shall be provided with expansion loops to take care of differential expansion between the tracer and main line.

Stubs for instrumentation, drains, vents etc. wherever not located on **PURCHASER**'s piping layout drawings shall be suitably located by **SUPPLIER** in accordance with the flow diagrams and layouts.

At all intersection joints, it is **SUPPLIER**'s responsibility to design and provide suitable reinforcements as per the applicable codes and standards.

SUPPLIER is responsible for the complete design and engineering of all supports, guides, restraints and anchors as required for the piping systems erected by him. **SUPPLIER**'s scope of work shall include but not be limited to the location of all required hangers, supports, anchors, restraints etc. and the design and detailed engineering of individual components of the assemblies as also all associated steel work, , welded attachments to piping etc. which form a part of hanger / support system. While the designs shall conform to applicable codes and standards and shall be consistent with international practice. Information contained in **PURCHASER**'s drawings regarding support location, type and detail etc. may be used for

guidance. This does not however relieve the **SUPPLIER** of his responsibility for the design and engineering of the support system.

The design and engineering of all temporary pipework as required for erection, cleaning, flushing, blowing out, testing and commissioning of the piping systems installed by the **SUPPLIER** is the responsibility of the **SUPPLIER**.

Pipelines of NB 40 size and below are regarded as field run piping. It is **SUPPLIER**'s responsibility to plan suitable layouts for these systems in-site as per the requirements of this specification and in consultation with **PURCHASER** and / or **CONSULTANT**. **SUPPLIER** shall prepare isometric drawings indicating the layout of field run pipework.

The SUPPLIER shall design and prepare all fabrication isometric drawings for all IBR piping and NB 50 and above Non-IBR piping. **SUPPLIER** shall also submit orthographic drawing with Bill of Material for Non-IBR piping of size NB 40 and below.

The **SUPPLIER** shall ensure that the design is as per ASME B 31.1 and in addition, shall meet the statutory requirement of Indian Boiler Regulations. The **SUPPLIER** shall furnish the calculations for reinforcement for nozzle openings and calculations for welded attachments carried out on the piping.

All pipe to pipe joints shall be by butt welding only and no couplings shall be used.

All flanges of pressure class 300 and above shall be of weld neck type. For class 900 and above the flanges facing shall be RTJ type, except equipment flanges which can be as per manufacturer's standard.

Pipe fittings like elbows, equal tees and reducers shall be as given below:

a) For pipe size 50 NB and above shall be butt welded type.(except for socket welded valves of NB 50)
b) For 40 NB and below shall be socket welded type.

All pressure tappings for pressure applications above 40 Kg/Sq.Cm shall be of size NB 25 with two root valves. For pressures 40 Kg/Sq.Cm and less the size shall be NB 15 with one root valve (refer Fig. 1 attached at the end of this volume). For temperature above 400°C irrespective of pressures, the root valve size shall be NB 25.

All thermowell boss shall be one (1) inch NPT.

3.16.4.1 Pipe Sizing and Layout

The design of the piping system shall be based on the ASME B31.1 code. In addition the statutory requirements of the IBR shall also be taken care of wherever required. Flexibility analysis shall be made for all piping systems with operating temperatures above 100 Deg.C. The correct locations of hangers and supports, with as applicable spring stiffnesses, shall be considered for the flexibility analysis. Suitable expansion loops, restraints and anchors shall be provided so as to ensure compliance with the applicable codes and to limit the stress and reactions to within the allowable values.

All piping shall be sized considering the allowable velocity and allowable pressure drop in the system. The indicative flow velocities in pipes shall be limited to the following values. However, if the available pressure drop are to be maintained, the piping system may have to be selected even with a lower velocity than the minimum indicated.

Allowable velocities for sizing of pipes

Note: The above velocity values are indicative and showing the maximum limits of the flow velocity. Lower velocities may be selected if found necessary.

The velocity in exhaust piping for SV, Relief valves, minimum flow line for feed pumps, balancing line etc shall be based on vendors recommendation. Exhaust pipe for 'Mach no' shall decide startup vent pipe size and not the absolute velocity of the medium.
For The other lines like individual feed water pump discharge line (Vel.=2 m/s) / Feed water line to economizer (Vel.=2.05m/s) / 30% control valve line (Vel.=2 m/s) / Feed water line after economizer (Vel=2.1 m/s) / Spray water lines from BWFP Discharge (Vel=2m/s) / Startup vent inlet line (Vel.=52m/s) / Makeup water + condensate return line (2.6m/s) velocities shall be slightly on the higher side for the selected pipe line sizes.
Line sizing for velocity shall be based on MCR capacities. For PRDS, the line sizing shall be done on normal flows

Drains at all low points and vents at all high points shall be provided. Drain size shall be minimum NB 25 and for saturated steam lines the drain size shall be NB 40. Vent size shall be NB 20 for pressures 40 Kg/Sq.Cm and above, and NB 15 for pressures below 40 Kg/Sq.Cm.

All local instruments shall be located on pipelines so as to render them observable from the nearest available platform.

3.16.4.2 The boiler feed water piping downstream of the Boiler feed water pumps and **upto the feed check** shall be designed for the cold shut off pressure of the boiler feed water pumps with positive tolerance.

3.16.4.3 The pipe schedule for all piping shall be arrived as per IBR calculations

3.16.5 Materials

Pipe materials for various services and materials for fittings, flanges, fasteners shall not be inferior to the specifications given below. All piping except, for cooling water, raw water, safety and relief valve exhausts, vents and air services shall be of seamless steel. For cooling water, raw water and air services the piping could be of ERW.

Piping for services with metal temperatures equal to or greater than 427 Deg.C and less than 510 Deg.C, 1 1/4% chromium, 1/2% molybdenum ferritic alloy steel seamless pipe as per ASTM A-335 P-11 or P12. **Piping for services with metal temperatures higher than 510°C shall conform to the specifications of ASTM A-335 P22 (2¼ chromium 1 molybdenum steel) or its equivalent.**

Piping for services at temperatures less than 427 Deg. C for steam, boiler feed, condensate, drain piping etc., carbon steel piping as per ASTM

HP and LP chemical dosing system: Stainless Steel to SA 312 TP 304 specifications.

Cooling water system: Carbon Steel Piping as per ASTM

DM water system: SA 312 TP 304 (ERW)

For the safety valve exhaust piping, where the exhaust steam temperature is less than 400 Deg.C, the piping material shall be API 5L Gr.B.

For raw water applications the piping material shall be IS 1239 Black Heavy Class for size upto NB 150 and as per IS 3589 for size NB 200 and above.

For Service air applications the piping shall be IS 1239 Black Heavy Class.

For instrument air applications : SA 312 TP 304

For piping system where IS1239 or 3589 pipes are used, the fittings shall be as per A 234 as per ASME B 16.9 and ASME B16.11. All flanges shall be as per ASME 16.5.

All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable references to enable identification of the certificate with

the material it purposes to certify. The heat number shall also be indicated on the material certified.

3.16.6 Fabrication and erection

3.16.6.1 Pipelines NB 50 mm and above size are deemed prefabricated. **SUPPLIER** shall prepare necessary fabrication isometric drawings. **SUPPLIER**'s fabrication drawings shall take into account the requirements of this specifications as also all applicable codes and standards including statutory regulations such as Indian Boiler Regulations. Fabrication and erection of piping systems NB 50 mm and above size shall be as per **SUPPLIER**'s fabrication drawings. In case of systems requiring statutory clearance, fabrication and erection shall commence only after the necessary clearance have been obtained from the statutory authorities. **SUPPLIER**'s fabrication drawings including isometrics, if required, shall carry all details of fabrication, welding etc. as may be required for obtaining the necessary statutory clearances.

3.16.6.2 Piping NB 50 mm and above size shall be fully fabricated at **SUPPLIER**'s Works which shall be adequately equipped with the required machinery, templates, gauges, tools and tackles etc. SUPPLIERs shall indicate in their offer details of the facilities available at their works for fabrication of pipework. The extent of fabrication at works shall be such as to restrict field welding to circumferential line joints alone. Further, the number of circumferential line joints to be performed in the field shall be held to a minimum, limited by transport considerations and erection constraints.

3.16.6.3 Pipelines having size NB 40 mm and below are deemed field run and are hence fabricated in site. For bends, only socket weld elbows to be used.

3.16.6.4 All welded attachments on pipelines shall be of same material as the parent pipeline and shall be subjected to the same fabrication and welding procedures as the associated piping.

3.16.6.5 The use of companion flanges to connect two pieces of pipe and the use of odd or short pieces of pipe in making up long runs is prohibited except as noted on **PURCHASER**'s piping drawings.

3.16.6.6 Where welded pipe or fittings are used, longitudinal welds in adjoining sections shall be staggered to a minimum of 90 degrees during fabrication. All piping shall be fabricated true to lines and elevations as indicated on the piping drawings.

3.16.6.7 Bends in seam welded pipe shall be oriented so that the seam is positioned along the neutral axis.

3.16.6.8 No welding shall be carried out on lined pipes.

3.16.6.9 Gas cutting for bolt holes including for U-clamp supports shall be prohibited.

3.16.6.10 Cutting of standard elbows to odd angles as required per layouts, is included in SUPPLIERS's scope.

3.16.6.11 Neither butt nor branch joints shall be closer than twice the pipe diameter to any other joint in the same pipe except where "weldolet" type fittings are used in which case the branch weld must be made to the "weldolet".

3.16.6.12 All welded branch connections shall be of suitable structural adequacy by virtue of the intrinsic weld connection, reinforcing plates or rings or material inherent in the branch. It is the **SUPPLIER'**s responsibility to provide reinforcement wherever necessary for branch connections. Welded branch connections are not an acceptable alternative where tees have been specified.

3.16.6.13 All threads on piping components shall be taper pipe threads as per applicable standards. The nipples shall be fabricated by the **SUPPLIER** at site as required.

3.16.6.14 The first circumferential weld joint after a pipe bend shall be after a minimum straight length of two times the pipe diameter or 500 mm, whichever is less.

3.16.6.15 No external support shall be welded on valves and specialties except as provided by the Manufacturer.

3.16.6.16 Welding ends for butt-welding shall be as per Standard V-bevel with an included angle of 75 degrees.

3.16.6.17 The **SUPPLIER** shall check the bench marks provided by the **PURCHASER**. It shall be the **SUPPLIER**'s responsibility to establish all layouts and levels using his own surveying instruments. The **SUPPLIER** shall protect the bench mark and shall not remove or disturb the bench mark without the approval of the **PURCHASER**.

3.16.6.18 All pipe flanges and contact surfaces shall be concentric with the axis of the piping. All flanges and fittings shall be accurately machined and drilled true to the template.

3.16.6.19 No welding / gas cutting shall be done locally to valves with soft seating components in order to prevent distortion of the soft seats.

3.16.6.20 All stub and other attachment to be welded on the piping system shall be carried out in the shop or in pre-fabrication yard and only insitu butt welding alone will be carried out.

3.16.6.21 Welding and Non-destructive examination

a. Welding, non-destructive examination of welded joints and repair of weld defect areas shall conform to Clause No.3.15.9, "Welding Specification for Fusion Welded Piping Systems".For body and bonnet, Liquid penetrant examination will be sufficient.

b. Final welding of joints shall be undertaken only after the set up of piping is fully checked with respect to layout drawings.

c. At equipment terminal points, welding shall be carried out after taking into account specific requirement and / or recommendations of the equipment supplier.

3.16.6.22 Cleaning, flushing & blow-out

a. All piping including valves and specialties shall be cleaned by the **SUPPLIER** before and during erection to remove grease, dirt, dust scale and welding slag.

b. After erection, all steam water and condensate lines shall be mass flushed with water. The cleaning velocities in water and condensate lines shall be 1.2 to 1.5 times the operating velocities in the pipelines. Use may be made of standby pumps wherever available for the purpose.

c. All compressed air pipework shall be cleaned by blowing compressed air.

d. All fuel oil, tight oil and lubricating oil lines shall be cleaned by pickling. Alternately, these lines can be cleaned by steam blowing subject to the timely availability of steam for this purpose.

e. All auxiliary steam lines shall be steam blown to effectively remove scale and slag.

f. For purposes of steam blowing, **PURCHASER** will make available low pressure steam as required. It is **SUPPLIER**'s responsibility to install necessary temporary pipework for blowing and remove the same after blowing and render all other assistance to **PURCHASER** for carrying out the blowing operation.

3.16.6.23 Inspection and testing

a. On completion of erection, the inside of all pipes, valves, fittings etc, shall be clean and free from loose scale and foreign matter before subjecting the line to any test / inspection.

b. All piping systems shall be tested hydrostatically pneumatically by the **SUPPLIER** after erection, at pressures given in the applicable codes listed in Data sheet or as given in the line designation schedule. The test pressures shall be maintained until all welded/flanged joints are inspected for leakage or atleast for ten minutes.

c. Mechanical equipment and pressure relieving devices should be blanked-off or removed from the line during pressure testing and control valves should be set in the open position for the duration of the test.

d. Orifice plates should not be erected until hydrostatic testing and cleaning operations are completed.

e. Lines having check valves should have the source of test pressure located on the upstream side.

f. Expansion joints, instruments, filters and similar equipment for which the maximum permissible cold test pressure is lower than the hydrostatic test pressure applied to the system, shall be removed or blanked off from the line before testing. The **SUPPLIER** shall consult the **PURCHASER / CONSULTANT** for specific guidance.

g. Test pressure readings may be taken at the lowest point of the system being tested provided the effect of static head is taken into consideration.

h. When conditions require a test pressure to be maintained for a period of time, during which the testing medium in the system might be subject to thermal expansion, provision may be made for the relief of excess pressure thereto.

i. After hydrostatic test any leaky joints shall be cut out and repaired or completely replaced and test repeated until the test has been satisfactorily passed. If any valve is found to be leaking part the bonnet joint or steam gland packing, **SUPPLIER** shall replace the gasket or gland packing and retest the system to the satisfaction of **PURCHASER**.

j. After completion of hydrostatic test, safety valves, orifice plates etc., withheld for the hydrostatic tests, shall be installed

in an approved manner. Orifice plates shall however be installed after completion of cleaning operations.

k. Clean water at a temperature of not less than dew point or 10°C whichever higher, nor exceeding 50°C should be used for hydrostatic test.

l. The rate of pressure increase must not exceed 7 bars per minute.

m. No one should be allowed near piping/equipment under test when the test pressure is near the yield strength or when test pressure over 35 bars are being applied. The pressure should be lowered by 10% before inspection for the leaks.

n. When draining the fluid, the pipelines should be vented slowly to avoid excessive vacuum.

o. A block valve is required on the line from the test pump to the pipeline/equipment under test.

p. Only calibrated test gauges should be mounted in the upright position. Pump discharge gauge must be visible to the pump operator for the duration of the hydro test.

q. The following test certificates shall be submitted to the **PURCHASER / CONSULTANT** for review:

3.16.6.24 Material

a) Chemical Composition
b) Mechanical properties such as tensile, flattening, bending, impact etc. as called for in the respective material specification standards.
c) Heat treatment in the case of pipes used for steam service.
d) Dimensions.
e) Hydrostatic Tests.
f) IBR approved Certificates.
g) NDT Reports.
h) Reports on Visual Examination.

3.16.7 Hangers and supports

All equipment covered under this specification shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed.

The **SUPPLIER** shall design, fabricate and furnish erection drawings for all hangers, anchors, guides, clamps, stops and supports, auxiliary structures, etc. required for the proper installation and support of the piping.

It is desirable that supports should as far as practicable, be arranged adjacent to the pipe joint.

Constant load hangers / spring hangers shall be provided wherever necessary for critical piping systems such as main steam piping and boiler feed delivery piping. The variation between hot and cold loads, if variable spring hangers are used, shall not exceed ± 25% of the rated load.

Lugs and additional structural members should be suitably welded to the pipes wherever necessary for hangers and restraints.

All bare pipes on racks and sleepers shall be clamped at intervals of atleast 2 M.

Pipe clamps shall have a minimum thickness of 6 mm.

All rigid hangers shall provide a means for vertical adjustments after erection.

All components of hangers which move relative to the pipe during expansion shall be connected to the pipe clamps or lugs in such a way that these parts are outside insulation.

Vertical pipes near tanks should be supported from pad plates already provided on the tank shell.

All vertical lines shall be properly supported on the vertical run and additionally provided with adequate number of lateral restraints where the length of vertical run exceeds 5 M.

Except for small bore lines, pipes should not be supported from brick walls.

In selecting position and type of hangers, **SUPPLIER** shall endeavor to layout the work such that pipe load stress imposed on the supporting steel are kept to minimum.

3.16.8 Valves

General Technical Requirement

- All valves shall be suitable for the service conditions i.e. flow, temperature and pressure, at which they are required to

operate. Valves performing similar duties and of same size, rating, material and type shall be interchangeable with one another.

- All rising stem valves shall be provided with back seat to permit repacking (of glands) with valves in operation. All valves shall preferably be of outside screw and yoke type.

- Reconditioning of seating surface shall be possible without removing the valve body from the line.

- All valves shall be closed by rotating the hand wheel in the clockwise direction when looking at the face of the hand wheel.

- All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening / closing can be readily determine**d**.

- All valves with pressure seal bonnet shall be provided with bonnet pressure relieving device. The bonnet pressure relieving shall be provided with the pipe connecting the bonnet with the upstream or downstream of the valve with locked open isolation valve, as per the piping requirements. For the valve size NB 80 & below, the bonnet pressure relieving can be by drilling a hole in the seat ring or the disc.

- When globe valves are provided as integral bypass valve, the direction of flow of fluid must be marked on the body of the main valve by stamping or embossing.

- Integral bypass valve shall be supplied in the condition of "As welded" with the main valve. The size of the integral bypass shall be as per MSS-SP-45.

- All globe valves shall be of vertical stem type. The construction of globe valves shall facilitate for easy disassembly of the internals (stem and disc).

- The body, seat shall be inclined at such an angle from the vertical so as to facilitate closing and to prevent chattering for check valves.

- Direction of flow shall be marked on the valve body by stamping or embossing and the tag Nos. for all valves shall be either riveted or punched on the valve body.

- Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion. All valve end connections shall suitably be protected to prevent damage and entry of dirt till erected.

- The valves as well as all accessories shall be designed for easy disassembly and maintenance. Face to face dimensions shall be in accordance to ASME B 16.10 for valve size NB 65 & above.

- All valves under the purview of IBR shall be provided with IBR certificate. SUPPLIER to clearly distinguish the valves under the purview of IBR with suitable identification.

- No asbestos or cadmium based material shall be used.

- All sampling and root valves furnished shall be of integral body bonnet type.

- **For the valve size NB 650 and above & for pressure class rating 150, for the steam application, double offset, metal seated butterfly valve shall be used.**

- **Locked open type valves shall be provided for the following:**

  - **Isolation valve in ARC bypass line to deaerator**
  - **Isolation valve in the soot blowing steam tap off from superheater**

The materials, design and construction of all types of valves shall be subject to the approval of the **PURCHASER**.

Both the continuous blow down valve and the intermittent blowdown valves shall be of angle type and shall be provided with motor actuators. Manually operated angle valves shall be provided as a bypass to the motorised valves.

The detailed Gate, Globe and check Valve specifications are enclosed in Annexure – 3.3.1.

3.16.9 Welding specification for piping system

3.16.9.1 Scope

This specification shall apply to all welded pipe joints of carbon and alloy steels including stainless steels for power plant piping system. This specification is applicable to shop fabrication, site fabrication & field erection. The welded joints are hereby defined as including:

All the line joints of the longitudinal and circumferential butt-welded and socket welded type.

All the attachment of castings, forgings and flanges to pipe.

Welded manifold headers and all other sub-assemblies.

Welded branch connection with or without saddles and reinforcement rings.

Fabrication of built-up fittings.

The attachment of smaller connections for drips, drains, instruments, branch lines, weldolets, sockolets, thermowells, couplings etc.

Closure of joints for inspection plugs and similar joints.

Any other similar joint not specified above but encountered during fabrication and / or erection stage. It is imperative that the CONTRACTOR makes every effort to secure the same high degree of competent supervision and workmanship during field erection as is intended for shop fabrication in view of the adverse field conditions of weather, piping location etc.,

3.16.9.1.1 The piping systems are generally classified as follows:

Alloy steel piping system for temperature above 427º C and all pressures.

Carbon steel piping system for temperature 427º C and below and pressure over 71Kg/sq.cm.
Carbon Steel piping system for temperature over 218º C and less than º427 C and pressure over 17Kg/sq.cm. and upto 71kg/sq.cm.

Carbon steel pipe system for temperature 218º C and less and pressure 17 kg/sq.cm (g) and less.

Stainless steel piping.

Material specifications for the above systems are generally covered by the following.

Alloy steel piping

Ferritic alloy steel pipes to ASTM A335 Gr.P11, ASTM A335 Gr.P12, ASTM A335 Gr.P22, ASTM A335 Gr.P91, ASTM A691 Gr.11, ASTM A691 Gr.12 & ASTM A691 Gr.22 or equivalent and corresponding materials for fittings, flanges, valves etc.

Carbon Steel Piping

Carbon Steel Piping to ASTM A 106 Gr. A, ASTM A 106 Gr.B, ASTM A 106 Gr.C, ASTM A 53 Gr.A, ASTM A 53 Gr.B, API 5L Gr. B, ASTM A 672 Gr. B60 C1-12, ASTM A 672 Gr.B70 Cl-12, IS 3589, IS 1239 or equivalent and corresponding materials for fittings, flanges, valves etc.

Stainless Steel Piping

Stainless Steel Piping to ASTM A 312 TP 304, 316 etc. or equivalent and corresponding materials for fittings, flanges, valves etc.

3.16.9.2 Codes and Standards

The welding of fusion welded piping system shall comply with currently applicable regulations, codes and safety codes in the locality where it will be installed. It shall also conform to the latest applicable standards. Nothing in this specification shall be construed to relieve the **SUPPLIER** of this responsibility. In particular, the pipe welding shall conform to the latest edition of the following codes and standards.

ASME codes for power piping - ASME B 31.1.

Indian Boiler Regulation – IBR

ASME Boiler and Pressure Vessel Codes

Section I – Rules for construction of Power Boilers
Section II Part A – Ferrous material specifications,
Section II Part C – Specifications for welding rods, electrodes & filler metals
Section V – Non destructive examination
Section VIII – Rules for construction of pressure vessels
Section IX – Welding & Brazing qualification

Specification of the American Welding Society.

Standards of Pipe fabrication Institute.

BS 2633 specification for Class I arc welding of ferritic steel pipe work for carrying fluids.

Any other codes and standards which are required to perform the specified welding.

The above mentioned codes and standards form an integral part of this specification. In the event of conflict between this specification and the codes and standards listed above, this specification shall

govern.

3.16.9.3 Welding Processes

The welding process that are used in the fabrication of pipes and fittings are restricted to shielded metal arc welding and gas tungsten arc welding (argon arc) or a combination of the two.

Argon arc root pass shall be employed for all alloy steel, carbon steel piping and stainless steel piping system. Subsequent welding, after root pass can be carried out by manual shielded metal arc welding with coated electrodes. For pipes of wall thickness less than 6 mm, the entire welding shall be carried out by tungsten inert gas welding process. When using tungsten inert gas welding process, welding without addition of filler metal shall not be done.

For critical carbon steel/Alloy steel piping system (Refer Exhibit F-1), the TIG root pass shall be employed and subsequent welding after root pass can be carried out by manual shielded metal arc welding with coated electrodes.

For Non-critical carbon steel piping system (Refer Exhibit F-2), the entire welding including root pass may be carried out by manual metal arc welding.

Where special welding techniques are recommended by equipment manufacturer for piping connecting to equipment, appropriate qualification test and welding technique shall be followed. The specific and detailed instructions of equipment manufacturer regarding welding, preheating, stress relieving etc., shall be strictly adhered to by the SUPPLIER at no extra cost to the PURCHASER.

3.16.9.4 Procedure and Performance Qualification

No production welding shall be undertaken until the procedure qualification test which are to be used have been established as per ASME boiler & pressure vessel code Section IX and / or IBR. The test results and specimens from qualification test of the welding process and welding operators shall be made available to the **PURCHASER** / CONSULTANT for approval. Where results of existing procedure qualification and of welders are acceptable to the **PURCHASER** / CONSULTANT, such results shall be kept on file and be subject as to review regularly. Where doubt exists regarding the acceptability of any qualification test, a retest may be required. All such qualification tests and specimen testing shall be conducted in the presence of the **PURCHASER** / CONSULTANT.

The Cost of all procedure qualification test shall be borne by the SUPPLIER.

The SUPPLIER shall prepare a written specification containing the information detailed in Section IX of ASME form QW-482, 483 & 484A (WPS, PQR & WPQ). These documents shall be provided to the PURCHASER / CONSULTANT for review and approval. The SUPPLIER shall prepare certificate of welder performance qualification test containing the information detailed in ASME Section IX. These shall be kept on file and made available to the PURCHASER / CONSULTANT upon request.

3.16.9.5 Welders and Supervisors

Unless otherwise agreed, the **SUPPLIER** shall advise to **PURCHASER** / CONSULTANT in writing, at least 3 weeks before any welder is employed on the work, the names and qualifications of the proposed welders and welding supervisors. It shall be the **SUPPLIER**'S responsibility to ensure that the welders employed by them or their SUB-**SUPPLIER**, on any part of the contract either at their works or at site are fully qualified as required by the code. Should the **PURCHASER** / CONSUL**TANT req**uire to test or r**etest of** any welder, the SUPPLIER shall make available at no extra cost to the PURCHASER, the men, equipment and materials for the test. The cost of testing the welds shall be borne by the **SUPPLIER**.

Welding supervisors shall have adequate qualifications and experience in **supervis**ing welding of pipe joints with knowledge of non-destructive testing.

All welding including the tacking of all welds shall be carried out by approved welders only. Any weld made by other than the unapproved welder shall be cut out and re-welded.

For the purposes of identification and to enable tracing the full history of each joint, records of weld completed by each welder has to be maintained by the SUPPLIER and records are to be handed over to the PURCHASER / CONSULTANT

For each welder, a record card shall be maintained showing the procedures for which he is qualified. These record cards shall be specified joint details, consumables and their repair frequency. The record shall be reviewed every fortnight by the PURCHASER / CONSULTANT and those welders whose work requires a disproportionate amount of repair shall be disqualified from welding. Re-qualification of welders disqualified more than two times shall be entirely at the discretion of the PURCHASER / CONSULTANT.

3.16.9.6 Preparation of Weld Ends

The surfaces to be welded shall be smooth, uniform and free from fins, tears and other defect which would adversely affect the quality of weld. All weld faces and adjoining surfaces for a distance of at least 150mm from the edge of the welding groove or 12 mm from the toe of fillet in the case of socket weld or fillet welded joints shall be thoroughly cleaned of rust, scale, paint, oil or grease both inside and outside. Both inside and outside of pipe ends shall be prepared for welding by painting with one (1) coat of deoxaluminate or equal for a length of 50 mm on either side of weld.

Unless otherwise specified, all pipe joints shall be butt-welded. All butt welds shall be full penetration welds. Wherever socket welding fittings are used, the connecting pipe will be socket welded.

3.16.9.6.1 Butt Joints

Butt joints shall be prepared as per ASME B 16.25, unless otherwise specified. Groove angle of the single V butt joints shall be 37.5 +/- 2.5 Deg. While meeting alignment of pipe joints as per ASME B 31.1 and / or IBR, care shall be exercised that the trimming depth in case of excess misalignment does not interface with Radiography / Ultrasonic (RT / UT) interpretations. In such cases the trimming width from the tip of the edge preparation along the pipe shall be large enough (1:3 or max. 300) that it is well away from the weld face.

Unless noted otherwise, all butt welds shall be made without using backing rings.

3.16.9.6.2 Tee, corner and lap joints

Fillet welds shall have a throat dimension equal to the nominal thickness of either of the joint members.

Weld edges of full penetration groove welds for Tee joints shall be prepared with minimum included angle of 45 Deg.

The ends shall be prepared by machining, grinding or flame cutting. Where flame cutting is used, the effect on the mechanical and metallurgical properties of the base metal shall be taken into consideration. Flame cutting alloy steel pipes is not allowed. However, flame cutting of carbon steel pipes is permitted. Wherever practicable, flame cutting shall be carried out by machine. Manual flame cutting edges shall be permitted only where machine flame cutting is not practicable and with the approval of the PURCHASER / CONSULTANT and such surfaces shall be ground or dressed to a smooth finish as required by the specification and to the satisfaction of the PURCHASER / CONSULTANT. Slag, scale or oxides shall be removed by grinding to bright metals at least 2 mm beyond the burnt area.

Thermal cutting of carbon steel piping shall be performed under the same conditions of preheat and post heat as for the welding of carbon steel material. However post heat is not required when:

The heat affected zone produced by thermal cutting is removed by mechanical means immediately after cutting. However in any case of removing, slag, scale or oxide shall be removed by grinding to bright metals at least 2 mm beyond the burnt area, or,

Thermal cutting is part of fabrication, manufacturing or erection sequence leading to a weld end preparation where heating immediately follows.

For the piping systems that are supplied by the PURCHASER but being erected by the SUPPLIER, bevelling of pipes for butt welds shall be carried out as indicated on the respective pipe fabrication drawing, where required. For systems with SUPPLIER supplies and erects, the pipe ends shall be bevelled to confirm to applicable codes / standards. At connections to equipment the bevelling of piping shall confirm to the requirement of the equipment connections.

Any change in the joint configuration must be done with the acceptance of **PURCHASER /** CONSULTANT.

All weld joint fit-up shall comply with the tolerances specified on the design drawings or applicable codes and standards.

If the **SUPPLIER** uses the header arrangement with central location of Oxygen and Acetylene for cutting and edge preparation operation, the arrangements shall be in accordance with the best safety practices and standards and shall be approved by the **PURCHASER** / CONSULTANT.

Before fitting up the weld joint, the profile and dimensions of the weld end preparation shall be offered to the **PURCHASER** / CONSULTANT.

All fit-ups shall be offered to the **PURCHASER** / CONSULTANT prior to welding the root pass.

3.16.9.7 Welding of Pipes

All vertical welding shall be carried out in the "UP" direction unless otherwise approved by the **PURCHASER** / CONSULTANT.

The maximum face width of any manual arc or inert gas weld run shall be as per standard as specified in ASME

No single run horizontal / vertical position manual metallic arc weld fillet shall exceed 8 mm in size.

Fillet welds shall have a throat dimension at least equal to the nominal wall thickness specified for the pipe. Each leg of the fillet weld shall have a length of at least 1.25 times in the nominal wall thickness of the pipe. Socket and fillet welds shall have a minimum of two (2) weld layers.

All tack welds shall be made using a qualified procedure and qualified welders. Any preheat requirement specified on the welding procedure shall also apply to tack welds.

All tack welds shall be examined visually for defects, and if found defective shall be completely removed.

As the welding proceeds, tack welds shall be either removed completely or shall be properly prepared by grinding or filling their stopping and starting ends so that they may be satisfactorily incorporated in the final weld.

Welded-on branches for all piping systems shall be of full penetration type connection.

Preheating prior to tack welding and welding shall be employed as a means of crack prevention and improving general weld reliability. At no time during welding, temperature of the joint shall not be allowed to fall below the minimum preheat temperature. Excessive preheating shall be avoided.

Irrespective of class of steel, root run shall be made without interruption other than for changing the electrodes or to allow the welder to reposition himself. Root runs made in the shop may afterwards be allowed to cool by taking suitable precautions to ensure slow cooling e.g. by wrapping in a dry asbestos blanket. Welds made at site shall not be allowed to cool until the thickness of weld metal deposited exceeds 1/3 of the final weld thickness or 10 mm whichever is greater.

When welding alloy steel, it is strongly recommended that interruption of welding shall be avoided. Where such interruption is unavoidable, either the preheat shall be maintained during interruption or the joint shall be wrapped in dry asbestos blankets to ensure slow cooling. Before recommencing welding, preheat shall be applied again.

No welding shall be done if there is impingement of rain, snow, sleet or high wind on the weld area.

Welded on bridge pieces and temporary attachment should preferably be avoided. Where approved by the PURCHASER / CONSULTANT, they may be used material of these shall be compatible with material which they are temporarily welded. All the weld pieces shall be removed after welding of pipe joint and the weld area ground flush and subjected to Magnetic particle / Dye-penetrant examination before applying any post weld heat treatment. These pieces shall be welded by qualified welders and with electrodes compatible with the parent pipe material. The preheating requirements shall be applied and maintained during the welding of pieces. These temporary attachments shall be removed by grinding, chipping or flame gouging. When arc flame gouging is used atleast 3.2 mm of metal shall be left around the pipe surfaces, which shall be removed by grinding.

The arc shall be struck only on those parts of the parent metal where weld metal is to be deposited. When inadvertent arc strikes are made on the base metal surfaces outside the joint groove, the arc strikes shall be removed by grinding and shall be examined by liquid penetration or magnetic particle inspection procedures.

Oxides shall not be permitted to form during welding or heat treatment or both on the internal surface of pipe, which will not be subsequently cleaned. Inert gas purging will be an acceptable method to prevent such oxidation. All joints in material which contain 1¼% or more chromium shall be purged to assure that less than 1% of oxygen is present on the joint under side before initiation of the welding. The purging operation may be terminated when 5mm thickness of weld metal is deposited into the joint. The SUPPLIER may submit examples of other procedures for consideration of the PURCHASER / CONSULTANT.

Argon gas used in GTAW process for shielding and purging gas purity shall be minimum of 99.95 %. Purging shall be carried out at the flow rate depending on diameter of pipe until six (6) times of the volume between dams is displaced. In no case shall the initial purging period be less than ten (10) minutes. After initial purging the flow of the backing gas shall be reduced to a point where only a slight positive pressure prevails. Any dams used in purging shall be fully identified and removed after welding and accounted for in order to avoid leaving them in the system.

Thorough check shall be exercised to maintain the required interpass temperature.

All equipment necessary to carry out the welding for supporting of the work, for the pre-heating and the post-heating including thermal insulation for retaining the heat and for the protection of the welder shall be provided by the SUPPLIER.

After deposition, each layer of the weld metal shall be cleaned with a wire brush to remove all slag, scale and defects to prepare for the proper deposition of the next layer. The material of wire brush shall be compatible with pipe material. Special care shall be taken to secure complete and thorough penetration of the fusion zone into the bottom of the weld. In case, where the weld joint on pipes 100 mm NPS and larger has to be radiographed as per the requirement of this specification, it is recommended that the root run be checked by liquid penetrant or magnetic particle procedures.

Gouging or back-gouging of butt welds may be carried out wherever feasible by grinding, chipping, machining or other approved methods, but the surface of cut must be cleaned to remove any carbon or oxidised metal before commencing the welding.

Repair of weld metal defects shall meet Cl. 127.4.11 of ASME B31.1 and /or IBR.

Upon completion of welding, the joints shall be wrapped in dry asbestos blankets to ensure slow cooling unless post-weld heat treatment is applied immediately.

No welding or welded parts shall be painted, plated, galvanised or heat-treated until inspected and approved by the PURCHASER / CONSULTANT welds shall be prepared / ground in such a way that welds surfaces merge smoothly in to the base metal surface

Except where necessary to grained flush for non destructive examination purpose, the centre of reinforcement for butt welds shall be as below.

Component Thickness (mm)	**Maximum Reinforcement (mm)**
Upto 13	2.0
Over 13 to 25	2.5
Over 25 to 50	3.0
Over 50	4.0

The reinforcement shall be crowned at the centre and tapered on each side of the joined members. The exposed surface of the weld shall be ground where required to present a workman like appearance and shall be free from depressions below the surface of the joined members. The exposed surface of the butt welds shall be free from under cuts greater than 0.5 mm in depth, overlaps from abrupt ridges and valleys and shall merge smoothly into the pipe surface at the weld toe. However, undercuts shall not encroach on the minimum section thickness.

All welds shall be subjected to the approval of the PURCHASER / CONSULTANT.

In the event of several unsuccessful repair attempts or if the PURCHASER / CONSULTANT feels that a satisfactory repair is not feasible, the joint shall be completely remade.

Post weld heat treatment shall be carried out as per Cl. 132 of ASME B 31.1 and / or IBR.

3.16.9.8 Identification of Welds

Whenever code symbol stamps are required on carbon steel and Ferritic alloy steel piping, they shall be applied directly to the pipe with low stress dotted design metal die stamps or to a small stainless steel plate especially provided for such marks. These plates shall be lightly tack welded to the pipe using electrodes (of diameter 2.5 mm or less) of the type specified for the material. Before making the required tack weld, the pipe material in the immediate surrounding area shall be preheated as required by electric means or propane or natural gas burners. Cooling shall take place under asbestos insulation in a draft free area. Stresses relieving of these welds are not required. Steel stamping directly on the surface of alloy steel piping with other than low stress die stamps shall not be permitted.

Seal welds

Seal welding shall be done by qualified welders and in accordance with approved drawings.

If necessary, threaded joints that are to be seal welded shall be made without the use of thread lubricating compound

3.16.9.9 Preheating

Preheating prior to tack welding and welding shall be employed as a means of crack prevention and to improve general weld reliability.

Carbon Steel

Welded joints in carbon steel piping where tensile strength is below 4900 Kg/Sq.Cm, the carbon content does not exceeding 0.3% and design thickness not exceeding 19mm need not be preheated except where the ambient temperature is below 16º C. For this condition the joint shall be heated to ambient before any welding is performed. When the thickness is 19mm and above, shall be preheated before any welding is performed as follows:

WALL THICKNESS (MM)	MINIMUM PREHEAT (º C) METAL TEMPERATURE

19 TO 38	100
38.1 TO 63	125
Above 63	150

Weld joints in carbon steel piping where the tensile strength is 4900 Kg/Sq.Cm, or greater or where the carbon content exceeds 0.3% When the thickness is 19mm and above, shall be preheated before any welding is performed according to the following requirement.

WALL THICKNESS (MM)	MINIMUM PREHEAT (º C) METAL TEMPERATURE
19 TO 38	125
38.1 TO 63	150
Above 63	150

At no time, during welding operation shall the temperature of weld area be allowed to fall below these temperatures. Before performing any tack welding which may be required in preparing carbon steel pipe for welding or other fabrication or before attaching thermocouples, the pipe area to which the tack weld is to be made shall be evenly heated to this temperatures preferably by resistance heating or induction coils. Propane or natural gas torches or preferably burner rings shall be employed where it is impossible to use electric heating. The use of oxy-acetylene gas is prohibited. The metal temperature in this procedure shall be determined by the use of thermocouples and potentiometers except that the temperature sensitive crayons shall be used as a temperature indicator in tack welding thermocouples. However, temperature indicating crayons may be used when approved by **PURCHASER** / CONSULTANT.

Weld joints for piping NB 100 and larger shall be heated by means of induction coils or resistance heating. Welded joints in smaller pipe shall be heated by means of electrical resistance coils or suitable propane or natural gas torches.

Alloy Steel

Weld joints in alloy steel piping shall be preheated before any welding is performed according to the following table.

MATERIAL	**MINIMUM PREHEAT-METAL TEMPERATURE**
1 Cr.0.5 Mo (SA335 P12)	150º C upto 38 mm thickness 200º C for over 38 mm and upto 63 mm thickness 250º C for over 63 mm thickness
1.25 Cr 0.5 Mo (SA335 P11)	150º C upto 38 mm thickness 200º C over 38 mm and upto 63 mm thickness 250º C for over 63 mm

	thickness
2.25 Cr 1 Mo (SA335 P22)	200º C upto 38 mm thickness 220º C over 38 mm and upto 63 mm thickness 250º C for over 63 mm thickness

At no time during the welding operation, shall the temperature of the welding area be allowed to fall below these temperatures. Before performing any tack welding which may be required in preparing alloy pipe for welding or other fabrication or before attaching thermocouple, the pipe area to which the tack weld is to be made shall be uniformly heated to the temperature indicated above preferably by resistance heating or induction coils. Propane gas or natural gas torches or preferably burner rings shall be employed where it is not possible to use electric heating. Heating by Oxy-acetylene gas is prohibited. The metal temperature in this procedure shall be determined by the use of thermocouples and potentiometers except that temperature sensitive crayons shall be used as temperature indicators in tack welding thermocouples.

Weld joints for piping NB 100 and larger shall be heated by means of induction coils or resistance heating. Welded joints in smaller pipe shall be heated by means of electrical resistance coils or suitable propane or natural gas torches.

Austenitic Stainless Steel

Welded joint in Austenitic Stainless Steel Piping need not be preheated except where the ambient temperature is below 0 º C. For this condition, the joint shall be heated to 40 º C by propane, natural gas or electrical means before any welding is performed.

Pre-heat for dissimilar Material

When parts of two different materials are joined together, the material requiring higher pre-heat shall govern.

3.16.9.10 Stress Relieving

Stress relieving of piping material is required when so specified and shall be performed as specified in ASME and / or IBR.

General Requirement

A complete automatic temperature recording shall be made of preheating and stress relieving operations where propane gas burners or electrical resistance coils are employed. A complete temperature record of the preheating and stress relieving operations shall be made by means of box type potentiometer. Other means of

recording the temperatures are permitted subject to **PURCHASER** / CONSULTANT approval.

Stress relieving may be performed locally or fully in furnace. Local stress relief shall be performed with electric induction or electric resistance coils. Suitable gas burning equipment using natural gas or propane may be employed.

At no time during stress relieving / preheating cycle shall any water or liquid cooling medium be employed.

Where members being joined are unequal in thickness the dimension of the heavier section shall govern the selection of width of the heated band and the duration of the holding period.

When local stress relief is performed, the area of the welded joint and the adjacent material extending for a distance of at least three (3) times the width and widest part of the weld on each side of the weld shall be heated by band.

Thermo couple shall be placed at least 2 locations on the weld to 180 each other. One more thermocouple shall be placed in order to measure the half peak temperature during heat treatment. Half peak distance shall be calculated from the formula.

Distance $=2.5 \sqrt{rXt}$
r = Radius of the component.
t = Thickness of the component.

Half peak temperature shall be not less than one half of the specified weld temperature measured at the weld.

For local stress relief using electrical methods the minimum of two (2) thermocouples tack welded to the surface of the potentiometer shall be used on the pipe under at least four (4) layers of asbestos paper. The hot junctions of thermocouples shall be located on either side of the joints at least 12 mm from the edge of the joint but no further away than 100 mm. When employing induction heating, at least six (6) turns of induction cable shall be wrapped on top of the asbestos paper protecting the thermocouples with the first turn approximately of 150 mm from the centre of the weld.

Local stress relief using gas torches or ring burners may be employed. However the procedure shall be limited to pipe below 100 mm nominal bore and must be approved by **PURCHASER** / CONSULTANT.

The stress relieving shall be maintained for a period of time proportioned on the basis of one hour per 25 mm of wall thickness of

the thickest section of the joint. The parts to be heated shall be brought slowly to the required temperature and the heating rate shall not exceed 150 ºC.

For tubing joints and for socket welded joints, pads, bosses and couplings, one (1) thermocouple shall be positioned on the minimum distance of two (2) pipe wall thickness from the weld.

For welds used for attachment of base brackets, two (2) thermocouples shall be used for determination of pre-heating and stress relieving temperatures. They shall be tack welded directly to the header located 180 Deg. apart on the circumference of the header and the mid-way between adjacent legs.

Piping on both sides on any joint shall be adequately supported throughout the preheating, welding and stress relieving operations to prevent distortion.

After PWHT, the hardness of the weld metal and the parent metal shall be jointly measured with the digital hardness tester to verify satisfactory completion of the stress relieving process.

Carbon Steel

Welded joints on carbon steel pipe where the nominal pipe wall thickness of the heaviest material being joined is greater than 19 mm shall be stress relieved upon completion of the welding operation.

When the height of the boss above OD of the pipe is 19 mm or greater the weld shall be stress relieved.

When the wall thickness of the coupling or a pad is greater than 19 mm the weld shall be stress relieved.

When local stress relief is employed, the weld joints shall be heated to a temperature of not less than 600°C. This temperature level shall be maintained within the limits of 610° C +/- 10^0C for a period of time proportioned on the basis of one hour per 25 mm of wall thickness but in no case less than 30 minutes. The weld area shall be allowed to cool and undisturbed in a still air to a temperature not exceeding 300° C.

All welded joints which are locally stress relieved in pipes of 100 mm NB and larger shall be heated by means of electrical induction coils or resistance heating. Welded joints in pipes smaller than 100 mm NB shall be stress relieved by means of electrical resistance coil or suitable propane or natural gas torches only.

When full furnace stress relieving is employed for a welded assembly,

the entire fabricated section shall be heated uniformly and at no time during the subsequent heating cycle, shall the temperature not be allowed to exceed 620° C or fall below 600° C. The furnace shall then be adjusted so that the material will cool at a controlled rate not to exceed 150° C until 300° C is reached. However, in no case the cooling rate shall not exceed 150° C per hour. At that time, the furnace may be shut off, the door opened and the piping material allowed to cool normally to handling temperature.

3.16.9.10.1 Heating and Cooling

The carbon steel after having reached their specific stress relief temperatures may be cooled under wraps (i.e.) leaving the induction coils or resistance heaters and insulation in place. This means that at the stress relief temperature the power to the furnace or heating coils may be shut off and cooling takes place in the furnace or with all insulation and coils remaining on the pipe. The stress relieving coils and insulation shall only be removed after the pipe has cooled below 300º C.

For furnace stress relief, the doors of the furnace may be opened after the power is shut off at 300° C. The thermocouples controlling the temperature shall remain during the cooling cycle so that the excessive cooling, if it occurs, can be observed and immediately corrected. The rate of heating and cooling shall confirm to Cl. 132.5 of ASME B 31.1 and / or IBR. This stress relieving coils and insulation shall be removed only after piping has cooled to below 300° C or if stress relieved in a furnace, the pipe may be removed from the furnace and permitted to cool in still air at a temperature of not below 10° C.

Alloy Steel

All welds in alloy steel piping shall be stress relieved after welding operation in accordance with the details given below:

MATERIAL	STRESS RELIEVING TEMPERATURE °C		REMARKS
	Min.	Max.	
1 Cr 0.5 Mo (SA 335 P12)	620	650	Over 13 mm minimum wall thickness (or) Over 0.15% C max.
1.25 Cr 0.5 Mo (SA 335 P11)	640	660	

2.25 Cr 1 Mo (SA 335 P22)	700	750	Over 13 mm thickness (or) Over 100 mm NB (or) over 0.15% C max.

The welds need not be stress relieved immediately after welding. Immediately after welding, the material shall be wrapped in asbestos and allowed to cool in still air. Full stress relief shall be performed commensurate with alloy after the above slow cooling. The stress relieving procedure shall include the welding joints, and the adjacent material extending for a distance of atleast 3 times the width of the widest part of the weld on each side of the weld. The stress relieving temperatures shall apply for local or furnace stress relieving.

Post weld heat treatment for dissimilar Material

When parts of two different materials are joined by welding, the post weld heat treatment shall be followed the higher PWHT temperatures.

Corrective action:
In case of interruption during heat treatment of the weld joint due to power failure or any other reason the following action to be taken:

- During heating: Whole operation to be repeated from the beginning
- During soaking: Heat treat subsequently for the balance left over period
- During cooling: Re-heat to the required soaking temperature and cool at the specified rate

Heating and Cooling

The low and medium alloy steels, after welding, shall be heated to their specific stress relieving temperature at a rate not to exceed 150º C per hour. The procedure for heating shall employ a suitable furnace, induction coils or electric resistance heaters and shall be controlled by at least two thermocouples.

Local Stress Relief

All welded joints in pipe 100 mm NPS size and larger shall be locally stress relieved by means of electric induction coils or resistance welding. Welded joints in smaller pipe sizes shall be stress relieved by means of electric resistance coils or suitable propane or natural gas torches only.

For full furnace stress relief of a welded assembly, the entire fabricated section shall be heated uniformly to the temperature specified. The temperature shall be maintained for a period of time proportioned on the basis of one hour per 25 mm of wall thickness of the piece having the greatest wall thickness in the furnace charge, but in no case less than one hour.

Austenitic Stainless Steel

Joints in Austenitic stainless steel piping need not be stress relieved after welding.

3.16.9.11 Electrodes

The specification and size of the electrodes, voltages, amperages, thickness of beads and number of passes shall be as specified in the approved welding procedure or otherwise agreed in writing. In general, basic coated electrodes shall be used which shall be deposited with weld metal having the same or higher physical properties and similar chemical composition to the members being joined. For each batch of approved brand, certificate showing compliance with the specification shall be secured and shall be submitted to the **PURCHASER** / CONSULTANT for review before being released for use on project piping. All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. All low hydrogen electrodes shall be baked in mother oven between 300 to 350° C for one hour and stored in holding oven at 80 to 100° C before being used. The recommendation of the electrode manufacturer shall be followed.

For welding of all grades of steel and alloys by the GTAW process, a two (2) percentage thoriated tungsten electrode confirming to AWS / ASME section II part C classification shall be used.

Carbon Steel and Alloy Steel

All electrodes to be used in carbon steel and Alloy Steel shall conform to ASME SEC II PART C or any other equivalent codes.

As welding electrodes deteriorate under adverse conditions of storage leading to dampness in the electrode coating, they should be normally stored in air conditioned rooms or in hot boxes or ovens in their original sealed containers whose temperatures shall be maintained within specified limits. Thermometer shall be used to monitor the room temperature in which the electrodes are stored. The condition of electrodes shall be frequently inspected. The electrodes with damage to coating shall not be used. Electrode shall remain identified until consumed.

The type of electrode used should be only those recommended by the manufacturer for the use in the position in which the welds are to be made. Electrodes which have the areas of flux covering broken away or damaged shall not be used.

All the pressure piping shall have root run carried out using "TIG" process and further run by attested electrodes for various material combination and the selection of electrodes shall be as specified in Exhibit.

3.16.9.12 Inspection and Testing

The **PURCHASER** / CONSULTANT shall have accessibility to inspect the welding area in other related operations at any time and at any stage of fabrication.

The **PURCHASER** / CONSULTANT may require non-destructive testing of any weld for reasons other than those given in the specification. The responsibility for the cost of such testing shall be mutually decided between the PURCHASER and the SUPPLIER.
The **SUPPLIER** shall inform the **PURCHASER** / CONSULTANT when the weld preparation and setting up for welding of various members selected by the **PURCHASER** / CONSULTANT is in progress so that the **PURCHASER** / CONSULTANT can inspect the assembly before welding starts.

The responsibility of **PURCHASER's** / CONSULTANT shall in no way reduce the **SUPPLIER'**s responsibility to ensure that the work is carried out in accordance with the specification.

Examination methods of welds

IBR system - Alloy steel

Edge preparation	DPT 100%
Butt welding	
- for size over NB 50	RT 100%
- for size NB 50 and below	RT 10% minimum 2 joints per welder
Branch Welding	
- for branch size over NB 100	UT 100%
- for branch size NB 100 and below	DPT 100 % or MPT 100%
Fillet, Socket, Attachment and Seal Welds	DPT 100% or MPT 100%

IBR system – Carbon steel - pressure 71 Kg/Sq.Cm(g) and higher, Temperature less than 400 º C.

Edge preparation	DPT 100%
Butt welding	
- for size over NB 50	RT 100%
- for size NB 50 and below	RT 10% minimum 2 joints per welder
Branch Welding	
- for branch size over NB 100 and branch thickness over 19 mm	UT 100%
- for branch size NB 100 and less and branch thickness over 19 mm	DPT 100 % or MPT 100%
- for all branch size with branch thickness 19 mm and less	DPT 10 % or MPT 10%
Fillet, Socket, Attachment and Seal Welds	DPT 10% or MPT 10%

IBR system – Carbon steel – pressure less than 71 kg/Sq.Cm(g) and Temperature less than 400 º C upto 218 º C

Edge preparation	DPT 100%
Butt welding	
- for size over NB 50	RT 100% if Hydraulic test is not done for completed piping
	RT 10% if Hydraulic test is done for completed piping subject to minimum 2 joints per welder
- for size NB 50 and below	RT 5% made by each welder subject to a minimum of 2 joints per welder if Hydraulic test is not done for completed piping
	RT 2% made by each welder subject to a minimum of 2 joints per welder if Hydraulic test is done for completed piping
Branch Welding	
- for branch size over NB 100 and branch thickness over 19 mm	UT 10%
- for branch size NB 100 and less and branch thickness over 19 mm	DPT 10 % or MPT 10%
- for all branch size with branch thickness 19 mm and less	DPT 10 % or MPT 10%
Fillet, Socket, Attachment and Seal Welds	DPT 10% or MPT 10%

IBR system – Carbon steel – pressure less than 17 kg/Sq.Cm(g) and Temperature less than 218 º C

Edge preparation	DPT 10%
Butt welding	
- for size over NB 100	RT 10% made by each welder subject to a minimum of 2 joints per welder
- for size NB 100 and below	RT 5% made by each welder subject to a minimum of 2 joints per welder
Branch Welding	
- for branch size over NB 100	DPT 10 % or MPT 10%
- for branch size NB 100 and less	DPT 5 % or MPT 5%
Fillet, Socket, Attachment and Seal Welds	DPT 10% or MPT 10%

Non - IBR system - For Alloy steel and carbon steel the NDE requirement shall be same as that given in Clause 3.16.9.12.5.1 to 3.16.9.12.5.4 above.

NDE Requirement for austenitic stainless steel piping:

Edge preparation	DPT 10%
Butt welding	RT 2% (subject to minimum two joints per welder)

Legend:

RT : Radiographic Examination
UT : Ultrasonic Examination
DPT : Dye Penetrant Examination
MPT : Magnetic Particle Examination

Note: Prior to commencement, all Non-destructive examination shall be performed in accordance with written procedure to meet ASME / IBR and shall be acceptable to the **PURCHASER** / CONSULTANT.

3.16.9.12.1 Penalty Clause

Penalty, where NDT carried out is less than 100%, shall be as follows:

For every weld found defective an additional penalty joint will be marked for NDT

If the defects of any welder increased above 10%, then for every defective joint two (2) additional penalty joints (one joint on each side of the repair joint) will be marked for NDT.

If the defect of any welder exceeds 20%, then all welding joints shall be subjected to 100% NDT.

Selection shall be shift-wise. The cost of any such penalty works or additional NDT shall be fully born by the SUPPLIER.

In addition, at the discretion of the PURCHASER and the CONSULTANT and where requested by them, the SUPPLIER shall perform radiography and other tests of the joints of any other piping.

Where access holes for radiography have been provided in the piping, the SUPPLIER shall employ the single wall thickness radiography. The access holes shall be plugged and seal welded only after the radiograph is found acceptable and before to carryout stress relieving. If required necessary pre-heating to be carried out for seal welding.

Where no access holes for radiography are provided in the piping, the SUPPLIER shall employ the double wall double image technique with elliptical projection or double wall single image or single wall single image technique.

The SUPPLIER shall ensure that isotopes of sufficient strength and quality are used in order that the radiographs taken are of proper density, contrast and visibility.

Access hole plug welding shall be examined by liquid penetrant or magnetic particle test methods.

3.16.9.13 Qualification and Certification of Non-Destructive Examination Personnel

Organisation performing code required, Non-destructive examination should be personnel competent and knowledgeable to the degree specified by the ASME and IBR.

3.16.9.14 Acceptance and Standards

The acceptance level of faults for visual, magnetic particle, liquid penetration, ultrasonic and radiographic test methods and examination shall conform to the requirement of ASME and IBR.

3.16.9.15 Repair Welding

All defects in welds requiring repair shall be removed by flame or arc gouging, grinding, or machining. The major repairs may involve:

i. Cutting through the weld

ii. Cutting out the length of pipe containing the weld, or

iii. Removing the weld metal down to the root depending upon the magnitude of the defect.

After removing the defect, the welds shall be examined by same non-destructive testing methods as specified for the original weld and the same acceptance criteria shall hold good.

All repair welds shall be made using the same or other specified welding procedures as those used in making the original welds including preheating and stress relieving as originally required.

All repair welds shall meet the requirement of the codes and standards specified and shall be acceptable to the **PURCHASER** / CONSULTANT

3.16.9.16 Welding Sequence for P-91 Material

3.16.9.16.1 Scope
This specification details salient practices to be adopted during welding of P 91 material.

3.16.9.16.2 MATERIAL SPECIFICATION:
SA 335 P 91

3.16.9.16.3 EDGE PREPARATION AND FIT-UP

Cutting of P 91 material shall be done by band saw / hacksaw / Machining / grinding only. Edge preparation shall be done only by machining. In extreme cases, grinding can be done with prior approval. During machining / grinding, care should be taken to avoid excessive pressure to prevent heating up of the pipe edges.

All edge preparation done at site shall be subjected to Liquid penetrant inspection. weld build-up on edge preparation is prohibited.

The weld fit-up shall be carried out properly to ensure proper alignment and root gap. Neither tack welds nor bridge piece shall be used to secure alignment. Use of site manufactured clamps for fit up is acceptable.

3.16.9.16.4 Welding Procedure

Only qualified welding procedures are to be used. Welders qualified as per ASME Sec. IX and IBR on P 91 material shall only be engaged.

Argon gas with requisite quality shall be used for purging the root side of weld. Purging is to be done for root welding (GTAW) followed by filler passes of SMAW in case of butt welds. Purging is not required in the case of nozzle and attachment welds, when they are not full penetration joints. Wherever possible, solid purging gas chambers are to be used which can be removed after welding. If not possible, only water soluble paper is to be used. Ensure that removal of all purging dam arrangement after welding.

Prior to start of pre-heating ensure that surfaces are clean and free from grease, oil and dirt. Pre-heating temperature shall be maintained at 220 deg. C (min.) by using induction heating.

Root welding shall be done using GTAW process (ER 90S B 9) five minutes after the start of argon purging. The SMAW electrodes (E 9018 B 9) used must be dried in drying ovens, as per manufacture recommendation.

Welding shall be carried out with short arc and stringer bead technique only. The inter pass temperature shall not exceed 350 deg. C. After completion of welding bring down the temperature to 80-100 deg. C and hold it at this temp for one hour minimum.

Before taking the Radiography of the joint, the surface of the joint is prepared by means of grinding and buffing.

The PWHT temperature for P 91 to P 91 shall be 760 + / - 10 deg. C and the soaking time shall be 2.5 minutes per mm of weld thickness, subjected to a minimum of Two hours. The rate of heating / cooling shall be as follows:

a. Thickness up to 60 mm – 110 Deg. C / Hr. (Max)
b. Thickness above 60 mm – 55 Deg. C / Hr. (Max)

All equipment like recorder, thermocouple, compensating cable, oven thermostat, etc should be calibrated in NABL approved labs.

All NDE shall be done after PWHT only. The NDE testing details shall as per clause 3.16.9.12.5.

3.17 Safety Valves

The safety valves shall be semi nozzle full lift, and open bonnet type and the selection and sizing of the safety valves shall conform to the

provisions of the IBR for the Boiler safety valves (drum and superheater safety valves). For other safety valves, the safety valve shall be full nozzle full lift and open bonnet type and selection and sizing shall confirm to the provisions of the IBR. In addition to meeting this requirements, the safety valves (drum and superheater safety valves) shall also meet the stipulations of ASME Section I with regard to the blowdown and overpressure requirements. The inlet of the boiler safety valves (on drum and SH header) shall be with butt welding end and all other safety valves shall be with flanged ends.

The body material of the superheater safety valve shall be of Carbon steel. The valves shall be supplied with lifting lever, test gag, cap and spring cover. The capacities of the safety valves provided downstream of pressure reducing stations shall be the maximum flow permissible thro' the control valves under 100 % valve opening with the rated full upstream pressure. The safety valve at the superheaters of the boiler **"shall not be located**" on the superheater headers. The superheater outlet safety valve shall be located at a distance of minimum 8 times the diameter of pipe from the superheater outlet elbow (outlet weld).

For relief valves, Supplier to provide IBR form 3C & attachement 11 to form 3C

3.18 Control Stations

3.18.1 General

All control valves in control stations shall be provided with a bypass valve for manual control. There shall be isolating valves on either side of the control valve as well on either side of the bypass valve. The bypass valve internals shall be identical to the control valve except that it shall be hand operated instead of diaphragm (pneumatic) operated. All manually operated control valves shall be provided with close limit switches. The noise levels at a distance of one meter from the control stations shall be less than 85 dB. All control stations shall be located in easily accessible areas with adequate space around for maintenance.

3.18.2 Feed water control station

Feed control station shall have two nos. 100 % MCR capacity valves. All these valves, the main and the by-pass valves, shall be pneumatically operated control valves with positioners, actuators etc. The feed control valves shall be capable of being operated in auto manual regimes from the control room. There shall be isolating valves on either side of the control valve as well on either side of the bypass valves. The upstream isolation valve provided in the control station (for both main & bypass) will be a motorized gate valve.

3.19 Control Valves and Desuperheaters

All control valves shall be with pneumatic actuator, side mounted hand wheel, SMART positioner, position transmitter, air filter regulator, air lock valve and other accessories. All desuperheaters shall be spring loaded variable orifice type nozzle (without pneumatic actuator), which can provide constant water atomization pressure for all flow conditions. Pneumatic actuated control valve shall be provided for temperature control with pneumatic actuated bypass control valve. Common Y-type strainer with isolation valve on either side of the strainer and bypass valve shall be provided for all the desuperheater in the spray water piping **SUPPLIER** shall indicate the flow through the control valve at 100% lift with maximum upstream pressure and temperature. The control valves shall be selected such that the rated maximum flow shall be achieved at the 85 % lift and minimum flow is achieved at 15% lift. The minimum size of the control valve shall be NB 25. The gland packing and gaskets used in the control valve shall be of non-asbestos type. Also, cadmium or cadmium based material shall not be used. The actuators shall be selected for the shutoff pressure. All control valves accessories shall be mounted on the valve itself and interconnected by stainless steel tubing. All control valves shall be with butt welded ends. Control valve outlet velocity shall be limited to 0.3 mach. Position transmitter to be provided for the control valves where the parameter being modified by the control valve is not indicated in the DCS.

For the PRDS taken from the main steam line, C.S piping shall be provided on the downstream of desuperheater as per the desuperheater vendor recommendation or minimum two (2) meters.

The general inspection and testing including hydraulically test shall be as per ASME B 16.34 and agreed quality plan. The seat leakage class shall be as per API 598. **SUPPLIER** shall conduct performance test for valve opening and closing.

3.20 Boiler Structures

The complete boiler and the auxiliaries structural steel supports including the roof over the boiler and fuel storage bunkers/silos and side cladding from the top to the drum operating floor and to the level of the top of the bunkers/silos, all foundation bolts and base plates for the structurals shall be the responsibility of the **SUPPLIER**. The roof of the boiler shall be provided with monitor roof and the side cladding shall be provided with adequate louvres for the proper ventilation of the covered space. The **PURCHASER's** responsibility ends with the finished floor level (except for the equipment

foundations), and all the foundations required for the columns and supports shall be provided by the **PURCHASER**. The complete structural work above the finished floor shall be of steel and shall be the total responsibility of the **SUPPLIER**. The finished floor level will be (+)300 mm. The firing floor shall be of steel construction.

Complete roof (covering the stair cases) and side cladding upto the steam drum operating floor level shall be provided. The roofing and side cladding shall include the fuel bunkers/silos area also. The side cladding in the silo / bunker shall be upto a level of 1 M from the top of the silo / bunker. The material shall be corrugated Galvalume sheet (Lloyds / Tata Blue scope steel make) of thickness 0.65 mm. Boiler front side cladding shall be brought upto top of coal bunker level.

The required structural columns, frame work for the economizer, air preheater ducting and piping, equipment, stair cases to boiler drum level, soot blower locations, access openings shall be provided with liberally sized stairs and walkways.

All the structural columns, transferring horizontal shear loads to the foundation, shall be provided with adequately designed shear lugs on the bottom side of the base plates. The height of the shear lugs shall be two times the grouting thickness.

In addition, pipe supports, hangers, duct supports etc., shall be provided for the complete systems covered in this specification.

3.20.1 Codes and Standards

The following Indian Codes and Standards shall be generally used for design of structural works. In all cases, the latest revisions with amendments / corrigenda, if any, at the time of execution shall be followed. For work not covered by Indian Standards, other International Standards, as applicable shall be followed.

a. General
IS 875 Code of practice for design loads building and structures.
IS 1893 Criteria for earthquake resistant design of structures

b. Steel Structure
IS 800 Code of practice for use of structural steel in general building construction

IS 806 Code of practice for use of steel tubes in general building construction
BS 4592 Industrial type metal floors, walkways and stair treads

BS 5395 Stairs, ladders and walkways

3.20.2 Design Loads

Design loads shall comply with the requirements of IS: 875 and IS:1893 as a minimum. The following types of loads in addition to Dead Loads (DL) shall be considered in general for the analysis and design of structures and foundations. Wherever any other special type of loading depending upon the type of equipment and operating conditions is likely to be imposed, the same shall also be considered.

3.20.2.1 Live loads

The minimum loading shall be 300 Kg/Sq.m
For operating Platforms, the loading shall be 500 Kg/Sq.m

3.20.2.2 Equipment loads

Equipment causing heavy concentrated loads shall be considered separately. The loading considered for tanks and piping shall include hydraulic test loads.

3.20.2.3 Wind loads

Wind Loading shall be estimated as per the provision of IS:875 (Part 3) - 1987 based on the basic wind speed and other factors as specified in the IS standard. The risk coefficient k1shall be selected from Table 1 of IS 875, suitable for "Important buildings and structures such as hospitals communication buildings / tower, power plant structures".

3.20.2.4 Seismic loads

Seismic loads shall be estimated as per the provision of IS:1893.

Importance factor of 1.5 and Soil foundation factor of 1.0 shall be considered in arriving at the horizontal design seismic coefficient.

3.20.2.5 Thermal loads

Thermal loads as per the operating conditions and support conditions shall be considered.

3.20.2.6 Load combinations

A judicious combination of loads keeping in view of the probability of their acting together, their disposition in relation to other loads and severity of stresses caused by combinations of various loads shall be considered for the design. Wind load and earthquake shall be

assumed not to act simultaneously. The **SUPPLIER** shall spell out the load combinations considered separately.

3.20.3 Design Requirements

3.20.3.1 General requirements

Platforms, walkways, staircases and landings shall be provided for safe operation and maintenance of the boiler and auxiliary equipment and in general conform to an acceptable and proven standard. Arrangement of platforms, walkways and landings shall provide safe access to all openings for inspection and cleaning purposes, permanent and test measuring points, control devices, local instruments, vents and drain valves, soot blowers, safety valves etc. Wherever possible platforms, walkways and staircases shall be supported from unheated structures of boiler or building and shall never be supported from pressure parts or other moving parts of the boiler or other plant. Platforms & walkway panels and stair treads shall be made of structural steel open bar gratings. Cantilever beams are acceptable if the span of the cantilever does not exceed Two and Half (2.5) metres. However, even with the above restriction on the span, depending on the loading, requirement of knee bracing or moment bracket should be ascertained & provided. Necessary calculations shall be furnished during the contract stage.

The boiler supporting structure shall be a braced structure with both vertical and horizontal bracing for the transfer of loads effectively. The vertical bracing shall be arranged form top to bottom and shall be continuous to transfer the horizontal loads to the base of the columns. Horizontal bracing shall be arranged at discrete levels to transfer the horizontal loads due to wind, seismic and thermal loads from the boiler, transmitted through the guides, to the columns.

The analysis of the boiler supporting structures shall be done by modeling the structure as plane frames or space structures. If the plane frame concept is used all the longitudinal and transverse frames shall be analyzed. In either of the cases the column bases shall be considered as fixed at the foundations. All the columns shall be provided with shear keys at the bottom of the base plates to effectively transfer the horizontal forces at the column bases to the foundations. The shear keys shall be arranged in two directions perpendicular to each other, coinciding with the boiler longitudinal and transverse axes. The minimum thickness of the shear keys for the main and auxiliary columns shall be 25 mm and 20 mm respectively.

The guides transferring the loads from the boiler envelope shall be adequately designed and arranged to permit the vertical and horizontal thermal expansion of the boiler. The guides shall be

located at the "0" expansion points, to the extent possible, so that the load transfer both during the cold and hot conditions are effective. The structural members transferring the guide loads shall be checked for the local bending and the axial loads. The columns shall be checked for bi-axial bending and for axial forces. The columns also shall be checked for the local stresses due to the transfer of the loads from the other structural members. The ceiling girders supporting the complete boiler shall be supported on columns through pinned arrangements, to eliminate transfer of large moments.

The minimum thickness of the base plates for the main and auxiliary columns shall be respectively 25 mm and 20 mm. The gussets and stiffeners used at the base of the columns shall be of minimum 16 mm thickness. The foundation bolts for the main and auxiliary columns shall be a minimum diameter of 40 mm (M36) and 32 mm (M27) respectively.

The number of foundation bolts shall be a minimum of four (4) per column.

3.20.3.2 Platforms and Walkways

Size of platforms shall be in such a way that the equipment to be attended shall be approachable from all sides. Minimum width of platforms shall be 750 mm and walkways shall be 500 mm. Minimum headroom above the top of platform or walkway should be 2200 mm. Members supporting floor panel shall not deflect by more than 1/325 of the span.

3.20.3.3 Stairs and Ladders

All stairs shall have a minimum clear width of 750 mm and the slope shall not exceed 45 Deg. with the horizontal. Minimum width of tread of stairs shall be 225 mm and the rise shall not exceed 200 mm. .

Fixed ladders shall be provided to platforms / roofs, which do not require frequent access by the operating personnel. Ladders should preferably of a sloping type with a maximum inclination of 15 Deg. to the vertical. Clear width between strings shall be 450 mm. Minimum thickness of strings shall be 10 mm. Rungs shall be MS rounds of 20 mm diameter, spaced at 225 mm (min) and 275 mm (max). Minimum clear space of 230 mm shall be provided behind each rung to allow foot room. Wherever the height of the stair exceeds 6.0 metres an intermediate platform shall be provided. Safety cages shall be provided wherever the height of ladder exceeds 4.5 metres. The cages may start at a height of 2.5 metres from the lower level. The diameter of the cage shall be 700 mm (min) with 5 Nos. of 50 x 6 flats for vertical and 50 x 6 flat at a spacing of 900 mm (max) for rings.

3.20.3.4 Gratings for Platforms, walkways and stair treads

Gratings shall be of structural steel with a minimum depth of 30 mm and a minimum width of 300 mm and shall conform to BS:4592 Part I.

3.20.3.5 Handrails

Top rail, knee rail and vertical post shall be 32 NB (medium) tube conforming to IS:1239. The spacing of vertical post shall not exceed 1.5 meters. The height of handrail shall be 1.1 meter with knee rail at mid height. At platform and landings toe guard of 100 x 5mm shall be provided.

3.20.3.6 Joint design

Generally all shop connections shall be welded and field connection welded or bolted. All moment connections, if bolted shall be of High strength bolts. Shear and other minor connections, if bolted may be made with mild steel / high strength bearing bolts.

3.20.4 Fabrication and Erection

All structural steel shall be of tested quality and shall conform to IS:2062Gr.A. High tensile steel, when supplied, shall conform to IS:961. All bolts and nuts shall confirm to IS: 1363 and IS:1364 and unless shown or specified otherwise shall be hexagonal. All nuts shall fit tight. Mechanical properties shall confirm to IS:1367. Mild steel and high tensile steel electrodes shall confirm to IS:814.

All workmanship shall be equal to the best practice in modern structural shops. Greatest accuracy shall be observed in the manufacture of every part of the work and all similar parts shall be strictly interchangeable.

Shearing or flame cutting may be used at the **SUPPLIER**'s option provided that the resulting edge shall be reasonably clean and straight. Sheared members shall be free from distortion at sheared edges. Unless clean, square and true to shape, all flame cut edges shall be planed.

The welding and the welded work shall conform to IS:816 unless otherwise specified. The permissible stresses for welding shall be taken as 75 per cent of those specified in IS:816 where welds are not tested either by radiographic or ultrasonic methods. All butt welds in critical structures such as girders, heavy columns, bunkers, etc. shall be tested either by radiographic or ultrasonic methods. As much work as possible shall be welded in shops and the layout and sequence of the operations shall be so arranged as to eliminate distortion and shrinkage stresses to the satisfaction of the Engineer.

The field assembling of the component parts of a structure shall involve the use of method of appliances not likely to produce injury by twisting, ending or otherwise deforming the metal. No member slightly bent or twisted shall be put in place until the defects are corrected and members seriously damaged in handling shall be rejected.

The **SUPPLIER** shall assume full responsibility for the correct setting out of all steel work and erecting it correctly as per alignment and levels shown on the drawings and plumbing of vertical members. Datum points will be fixed by the Engineer. Notwithstanding any assistance rendered to the **SUPPLIER** by the Engineer, if at any time during the progress of the work any error should appear, on being required to do so, the **SUPPLIER** at his own cost shall remove and amend the work to the satisfaction of the Engineer. Trial assembly of bolted construction of girders and beams should have done at shop for critical supporting system.

All field assembly and welding shall be executed in accordance with the requirements for shop fabrication, excepting such as manifestly apply to shop conditions only. Where the steel has been delivered painted, the paint shall be removed before field welding, for a distance of atleast 50 mm on either side of the joints.

Correction of minor misfits, a reasonable amount of reaming and cutting of excess-stock from rivets will be considered a legitimate part of the erection.

Any error in shop work which prevents the proper assembling and fitting up of parts by the moderate use of drift pins or a moderate use of reaming and slight chipping or cutting shall immediately be reported to the Engineer and his approval of the method of correction obtained.

Bolted construction shall be permitted only in the case of field connections, if called for on the drawings. Unless otherwise specified, faces of heads and nuts bearing on steel work shall be machined. All such bolts shall be provided with washers having a hole of 1.6 mm larger in diameter than the barrel of bolt and thickness not less than 6.5 mm so that the nut when tightened, shall not bear on the unthreaded body of the bolt. In all cases, where the full bearing area of the bolt is to be developed, the threaded portion of the bolt should not be within the thickness of the parts bolted together. The threaded portion of each bolt shall project through the nut by atleast one thread. Tapered washers shall be provided for all heads and nuts bearing on beveled surfaces.

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers, shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns and other defects that would prevent solid seating of the parts All high strength friction grip bolts shall be tightened by any of the following methods:

a) Turn - of - nut method.
b) Torque wrench tightening method.

3.20.5 Foundation Grouting

Annexure-3.1 – Minimum Tube Thickness for the Pressure Parts

The thickness of the pressure part tubing shall be calculated for the diameter of the tube under the worst service condition (pressure, temperature, corrosion etc.) the tube is likely to face using the permissible allowable stresses recommended by the applicable codes and standards. However the provided thickness of the tubes shall not be less than that indicated below except .

1. OD 76.1 x 4.06 Thk
2. OD 63.5 x 4.06 Thk
3. OD 50.8 x 4.06 Thk
4. OD 44.5 x 4.06 Thk
5. OD 38.1 x 4.06 Thk

However, Minimum tube thickness for memberane water wall panel tubes, economizer and evaporator tubes shall be 4.06 mm.
Superheater tube thickness shall be 4.06 mm.

Annexure- 3.2 – List of Motorized Valves

- Main steam stop valve
- Main steam stop valve bypass (line bypass of size NB 20) with ON/ OFF type.
- Soot blower steam line main valve (upstream of control station) and drain valve

- The continuous blow down valves shall be of inching type and intermittent Blow down valves with ON/OFF type.
- Startup Vent

Note- The valves present on the water side shall be half stellited.
The valves present on the steam side shall be full stellited.

Annexure- 3.3 – Specification for Electric Actuators for Valves

1 Intent

1.1 This exhibit is intended to cover the selection, design, manufacture and testing of electric motor actuators for valves.

1.2 The valves which are to be provided with electric motor actuators are indicated in Annexure – 3.2 of this volume of the specification.

2 General Design Requirements

2.1 Electric actuators shall essentially consist of electric motors, limit switches, handwheel and gear train, mechanical position indicator, internal wiring, integral starters and terminal block.
Actuators shall be sized so as to open / close the valve at the rated speed against the design differential pressure, at 90% of the nominal voltage.

Operators shall be flange mounted on the valve bonnet. welding of operators onto bonnets is not permitted.

No. of starts / stops per hour shall be 300.

Electrical motors above 30 KW shall have space heater

3 Manual Operation

5.1All actuators shall have mechanically independent manual drive arrangement with handwheel and motor declutching mechanism.
The hand wheel shall disengage automatically during motor operation.

4 Position Indicators

4.1 All actuators shall be provided with mechanical 3 point dial position indicators. Rising Stem Valves shall additionally have visual position indication through plastic Stem Covers.

5 Limit Switches

5.1 Position Limit Switches

5.1.1 Each actuator shall have four (4) rotary drum position limit switches, two (2) for open and two (2) for close position, each with adjustable setting between

fully open and fully close positions. Each rotary drum position limit switch shall have two (2) normally closed (NC) and two (2) normally open (NO) independent contacts. The adjusting mechanism for the limit switches shall be easily accessible.

5.2 Torque Limit Switches

5.2.1 Each actuator shall have two (2) torque limit switches with suitable arrangement to limit the opening / closing thrust. The torque switch, actuated by the torque clutch when the valve is restricted during opening / closing, shall stop the motor thereby protecting the motor from overloading torque. The torque switches shall be set as near as possible to the 'pull out' torque of the motor without damaging the valve or the operator.

5.2.2 Each torque switch shall have two (2) normally open (NO) and two (2) normally close (NC) independent contacts.

5.2.3 The torque limit switch adjusting mechanism shall be easily accessible.

6 Electric Motors

6.1 Electric motors for the actuator shall be 415 V, 3 phase, Class F insulated, solidly earthed, squirrel cage induction motors. All motors shall be of the full voltage reversible type.

6.2 Electric motors for the actuators shall be specially designed for valve operation with high torque; low inertia characteristics. Motors shall be fifteen (15) minutes rated capable of four (4) consecutive starts.

6.3 All motors shall have TEFC enclosures with spaceheaters to maintain the internal temperature above dew point when the motor is idle. Spaceheaters shall be rated for 240 V AC.

6.4 The motors shall be capable of operating its valve against the maximum load on the valve disc with drive bearings in dry and dirty conditions.

6.5 Each motors shall be provided with two (2) direct temperature sensing thermostats to prevent thermal overload.

6.6 All motors shall have 'O' ring seals to provide complete environmental protection when the motor is idle.

7 Specific requirements of Integral Starter and Controller

7.1 The integral starter and controller shall be provided with the following devices / controls:

- Local / remote / off-selector switch
- Open / off / close control switch
- Emergency stop PB
- Mechanically interlocked forward / reverse contactors
- Overload relay
- Control transformer
- Indicating lamps for open / close position and stator off / on indications

- Auxiliary relays for control logic instruments.

7.2 From the DCS, the following command (DOs) shall be made available:

- Local Permissive
* Stop
- Open
- Close

7.3 Following feed back signals (DIs) shall be arranged for DCS:

- Valve closing
- Valve opening
- Valve opened
- Valve closed
- Torque switches operated
- Motor tripped

7.4 Thermostat of actuator and torque switches shall be used in the starter scheme to trip the starter.

ANNEXURE – 3.4 Important points in Tender:-

1. A visit to the plant is to be arranged by bidder for layout and other data.
2. L P Vapour Line from T G Set to Distillery Header shall be considered @150 m
3. Ash Silo of twelve-hour storage capacity with MS structure with SS lining to be provided.
4. Belt conveyor shall be of 4 ply type.
5. De-aeration tank shall be designed for 4.5 Kg/cm^2
6. Boiler Steam Temperature shall be 400 Deg C +/- 5 Deg C
7. System shall be fuesless type , hence use MCCB /MCB
8. DCS system with latest version of ABB make will be preferred
9. Coal bunker of sixteen-hour storage capacity to be considered
10. DM water tank of 75 m3 capacity to be considered.
11. Design Flue gas temp shall be 180 Deg C
12. Supply, erection and commissioning shall be done in 12 months from date of Agreement
13. P B G of 2 years is to be considered.
14. Boiler Operation – Minimum continuous operation days without chocking shall be specified by BIDDER and shall be guaranteed.

4.0 DETAILED SPECIFICATION FOR ELECTRICAL ITEMS

4.1. Motor Control Center / Auxiliary Panel Construction

The MCC shall be single front non draw out compartmentalized, floor mounting, dust & vermin proof, cubicle type suitable for indoor application.

The operating height of feeders shall be 300 mm to 1800 mm.

The MCC shall be fabricated from CRCA sheet of following thickness; Load bearing structure: 2mm
Gland plate: 3mm
Doors / Side covers / Component mounting plates: 1.6mm

The cable entry shall be bottom for which removable gland plate shall be provided. The cable alleys shall be on working front of the MCC & min size shall be 300mm, the vertical bus bar shall be on rear side.

MCC shall be suitable for being extended on both sides. For the transportation as well as for erection purpose I bolt or M.S angle shall be provided on the Top of the MCC.

The maximum height of the MCC shall be 2350mm along with the bottom base frame. The depth of the panel shall be 800/600mm; for incoming feeder 800mm & for O/G feeder 600mm. The length of the MCC shall be based on the quantity of feeders.

The minimum module size shall be 300mm up to 15kW, 450mm for 18.5/22kW, 600mm for 30/37kW DOL, The min module size for S/D shall be 450/600 up to 40kW & above 40kW 900 /1200mm.

Every MCC shall have marshalling compartment.

The MCC shall be suitable for indoor application having degree of protection IP 52.

4.1.1 Painting:

The sheet steel treatment shall be carried out by 7 tank process followed by power coating & final paint shed shall be RAL 7032 Siemens Light Grey. However, the paint shed of the panel can be changed as per the client's requirement at later date.

4.1.2 Bus bars:

The main Bus bar shall be of Aluminum (EC 91 – E grade) & mounted on the top the MCC & supported by Epoxy type insulator at equal interval. The system shall be suitable for 3Ph, 4W, 415V AC, 50Hz, 50kA for 1sec. The panel shall be designed by considering the ambient temperature 40deg C. & final working temperature shall be 85 deg C.

The min size of the vertical bus bar shall be based on the connected load of the vertical panel, R. Y.B color sleeving shall be provided for main & vertical bus bar.

4.1.3 Switchgear component

The switchgear selection shall be as per type - 2 coordination chart for acceleration time of motor up to 5 sec and for more than 5 sec the switchgear selection shall be as per manufacturers recommendation. In case of S/D starter the contactors Star, Delta & main shall be same size.

The Incomer rating of the MCC shall be 1.2 times higher than connected load after deleting the standby load.

The Incomer shall have MCCB's up to 630A rating & above 630A MDO ACB shall be provided with E/F, O/V, U/V and single phase protection. Every Incomer shall have Ammeter + ASS, Voltmeter + VSS, C.T 3 Nos, R. Y. B indication lamp, C.F & Digital type kWH mater.

DOL Feeder:-
DOL up to 30kW shall have MCB with Aux contact, Power contactor, Bimetallic Over load relay, ON, OFF, TRIP Indication lamp, OFF P.B, L/R switch, C.F , N.L, Ammeter direct reading up to 11kW & above 11kW C.T operated Ammeter &1No C.T up to 30kW, & above 30kW3C.T with selector switch shall be provided,

S/D Feeder :-
S/D motor feeder MCB, 3Nos Power contactor of same rating, but 1.2 times of its rated current, Bimetal relay up to 55kW & above 55kW electronic over load relay shall be provided, 3C.T, C.F, N.L, Ammeter with ASS, ON, OFF TRIP indication lamp, OFF P.B, L/R selector switch, S/D Timer.

Capacitor reactor feeder: -
Capacitor reactor feeder with MCB , Power contactor, ON delay Timer, ON, OFF Push button, ON, OFF indication lamp, C.T (1No) Ammeter, C.F, N.L.

Plug socket Feeder: -
MCB, Plug socket, ON indication lamp, C.F N.L.

Every MCC shall have 3 Phase 4 wire system with 1Nos. control Transformer with changeover arrangement.

4.1.4 Spare feeder: -

One number lower size, one no. medium size, one no. higher size feeder with Ammeter, C.T indication Lamp.

4.1.5 Wiring

Control / Power wiring: PVC copper wire shall be utilized for control wiring of 1.5sq. mm in case of C.T wiring it should be 2.5sq mm.
Up to 125A flexible wires shall be used & above 125A Aluminum flats shall be used.

4.2 Motor (VFD Motors)

All electrical motors (for equipment in the scope of supply) shall be supplied. These shall be suitable for operation at 415 V +/- 10%, 3 phase, 50 Hz power supply

Motors shall have insulation of class 'F' but temperature rise shall be limited to class 'B'.

4.3 Cabling System: Power and Control Cables

4.3.1 Design Criteria

The power electric cables shall be suitable for the connected load at unity load factor excluding standby equipments. Suitable derating factor for the cables shall be considered as per the recommendations of cable manufacturers.

All power cables shall be armoured, 1100 V grade, Aluminium conductor, XLPE insulated above 16 mm2 size, PVC insulated upto 16 mm2 size. The minimum cross sectional area for power cable shall be 2.5 mm2.

All control cables shall be armoured, 1100 V grade, copper conductor, PVC insulated. The minimum cross sectional area for control cables shall be 1.5 mm2. All the cables on the ground shall be laid in trenches on proper racks, suitably spaced and clamped to the racks. Civil work of cable trenches including cable racks in cable trenches shall be in client's scope of supply.

All cable terminations shall be through crimping type cable lugs. Cable glands shall be provided at panels. Starters, motors, push button etc Power cable 11KV system shall be with aluminium conductor XLPE insulated, sheathed, armored and overall PVC sheathed.

4.3.2 Structural Steel

The structural steel (MS IS-2062, Gr.A ,Painted) consisting of angles, channels, rods & flats (like channels of 100 / 75 and angles of 50 x 50 x 6) for supporting the cable trays, panels in switchgear room, control room and push button stations to suit site requirements.

The fabricated structure to be properly cleaned and primer applied before painting. Two coatings of painting shall be applied.

4.4 Earthing and Lightning Protection

This lightning protection shall be complete with horizontal / vertical conductors / spikes and installation accessories as per the codes and practices for lightning protection IS:2309.

Copper air terminals of 20 mm dia. lead coated solid rods of sufficient numbers shall be provided on the roof of the boiler and ESP. Detailed calculations and layouts for lightning protection arrangement shall be submitted for **PURCHASER / CONSULTANT**'s approval.

Conductors for lightning protection shall be with GI conductor of minimum 25x6 mm.

Earthing protection shall be as per the codes and practices for lightning protection IS:3043.

The sizes of the earthing conductor and material for various equipment shall be as below:

Conductor Size	Application
8 SWG	Used for Local Push Button stations (LPBS) & cable glands
7/16 GI	Used for motors below 11 kW.
25 x 3 GI Flats	Used for motors from 11 kW to 55 kW
25 x 6 GI Flats	Used for lightning down conductors, motors from 75 kW to 110 kW, light Poles & DBs

Conductor Size	Application
50 x 6 GI Flats	Used for motors above 110 kW, MCC & Control Panel earthling, cable trays, buried conductor and Interconnection

4.5 Local Push Button Stations

4.5.1 Local Push Button Stations shall be housed in die cast aluminum enclosure with IP 65 degree of protection.

4.5.2 These Push button stations shall be provided with key lockable arrangement in STOP / OFF position.

4.5.3 These LPBS shall be mounted on walls / structures and nearer to particular motor feeders.

4.5.4 Each push buttons shall have 2NO + 2NC contact blocks.

4.5.5 Local Push Button Stations (LPBS) shall be used for the following applications:

Description / Types	Application
Start, Stop PBs	DOL, SDOL, S/D, CONV(I), RSB & VFD starters
Open, Close & Stop PBs	LRSB (i.e.) Soot blower feeders
Reverse, Forward & Stop PBs	RDOL, CONV(R)

5. SPECIFICATION FOR INSTRUMENTATION AND CONTROL

5.1 Scope

This specification covers the design, supply, erection, testing and commissioning of the following

- DCS system

As per I/O count list

Two Engineering cum Operating stations with 20" colour moniter,1 TB sata Hard disk, I7 processer,4 GB RAM,DVD,ROM/CD READ WRITE,6 No USB Port,1 No.Serial port,Standard Key Board,Option Mouse,1 Colour Ghraphic Laserjet Printerand one Dot matrix printer,Required furniture,requird Hardware for SOE Recorder

- **Redandancy Level –**

Controller Redandancy,server computer Redandacy,Power supply Redandancy,Communication Redandancy

Software –

Runtime +Devlopment

Runtime software

Project Application Engineering.

- **UPS –**

Parallal Redundacy with Battery backup 1 Hour,Battery pack AA Battery,Lead set,UPS Power supply Distribution board.

- Inter connecting cable between system cabinet above ground earthing, power cable for system cabinet.
- Software links RS 485,Modbus protocolfor Tempreture scanners, TSI moniter, Woodward Governer, Electrical metering etc.

- **Scope of supply –**

The scope of supply for Intigrated Control System shall be include but not limited to the following

Design,system and software engineering ,manufacturing,supply of Hardware and Licened software, Testing, Inspection, factory Acceptance Test (FAT), Site Acceptance Test (SAT)Packing forwarding, Transportation, Errection and Commissioning ,assistance still plant stabilization The field Instrumentation, nessesary panels, Mechanical and Electrical Interlocks,MCCs etc. will be provided by the respective package suppliers.The integration of all the inputs / signals for the continuous monitoring, operation ,data logging, data analysis, alarms, safety interlocks, annucations etc.will be achived through theDCS.

The DCS scope will include the DCS control station,related licensed software and hardware,Insrument and Control cabling the marshaling cabinet reciving signals from junction boxes,all Boiler and Turbine equipment, all MCCs and Software linkswith Turbosupervisary panel,Woodward Governer, electrical metersand Turbine Tempreture scanners.The Scope will also includes all required cable trays,above ground earthing,UPS,Battery,Required Hardware
etc.

The scope also includes Training, Documentation establishing communication between Operating station and DCS and any other item,which is necessery for smooth operation of the system but not specified in the specification.

- Basic Control Design –
- All Boiler parameters monitoring , Controlling through DCS. Genrator,Gear box,Turbine bearing tempreture monitoring,controlling through DCS.
- Critical AI/AO/DI/DO signals will be redundant while Non critical and DAS points will be non redundant.All controllers for critical controls will be redundant.The field inputs for critical inputs will be 1/2 logics.10% of the I/Os to be considerd as critical.
- Sequense of Event recorder will be provided
- Required annucation windows shall be included,first out logic for alarm annunciator for critical alarms to be developed.
- Remote/local selection to be considerd in DCS
- 25% spare I/Os to be considerd.
- For SWAS system ,Oxygen analyzer and level indicator 230VAC power supply to be provided from DCS UPS system.
- All nessesary graphics for all packages will be developed in DCS.
- Square routing for Transmitters to be done in DCS.
- Hart Communicater will be supplied.
- PC should be Dell/HP make.
- All panels should be Rittal/Pyrotech make.
- Trends to be part of DCS.
- Complete DCS system for Boiler and Turbine operation shall be in the scope of Boiler manufactures scope.The cabling from TG set marshaling box to DCS should be Boiler manufacturers scope.

- **Local field instruments Temperature elements (Duplex)**

Sl. No.	Particulars	Qty
1	Feed water temperature after economizer	1
2	Feed water temperature before economizer	1
3	FG at ESP outlet	1
4	FD air after steam coiled air pre heater	1
5	FG after economizer	1
6	Feed water temperature at deaerator outlet	1

7	Steam to deaerator line	1
8	FG after evaporator	1
9	FD discharge line	1
10	Steam, coiled airpreheater inlet temperature (air side)	1
11	Furnace temperature	2
12	FG at ESP inlet	1
13	FG at Primary SH outlet	1
14	Soot blower temperature	1
15	Primary superheater inlet temperature	1
16	Primary superheater outlet temperature	2
17	Feed water temperature at outlet of HP heater	1
18	Main steam temperature at operating floor level	1
Pressure Gauges		
19	Drum level at operating floor	1
20	Drum pressure (at operating floor)	1
21	Main steam pressure (at operating floor)	1
22	Main steam pressure	1
23	Attemperator spray water line pressure	1
24	Boiler feed pump discharge pressure	1 (each)
25	Boiler feed pump suction pressure gauge	1
26	BFP recirculation line pressure	1 (each)
27	Feed water pressure before economizer (at operating floor)	1
28	Feed water pressure before economizer	1
29	Feed water pressure after economizer	1
30	BFP balancing leak off line	1
31	Steam to deaerator pressure	1
32	Blowdown tank pressure	1
33	Soot blower line pressure	1
34	BFP discharge header pressure gauge	1
35	HP dosing pump discharge pressure	1 (each)
36	HP & LP dosing pump discharge pressure	1(each)
37	Instrument air pressure	1
38	Deaerator pressure	1
Draught Transmitters		
39	FD fan discharge	1
40	ID fan inlet	2
41	FD air after steam coiled air heater	1
42	SA fan discharge	1
43	FG after evaporator bank	1
44	FG after air heater	1
45	FG after economizer	1
46	FG after Electrostatic Precipitator	1
47	ID fan discharge	1 (each)
48	Flue gas at SH-I outlet	1
49	Flue gas at SH-II outlet	1
Temperature Gauges		
50	Steam at primary SH outlet	1
51	SA fan discharge air temperature	1

52	FG after APH temperature	1
53	FG after ESP temperature	1
54	FD air after air heater temperature	1
55	Feed water temperature before & after economizer	1
56	Main steam temperature	1
57	Deaerator inlet & outlet temperature	1+1
58	Steam to deaerator line	1
59	Spray water temperature	1
60	Secondary super heater inlet temperature	1
61	FG temperature after economiser	1
62	Steam at Primary Superheater inlet	1
63	Soot blower steam temperature gauge	1
Level gauges		
64	HP dosing tank	1
65	LP dosing tank	1
66	Deaerator tank	1
67	Feed Water Tank	1
Miscellaneous		
68	Traveling Grate Limit Switches	2
69	HP dosing tank low level switch	1
70	LP dosing tank low level switch	1
71	Feed water inlet to economiser isolation valve open and close limit switches	1 (each)
72	Soot blower steam PCV isolation valve open and close limit switch	1
73	Flow nozzle in the steam line to dearator	1
74	Flow transmitter in the steam line to dearator	1

- Compensating cables from thermocouples to junction boxes and from junction boxes to DCS marshalling cabinet will be located in the boiler house.
- Impulse piping wherever necessary for the items which are under scope of supply.
- Field instruments required for DCS based control system.
- PLC based annuciator (Dislplay) on boiler operating floor.

  - Feed water tank level low
  - Deaerator tank level low
  - Deaerator tank level high
  - Drum water level low
  - Superheater steam temp high
  - ID fan trip

- FD fan trip
- Feed water pump trip
- Feed water transfer pump trip

Fields instruments for following loops:

Three element drum level control

Sl. No.	Particulars	Qty
1	Drum level differential pressure transmitter	3
2	Drum pressure transmitter	1
3	Steam flow transmitter	2
4	Feed water flow transmitter	2
5	Flow nozzle for steam flow	1
6	Orifice plate for feed water flow	1
7	Feed water control valve with position transmitter	2
8	I/P converter for feed water control valve	2
9	Drum level bar graph indicator	1
10	BFP discharge header pressure transmitter	1
11	Main steam header pressure transmitter	1
12	Feed water flow Digital Indicator Combustion control	1
13	Main steam pressure transmitter	1
14	FD fan air flow transmitter	1
15	FD air flow element (Aerofoil)	1
16	Oxygen analyzer	1
17	FD fan damper power cylinder	1 each
18	I/P converter for FD fan power cylinder	1 each
19	Suction IGV close limit switch	1 each
20	Main steam Digital Pressure Indicator	1
Furnace draft control		
21	Furnace pressure transmitter	2
22	Furnace pressure very low switch	1
23	Furnace pressure very High switch	1
24	ID fan damper power cylinder	1 each
25	I/P converter for ID fan power cylinder	1 each
26	Suction IDC close limit switch	1 each
Steam Temperature Control		
27	Main steam temp. element (Duplex)	3
28	Attemperator outlet temp. element (Duplex)	1
29	Temperature transmitter	3
30	Main steam digital temperature indicator	1
31	I/P converter for spray water control valve	1
32	Control valve	1
33	Attemperator water flow element	1
34	Attemperator water flow transmitter	1

SA Fan		
35	SA Air flow element (Aero foil)	1
36	SA Air flow transmitter	1
37	SA fan damper power cylinder	1 each
38	I/P converter for power cylinder	1 each
39	Suction IGV close limit switch	1 each
Deaerator level control		
40	Deaerator level transmitter	2
41	I/P converter	1
42	Deaerator level very low switch	1
43	Deaerator level very high switch	1
44	ON/OFF shut off valve with SOV	1
Deaerator pressure control		1
45	Deaerator pressure transmitter	1
46	Deaerator pressure control valve	1
47	I/P converter for PCV	1
	Start:	
48	I/P converter for Start-up vent valve	1
49	Position transmitter for startup vent valve	1
Soot Blower Pressure Control		
50	Steam pressure transmitter	
51	Soot blower control valve	
52	I/P converter	
PRDS Pressure Control		
	Pressure transmitter	2 each
	I/P converter	1
	PRDS Flow Nozzle	1 each

Instrumentation Air

Suitable Capacity compressor (1 W+1 S) for Instrumentation (DCS) With drier shall be in the scope of supplier.

6. DETAILED SPECIFICATION FOR THE ELECTROSTATIC PRECIPITATOR

6.1 Detailed Scope of Supply for ESP

The scope of supplies shall include, but not limited to the following:

6.1.1 The Electrostatic Precipitator complete including all components and accessories stated in this section.

6.1.2 Complete structural steel required for supporting the ESP with all associated beams, cross ties, foot plates, foundation materials (bolts, anchor channels, sleeves, etc).

6.1.3 Required stairways and walkways with handrails for the ESP.

6.1.4 All sliding supports for thermal expansion of casing. If found suitable standard Teflon based Structural Bearings may be used.

6.1.5 Precipitator housing (all walls and roof, with required columns, stiffeners, access door, etc.).

6.1.6 Thermal insulation complete with lagging, wire mesh fixing cleats and outer aluminum cladding.

6.1.7 Inlet and outlet funnel with gas distribution devices, deflector plates, flow splitters and all necessary gas flow control devices.

6.1.8 Ash hoppers complete with required thermostatically controlled heating elements, inspection doors, level monitoring and indicators, outlet flanges, poke holes, manually operated gates, junction boxes for field instruments and heaters etc.,

Each hopper heater and thermostat shall be provided with IP 55 junction box on the hopper itself, so that the termination of the hopper heaters and thermostat can be made in the junction box itself. The heater type shall be of tubular. All interconnection from junction boxes to individual instrument and equipment.

6.1.9 High voltage emitting system with required frame work, support arrangement and support insulators emitting electrodes, etc.

6.1.10 Collecting electrode system complete.

6.1.11 Rapping mechanism complete with structural supporting frame, drives, geared motor and automatic rapping control panels, etc.

6.1.12 Required number of high voltage transformer - rectifier sets, accessories and control cubicle, with automatic voltage control system for the ESP system.

6.1.13 Required sets of insulators, heating system for the support and shaft insulators complete with thermostats.

6.1.14 Junction boxes to supply power for heater units and control supplies, as required. Each insulator heater and thermostat shall be provided with IP 55 junction box on the insulator itself, so that the termination of the insulator heaters and thermostat can be made in the junction box itself.

6.1.15 Electronic controller unit for TR sets, in a cubicle.

6.1.16 High voltage bus duct connection (between the transformer rectifier and high voltage emitting system) including insulator, HV disconnecting switches, for isolating bus section with earthing position.

6.1.17 Complete lifting and handling arrangement for the transformer, rectifier sets. The lifting & handling installation shall be tested, certified and issued with a logbook.

6.1.18 Mechanical interlock system and electrical interlocks for personnel protection.

6.1.19 Complete special / signal / screen cabling arrangements to and from the ESP Control panel located in the central control room located in the TG building and cabling between heaters and JBs. The distance central control room and the first column of ESP shall be around 70M.

6.1.20 Complete cabling arrangements to and from the ESP Control panel located in the central control room located in the TG building.

6.1.21 Provision for water washing system for the precipitator and hoppers along with all piping, valves, nozzles, etc.

6.1.22 External annunciation system for indication of faults in central control room. The ESP panel will also be located in the central control room. This central control room is located in the TG building. There will be no MCC room or control room near the ESP.

6.1.23 All instrument test connections (pressure, temperature, velocity, dust concentration measurement, etc).

6.1.24 Matching flanges along with all bolts, nuts, gaskets etc., required for connecting to matching ducting / components.

6.1.25 Metallic expansion bellows of stainless steel material of 1.6 mm thick, at the inlet and outlet funnels

6.1.26 All ash hoppers shall be with motor operated air lock ash discharge valves, and with manually operated isolation gates upstream of the air lock valves.

6.1.27 Electromagnetic vibrators with control panel shall be provided for the free evacuation of ash from the hopper.

6.1.28 Temperature indications of the inner parts of the hoppers shall be provided at local and also in the control room.

6.1.29 Rapper controller complete with timers and accessories, as a part of TR set control panel or in a separate floor mounted control panel.

6.1.30 The ESP design should incorporate a minimum of four fields and three phase supply.

6.1.31 The ESP shall be sized for all the fuel firing combinations specified in earlier section.

6.2 Equipment and System Description

6.2.1 Design Considerations

The electrostatic Precipitator shall be sized for all the firing combinations indicated in the earlier sections.

- The inlet dust concentration shall be the maximum expected in the fuel firing combinations the boiler is designed for.

- The design gas flow to the ESP shall be the maximum of 110% of the gas flow at MCR capacity calculated as per Section 2 of this specification or the MCR gas flow calculated as per Section 2 of this specification corresponding to a gas temperature of 30 Deg.C higher than the predicted MCR flue gas temperature.

- The moisture percentage (in volume basis) in flue gas shall be the value calculated as per clause indicated in the “Specific Design Requirements”.

- The ESP shall be designed for not less than 10% carbon in fly ash.

- The gas velocity through ESP shall be less than 1.2 M/sec.

- An electrode spacing of 400 mm will be preferred.

  The ESP shall be sized considering the above and the provided specific collecting area (SCA) shall be greater of the area calculated based on the above or 75 m^2/m^3/sec. with an electrode spacing of 400 mm. The SUPPLIER shall design the ESP with minimum 4 fields.

The ESP shall be designed to provide an outlet dust concentration level of LESS than 50 mg/N.Cu.m, at the rated excess air conditions and with the boiler operating with the fuels indicated in the design basis. However, adequate space shall be provided to install an additional field in future, to bring down the dust concentration level to a lower value. The ESP design and the layout of the equipment shall take care of the above requirements. The above dust concentration shall be achieved with the specified excess air levels.

The ESP shall be designed with a minimum of two independent electrical fields with all associated electrical, controls, cables, panels, hoppers etc.

The aspect ratio of the ESP (electrode zone) shall be optimally selected, so as to minimum re-entrainment and carry over of the collected dust and for assured ESP performance.

6.2.2 Flow Model Study

If necessary the **CONTRACTOR** shall perform a three dimensional flow model study of the precipitator in the presence of **EMPLOYER / EMPOYER'S REPRESENTATIVE** to achieve optimum size and layout ducting, good gas distribution, maximum particulate collection, minimum draft loss and minimum re-entrainment. The study shall be conducted to stimulate 90% and 100% of design gas flow. **Flow model study may be waived off, if the CONTRACTOR has already supplied ESPs for similar applications and depending on his experience.**

The **TENDERER** shall submit the detailed procedure carrying out flow model study for the approval of **EMPLOYER**.

6.2.3 Housing

ESP housing shall be gas tight, weather proof, all welded steel envelope suitably stiffened. The housing shall be designed to withstand 250 Deg.C Housing Shall be designed to maximum suction pressure generated by ID fan. Necessary sealing arrangement to prevent moisture and air ingress into the casing shall be provided. Air ingress shall not exceed 1% of design gas flow. The casing shall be provided with required number of gas tight access doors for inspection and maintenance. The casing steel plate shall be of adequate thickness. The precipitator casing and hopper shall form a common structure suitably reinforced to withstand the wind load, specified under the site data, load due to dust in collecting hoppers, etc. A weather proof penthouse, if required, shall be provided over the precipitator for the electrical equipment. The housing shall be supported on suitable roller bearings to allow the movements due to thermal expansion.

6.2.4 Funnels

The inlet to and outlet from the precipitator shall be provided with suitable flanged transition funnel equipped with access doors and shall be completely seal welded on the inlet and outside after assembling. Necessary guide vanes, deflector plates, flow split and any other flow control devices warranted by the results of flow model study shall be provided. The funnels shall be complete with supports, stiffeners, bracings, brackets, expansion bellow etc.

6.2.5 Ash Hoppers

All ash hoppers shall be of pyramidal type, identical size and capacity with flanged outlet connection, to connect it with dry ash removal system to be provided by the **EMPLOYER**.

The size of the RAV at the discharge of all ash hoppers shall not be less than 450NB.

Ash storage capacity shall be minimum 4 hours with the rated conditions specified in this specification. A margin of 10% shall be provided in the hopper capacity over the calculated values.

Specific weight of ash may be taken as 150 Kg/Cu.m for calculating storage capacity and 1100 Kg/Cu.m for structural design.

Individual hoppers per module shall be provided by SUPPLIER.

MOC of Riddling Hopper/Second pass hopper & superheater zone shall be SS409 and all other hoppers shall be of carbon steel.

Hoppers shall be of welded steel plate of 6 mm thickness suitably stiffened.

Each hopper shall be complete with an access door. Access doors shall be fitted with sequential key locks or similar.

Hopper valley angle shall not be less than 60 Deg. for free flow of ash to dust removal system.

Each hoppers shall be provided with adequate number of poke holes with screw caps. Aeration blocks / fluidizing pads to be provided. Adequate number of electromagnetic vibrators shall be provided in each of the hopper to enable the free discharge of the ash from the hoppers.

The internal surface of the hopper shall be free from ridges. The outlet of the hopper shall be provided with a thermostatically controlled hopper heating system of adequate capacity to ensure free flow of dust from the hoppers and close them at present with a suitable leak proof door to be manually operated.

Each hopper shall be provided with suitable dust level monitoring system incorporating all the necessary accessories including level switch, local and remote signaling lamps and high level alarm. A timer shall also be provided for de-energizing the affected electrical section.

6.2.6 Structures, Platforms, Walkways and Stairs

All platforms & stairs shall generally be designed in accordance with applicable BS standards.

The structural design requirements given here under are specific for the ESP and for general applications, requirements indicated under Section 4.3 of this specifications shall be followed.

All supporting steel structures required for precipitator shall be provided in accordance with the design codes, including columns base plates, anchors, anchor bolts, sleeves, inserts, beams, girders, hangers required for installation, inspection / maintenance.

The structure shall be designed taking into consideration total ESP weight, hopper dust load, live and dead loads and applicable wind loads. The design shall also take into account the suitable seismic coefficient.

Adequate platforms, walkways and stairs shall be provided for easy access during operation and maintenance of all parts of precipitator.

Platforms and stairs shall be designed for a live load of not less than 5 kN/Sq.m. Clear head room of not less than 2.2 m shall be maintained over platforms and walkways. Minimum clear width of 855 mm shall be provided for stairs /staircase landings and 1000 mm for platforms.

The access to the precipitator top shall be by means of normal stairs and not by ring ladder. The stairs shall be arranged, with a maximum slope of 45 Deg. to horizontal.

6.2.7 Thermal Insulation

All exposed parts which will operate at temperature above the maximum ambient temperature of 60 Deg.C shall be provided with external thermal insulation and cladding. Insulation shall be mineral wool / ceramic blanket of adequate thickness such that the skin temperature does not exceed 20 Deg.C from the ambient temperature. The insulation shall be kept in place by means of adequate number of pins spot welded to the

6.2.8 Gas Distribution Screens

For uniform gas flow and distribution throughout the ESP cross section area gas distribution screens shall be provided at inlet and outlet section of the ESP. The distribution system shall be designed to minimize local velocity regions and re-entrainment of dust and shall not cause undue resistance to the passage of gases. **The distribution screens shall be of modular design with suitable on line cleaning system.**

6.2.9 Emitting Electrodes

The high tension emitting electrodes shall be made of durable and corrosion resistant material. The material selection shall consider the fact that the flue gas contains traces of both chlorine based corrosive elements and sulphur tri oxides. They shall be accurately centered between the collecting electrodes, duly supported to prevent swinging and shall be properly insulated from the precipitator casing.

The emitting electrode design, geometry, size, arrangement and material shall be of well proven type, considering the duty

conditions for achieving uniform corona effect, reliable operation, performance and long life.

Provisions made to maintain alignment of electrodes during normal operation, including rapping and thermal transients shall be clearly brought out in the offer.

6.2.10 Collecting Electrodes

The collecting electrodes shall be designed on concept of dimensional stability and maintain the collecting efficiency at desired level. The profile of the collecting plates shall be such as to minimize the re-entrainment of the collected dust at the time of rapping.

Each plate shall be shaped in one piece by roll forming and shall be stiff enough to carry the rapping intensity. The swinging tendencies of plates shall be prevented by suitable means. These means shall be clearly brought out in the proposal.

6.2.11 Rapping Systems

Independent rapping system shall be provided for discharge and collecting electrodes with independent control systems. The rapping mechanism shall be of either electric impact type or tumbling hammer type. This shall be adjustable in frequency, intensity and duration to provide an efficient cleaning rate. Separate rapping equipment shall be provided for each field so that each mechanism can be suitably adjusted when required. It shall be so arranged that the rapping frequency can be independently set from the control room (without requiring any opening up of the panel) in accordance with the dust build up, inlet dust loading and changing gas volumes.

Sufficient number of rappers and rapper drives shall be provided so that maximum collection area and discharge electrode lengths are rapped at any instant. In case any special features are added to meet this stipulation, the same should be clearly brought out in the offer.

The rapping system shall be designed for continuous sequential rapping to prevent puffing under any conditions of precipitator operation.

All internal parts of the rapping mechanism shall be accessible for inspection and they shall be placed on wide access passages. Major part of the rapping mechanism shall be located external to

the precipitator. Necessary lubrication system shall be provided for the rapping mechanism.

The gas distribution screen system shall also be provided with rapping systems.

6.2.12 Electrical Equipment

Power Supply

Power supply for the precipitator is needed for the following functions:

i. To produce high voltage DC corona.
ii. To actuate electrical auxiliary components.

The necessary power for the high voltage DC corona is obtained by providing a thyristor controlled rectifier transformer unit.

Transformer - Rectifier Units

The transformer-rectifier unit essentially consists of a high voltage transformer, SCR bridge, high frequency choke all contained in a common tank filled with power transformer oil. Necessary controls and other protective devices are to be incorporated in a control cubicle, which shall be kept in the control room. Automatic constant current regulation and spark rate regulation is to be achieved by controlling the input to the transformer rectifier unit through SCR's connected in anti-parallel fashion. Protection should include the following:

a. Arc suppression unit
b. Under Voltage protection.
c. Protection against excessive temperature rise of oil and internal short circuit on transformer winding.
d. Overload protection.

The control panel should be provided with the following meters:

a. Voltmeters to measure primary and calibrated secondary voltage.
b. Ammeters to measure primary and the precipitator current on the high voltage side.
c. Spark rate.
d. Time totalizer.

For 'ON' and 'OFF' operation the following switches are to be provided in the control panel:

a. Main LT switch for LT supply in the control cubicle.
b. 'START' push button for energizing the rectifier.
c. 'STOP' push button for tripping the supply.
d. Other features as part of interlock scheme.

The transformer rectifier shall be suitably mounted on top of the precipitator inside a weather proof penthouse. Each leg of the transformer rectifier shall not be connected to more than one bus section.

The rectifiers shall be silicon diode type and shall conform to relevant IEC standards. The rectifier units shall be suitably arranged to give satisfactory operation at all loads with arrangement to take any one unit of the system without affecting operation of the precipitator.

Instruction manual shall be furnished for the operation and maintenance of rectifier-transformer unit.

Insulator and Insulator Compartments

In the precipitator, each individual discharge system shall be supported from the required number of high tension insulators which shall be located outside the gas stream. These shall be properly housed in insulator compartments so that it shall remain dry and clean. The high voltage conductors should be enclosed in weather proof ducts with suitable provision to protect the insulator against fouling of flue gas. The insulator compartments shall be equipped with electrical heating by thermostatically controlled heating elements.

7. DETAILED SPECIFICATION FOR INSULATION AND REFRACTORY

7.1 Scope

This specification covers the technical requirements and essential particulars for the supply, application and finishing of the complete thermal insulation and its protective covering for pipes, valves, fittings including bends, equipment, tanks and vessels, ducts & steam generator casing, etc. with working temperatures above 60 Deg.C upto 540 Deg.C. This specification also covers technical requirements for refractory work. Unless otherwise specified the scope of supply of the **SUPPLIER** shall include, but not be limited to the following items:

a. Insulating materials for all types as specified/required.
b. Finishing materials of all types including cement, protective coating, sheeting, as specified / required.
c. Angles, irons, clamps, lugs, etc. for supporting insulation on pipes, ducts, furnace, valves & fittings and equipment.
d. Wire mesh, lacing/binding wires, bands, straps, screws, etc. as required.
e. Weather hoods.
f. Refractory, insulating and red brick works with suitable bonding material.
g. Any other material as may be required for making the refractory and insulation work complete.

7.2 Codes and Standards

The supply and application of thermal insulation to piping systems and equipment covered under this Specification shall comply with all currently applicable regulations and safety codes in the locality where the thermal insulation will be applied. The insulating materials shall also conform to the latest editions of the codes and standards listed below.

Nothing in this specification shall be construed to relieve the **SUPPLIER** of this responsibility.

IS:6 : Moderate heat duty fire clay refractories Group-A

IS:8 : High heat duty fire clay refractories

IS:737 : "Specification for wrought aluminium and aluminium alloys sheet and strip (For General Engineering Purpose)

IS:2042	:	Insulating bricks
IS:3346	:	Method of determination of thermal conductivity of thermal insulation material.
IS:10556	:	Code of practice for storage and handling of insulating materials.
IS:14164	:	Industrial application and finishing of thermal insulating materials at temperatures above 80°C and upto 700 Deg.C

American Society for Testing and Materials

IS:8183	:	"Specification for Bonded Mineral Wool"
IS 3150	:	"Hexagonal wire netting for general purpose".
IS 3144	:	"Methods of test for Mineral Wool Thermal Insulation Material"

7.3 General Design Requirements

The **SUPPLIER** shall furnish all required details of insulating materials and also furnish curves of thermal conductivity plotted against mean temperature. The **SUPPLIER** shall also state maximum permissible hot face temperature which the insulating material can withstand without deterioration and the weight per unit volume of each material offered.

All exposed portions of the plant which operate at temperatures of 60°C and above during normal operation shall be thermally insulated so that the temperature on the outer surface of the cladding shall not exceed by more than 20°C above ambient, based on an ambient temperature indicated in site data.

Unless otherwise specified, the **SUPPLIER** shall calculate the insulation thickness based on the insulating material properties and the requirements of para 8.3.2.

The specified insulation thicknesses shall not include the thicknesses of wire netting, finishing cement or any other finishing or weatherproofing application.

Where insulation thicknesses are specified in Table 8.1, the SUPPLIER shall provide same thicknesses.

In refractory walls suitable expansion gaps shall be provided at regular intervals.

Removable insulation arrangement shall be provided for manholes and hand holes.

Perfect leak tight arrangement of sealing shall be provided for points at furnace roof/ wall where superheater tubes penetrate. Detailed arrangement sketches shall be submitted for the approval of the **PURCHASER / CONSULTANT**.

Insulation shall not fill the contours of the expansion bellows.

Personnel Protection

Piping and equipment that are not insulated but having a surface temperature exceeding 60 Deg.C shall be insulated for personnel protection. All insulation shall be protected by 24 Swg. out covering of Aluminum sheeting.

7.4 Insulation of Equipment and Piping

7.4.1 Material Specifications

Insulating Materials

a. The insulating materials and any component of the finished insulation job shall not react chemically singly or in combination, with water or moisture to form substances which are more actively corrosive to the applied surface than water or moisture alone. The materials shall not offer sustenance to fungus or vermin and must not pose a health hazard. The **SUPPLIER** shall submit with the Bid, details of application of protective coatings or other methods, he proposes to use for corrosion protection of insulated surfaces.

b. Compressed Resin bonded mineral wool mattress insulating material is specified in Table 1, it shall be of the required grade. The application density of insulation for temperature upto and including 400 Deg.C shall be 100 Kg/Cu.m. The application density for temperatures above 400 Deg.C shall be 125 Kg/Cu.m.

Sheeting Material

The sheeting material for all insulated piping and equipment shall be aluminium conforming to codes specified in Table 1. The thickness of aluminium sheeting to be used shall be as follows:

a. Pipes of 450 mm (18 in.) and above, over outside diameter of insulation - 1.219 mm (18 SWG)
b. Pipes of 150 mm (6 in.) and above, over outside diameter of insulation but less than 450 mm (18 in) - 0.914 mm (20 SWG)
c. Pipes less than 150 mm (6 in) over outside diameter of insulation - 0.711 mm (22 SWG)
d. Flues and ducts, not less than 0.914 mm

7.4.2 Piping

All vertical pipes shall be provided with suitable insulation supports to prevent the insulation from collapsing due to its own weight. Any welding required shall be done by the **SUPPLIER** with the prior permission of the **PURCHASER**/Engineer and only under his direct supervision. Where welding is not permitted, suitable clamped supports shall be used by the **SUPPLIER**. The insulation shall be applied starting from bottom to top.

The insulation shall be formed to fit the pipe and applied with edges pulled together tightly at the longitudinal joint and secured by lacing wire. The insulation shall be turned to bring this joint to the lower side. Adjacent length shall be butted closely and laced together with lacing wire. For insulation thickness of more than 75 mm, where application will be in two or more layers, each layer of mattress shall be backed up with wire netting chosen from 20 SWG galvanised steel wire and having hexagonal opening of 25 mm size. If the interface temperature is 400 Deg.C or more, the wire netting shall be from 20 SWG stainless steel wire and having hexagonal opening of 25 mm size.

The ends of all wire loops shall be firmly twisted together with pliers, bent over and carefully pressed into the surface of the insulation.

All insulation shall be protected by an outer covering of aluminium steel sheeting. All insulation sheeting joints shall be sealed and made effectively weather and water-proof. Extreme care shall be taken during the designing and installation of the insulation and the outer sheeting keeping in mind that the boiler will be installed outdoors. All flat surfaces shall be adequately sloped to prevent pools of water collecting. The sheeting shall be protected internally with 2 coats of bitumastic paint. The jackets shall be installed with the longitudinal lap joints at 45 Deg.C below the horizontal for horizontal pipes and the joints sealed with bitumastic paint.

On vertical pipes the jacketing shall be applied working from bottom up. Each section of jacketing shall have a minimum lap of 50 mm longitudinally and circumferentially. Each circumferential

joint shall be made weather-proof by securing with an aluminium/galvanised steel strap and sealing with bitumastic paint. Longitudinal lap joints shall be fixed with zinc plated screws on approximately 150 mm centres.

7.4.3 Valves and Fittings

All valves, fittings and specialities shall be covered with the same type and thickness of insulation as specified for the adjoining pipe, with the special provisions and/or exceptions as listed below.

All valves and flanges shall be completely insulated with removable type of boxes fabricated from aluminium sheets of same thicknesses as used on adjoining pipes. Pipe insulation adjoining flanges shall be beveled back to permit removal of the bolts and nuts. The insulation shall be applied after the finish has been applied over insulation on the adjacent piping.

Flanges on lines covered with the minimum thickness of insulation (lower temperature range) shall not be insulated. Flanges on all other lines shall be covered with provisions for making the insulation removable and replaceable.

Unions shall not be insulated.

Non Metallic Expansion Joints shall not be insulated.

Safety valves, traps and safety valve discharge lines shall not be insulated. However, trap discharge lines shall be insulated for personnel protection.

Nozzles and other connections on tanks, heaters and other equipment shall be insulated in the same manner as the pipes.

Valves shall be insulated upto and including their bonnet flange.

Pipe hanger clamps shall be covered with insulation along with the pipe. When pipe hangers pass through insulation on piping outdoor, a metal hook placed with waterproof sealing material shall be supplied and installed. Care shall be taken to ensure that the upper bolts of hangers clamps are not insulated.

7.4.4 Equipment

Mineral wool blanket insulation to the specified thickness shall be provided. The **SUPPLIER** shall tack weld suitable 9 SWG wire lugs atleast 25 mm longer than the required length to support the insulation in place. These lugs shall be bent and secured with the metal fabric of the blanket, after the insulation has been applied.

Where welding is not permitted, clamps of mild steel flats with bolts, nuts and lugs welded over the flat shall be used. The lugs shall be spaced at approximately 300 mm centres. Spacer rings, at 1000 mm shall be provided for fixing aluminium sheets. All blanket joints shall be butted tightly and the blankets shall be secured with 10 mm wide 25 SWG galvanised bands. After banding, all blanket edges shall be laced tightly.

All equipment shall have a smooth sheet aluminium jacket, applied in a manner similar to that specified for piping. All vertical and horizontal sheets shall be overlapped at a minimum of 50 mm. The longitudinal lapped joints of adjoining sections of sheets shall be secured with zinc plated screws. On all vessels over 2.5 metre diameter, the jacketing shall be further secured by circumferential bands at approximately one more centres. Each sheet joint shall be sealed with bitumastic paint. The roof sections shall overlap the side walls to prevent water seepage between insulation and the vessel wall. Side wall sheets shall be securely banded at inter-sections of the side wall and roof sections.

All equipment and vessel manholes, hatches, bolted or screwed cover plates, flanged ends, etc. shall have removable box type insulation, with same thickness of insulation as for adjacent surfaces. Insulation adjoining such equipment or vessel openings shall be tapered towards these openings to permit removal of bolts, screws, heads, covers or plates with no damage to adjacent surface insulation or cover.

The insulation applied to equipment shall be reinforced with 25 mm (1 inch) 20 SWG galvanised wire netting with hexagonal mesh. One course of wire netting shall be applied to the surface of the equipment, with an additional course per 40 mm of thickness. All irregularities of the surface shall be filled and leveled over with insulating cement. Mineral wool blankets as specified shall be applied over the dry cement surface and secured with annealed wire lacings.

7.5 Refractories

7.5.1 All necessary refractories and setting materials shall be supplied. The refractory bricks supplied shall be of the best quality consistent with temperature obtained at various zones. The refractory and insulation thickness of all sides of the boiler shall be such that the temperature on the surface of the casing would be low enough from the point of view of safety of the operating personnel and also consistent with the permitted heat losses.

7.5.2 On the refractory portion of the boiler walls necessary access doors and observations ports shall be provided. Boiler surfaces which are to be insulated shall have insulation lugs fitted.

7.5.3 Where castable refractories are used special care shall be taken to see before it is applied that its 'shelf life' period is not over.

7.5.4 Necessary anchors for supporting the castable refractory to be provided and the same shall be coated with bitumen paint to allow for differential expansion of anchors and refractory. All parts of tubes and drums to which the castable refractory is applied shall be coated with aluminium or bitumen paint and allowed to dry thoroughly before refractory is applied.

7.6 Guarantees

In addition to the guarantees called for in the **PURCHASER**'s General Conditions of Contract for Supply and Erection, the **SUPPLIER** shall also guarantee that if the specified maximum surface temperatures are exceeded on actual measurement the **SUPPLIER** shall either replace the insulation with a superior material or provide additional insulation thickness at the **PURCHASER**'s/Engineer's discretion and at no extra cost to the **PURCHASER**.

7.7 Miscellaneous

Approval of the **PURCHASER** Engineer shall be obtained for samples of all insulating refractory and sheeting materials and necessary test certificates of approved national laboratories, shall be sent to the **PURCHASER** before despatching these materials to Site. Insulation shall not be applied until specific approval is given by the **PURCHASER / CONSULTANT**.

TABLE 7.1 - RECOMMENDED MINIMUM THICKNESS FOR THERMAL INSULATION (MINERAL WOOL)

NOMINAL DIA IN MM	OPERATING TEMPERATURE (°C)								
	100	150	200	250	300	350	400	450	520
15	25	25	40	40	50	60	75	90	100
20	25	25	40	50	60	60	90	90	115
25	25	25	40	50	60	60	90	100	115
40	25	40	40	50	60	65	90	115	150
50	25	40	40	60	75	75	100	115	150
65	25	40	40	60	75	75	100	115	150
80	40	40	50	60	75	90	100	125	150
100	40	40	50	60	75	90	115	125	150
150	40	50	50	75	75	100	115	150	175
200	40	50	60	75	75	100	125	150	175
250	40	50	60	75	75	115	125	150	175
300	40	60	60	75	80	115	150	175	200
350	50	60	65	75	80	115	150	175	200
400	50	60	75	75	85	115	150	175	200
450	50	60	75	90	90	115	150	175	200
500	50	60	75	90	90	115	150	175	200
550	60	60	75	90	90	115	150	175	200
600	60	65	80	95	95	115	150	175	200
ABOVE 600 and for flat surfaces	60	65	80	95	95	115	150	175	200

Insulation thickness and aluminium cladding for deaerator, deaerated water storage tank, feed water tank, CBD & IBD tank shall be 75 mm thickness and 0.914 mm respectively.

Note: The table is given only as a guideline and the **SUPPLIER** shall select the thickness as per the calculations using IS Standard for conductivity.

8. PAINTING SPECIFICATION

8.1 General

8.1.1 Primer painting (2 coats) prior to dispatch.

8.1.2 The structural parts of the cranes are thoroughly cleaned and are applied with two coats each of red oxide primer & synthetic enamel paint of Yellow Shade before dispatch. Exposed machinery parts such as wheels, bright bars, etc. also coated with rust protective paints.

Internal and External Painting

8.1.3 All tanks/ vessels / pipes shall be cleaned and shall be free from rust, scale, weld spatter and other foreign substances. The surface of the tanks/ vessels / pipes to be painted shall be cleaned by either shot or sand blasting, however around field joints the surface shall be cleaned by wire brush. The finish of the surface shall be as per SA 2 1/2.

8.1.4 The external surface shall be applied with two of primer and two coats of enamel. The internal surface of the unlined vessels shall be applied with two coats of primer and two coats of epoxy. Two coats of primer and one coat of enamel paint on the external surface of the tanks & vessels shall be completed in the fabrication shop of the **BIDDER.** The final coat of enamel paint shall be completed at site.

8.2 Safety precaution

SUPPLIER should ensure necessary safety measures while doing surface preparation, painting & galvanizing. Proper earthing shall be provided for the electrical equipment. Any spillage of volatiles shall be wiped off immediately.

9. PERFORMANCE GUARANTEE

9.1 General

All equipment shall be guaranteed for workmanship and materials and satisfactory performance in accordance with the relevant clauses of Volume-I of this bid document. The guarantee for performance shall cover individual items and systems including the electrical for their ratings/outputs, as required in the specification.

The **SUPPLIER** shall conduct performance/acceptance tests on each of the major items of equipment supplied to demonstrate that the equipment supplied is capable of achieving the performance parameters specified and contracted for, in accordance with the Terms And Conditions of Contract. Instruments, gauges and flow meters installed for the normal operation of the equipment shall be made use of during the acceptance tests as far as practicable. If special instruments are required for conducting the performance tests, it shall be included in the scope by the **SUPPLIER**. However, these special instruments could be taken back after the performance test.

9.2 Performance Tests

9.2.1 The Performance tests shall be conducted for the demonstration of the following guaranteed values. **All guarantee values shall be with "Zero" tolerance.**

9.2.2 Maximum Continuous Rating (MCR) of the boiler while firing the following fuels:

-
- For Slop + Indian Coal/bagasse Firing : 38 TPH
- 100% Indian Coal/bagasse Firing : 38 TPH

Fuel analysis is given in Section 2 of Volume 2 of the contract documents, with feed water temperature of 150 Deg.C and superheater outlet conditions of 46 ata and 400 $\pm$5 Deg.C

9.2.3 Boiler efficiency at MCR for the above condition.

-
For Slop + Indian Coal Firing (GCV 3800 kcal/kg) STI*
* STI-SUPPLIER to Indicate

9.2.4 Auxiliary Power Consumption under MCR for the above condition.

- For Slop + Indian Coal Firing (GCV 3800 kcal/kg) : STI*

9.2.5 Support Fuel required to generate the boiler steam generation with the above steam parameters along with slop (slop quantity and analysis given in Section 2).

- Indian coal firing (GCV 3800 kcal/kg) : STI*
  Imported Coal (GCV 5400 kcal/kg)
  Bagasse with 50% moisture (GCV 2270 kcal/kg)

9.2.6 Steam Purity shall be guaranteed as the following, for all operating loads under any fuel firing condition:

- Solids content Less than or equal to 0.10 ppm
- Silica Less than or equal to 0.02 ppm

9.2.7 Dust concentration in the flue gases leaving the pollution control equipment , for all the fuel combination and all generation capacity shall be 30 mg/N.cu.M

9.3 Other Requirements

The guarantee tests for the boiler and tolerances permissible shall be in accordance with ASME PTC 4.

The **SUPPLIER** shall also furnish as part of his offer correction curves applicable in case the specified operating conditions are different from the operating conditions during the guarantee tests.

10. DRAWINGS AND DOCUMENTS TO BE SUBMITTED

10.1 After Award of the Contract

The drawings and documents to be furnished by the successful **SUPPLIER** after the award of the contract shall include but not limited to the following. A drawing/document submission schedule clearly identifying the documents to be submitted and the purpose of the submission (for information/approval etc.) shall be furnished after discussions and in consultation with the **CONSULTANT** and **PURCHASER**. The same shall be mutually discussed & agreed during the contract stage.

10.1.1 General

- Detailed time schedule in the form of Network or bar chart for the design, manufacture, delivery, erection testing and commissioning period with critical milestone activities and other important intermediate dates for uninterrupted progress of the project.
- Technical Specifications and data sheets for the Boughtout items
- Test certificates & inspection reports
- Boiler operation and maintenance manual including catalogues, bought out items, start up procedures and O&M manuals of boughtout items.
- Quality Assurance Plans.
- Any other drawings and documents as required for statutory approval
- Proposed detailed training program of **PURCHASER's** operating personnel for operation and maintenance of various equipment/systems.

10.1.2 Process and Mechanical

- Technical Specifications and data sheets for the Boughtout items

- Piping and instrument diagrams for Steam & Feed Water System, Air & Flue Gas System , Fuel System, Cooling Water System, Instrument Air system, dosing system etc.
- Complete boiler performance data including predicted performance at various loads, heat transfer areas, pressure drops, temperature profiles, etc.
- Start-up and shut-down curves for the boiler.
- Boiler plant equipment layout plan and elevation.
- Foundation loading data for the boiler and auxiliaries and other equipment and supports.
- Boiler sectional plan and elevation.
- Boiler pressure part arrangement drawings
- Layout of Gas Ducting.
- Layout of Air Ducting
- Furnace Openings & Buckstays
- IBR approved drawings and documents.
- G.A. of fuel firing system inclusive of the feeding, distribution and fuel feed control.
- Chemical dosing system arrangement and piping layout drawings
- G.A of all fans and cross sectional view showing parts and materials for all fans .
- G. A of boiler feed pump and cross section view showing parts, materials and fittings and the characteristic curves.
- Fans & pumps performance test reports.
- Completed data sheets for pumps/motors/fans
- Calculation for determining capacity and head of pumps.
- General Arrangement of ESP and its technical particulars.
- General Arrangement of Soot Blowers and Wall Blowers

- G.A. of Deaerator Assembly
- G.A. of Blow Down Tanks
- Allowable Forces & Moments, Displacements at piping connecting points
- Piping Line list and schedule
- Valve schedule & Data sheets for control valves, safety valves
- Insert plate drawing for pipes & equipment supports
- G.A. drawings of Control valves, Isolation valves, Non-Return valves, Safety Valves, etc.
- Thermal Insulation schedule
- Expansion Bellow data sheets and drawings.
- Isometric Drawings of all piping under the purview of IBR along with support location and Bill of Material.
- Isometric Drawings of all Non-IBR piping of size NB 50 and above along with support location and Bill of Material.
- Orthographic Drawings of all Non-IBR piping of size NB 40 and below along with support location and Bill of Material.
- Welding Procedure Specification (WPS) for all material and all types of welding, that will be employed.
- Technical delivery conditions for all the items that are procured provided contract is given for supply.
- Quality Assurance Plan for fabrication
- Pipe support drawings
- Boiler operation and maintenance manual including cata-logues, bought out items, start up procedures and O&M manuals of bought out items.

10.1.3 Electrical

- Motors
    - Complete motor data
    - Thermal withstand hot & cold curves
    - Speed torque and time curves
    - Motor GA Drawings
- Final AC load list.
- Test certificates for panels, critical components and electric motors.
- Single line diagram of boiler & ESP loads
- Control schematic diagrams for different types of feeders
- Cable schedule for complete power & control cables
- Interconnection chart for control cables
- Cable tray and trench layout for the complete scope
- Earthing layout drawings for the complete equipment in scope
- Requirements of local push button stations
- Bill of materials for power & control cables, local push button stations, earthlings conductors and cable trays to enable the **SUPPLIER** to procure the materials

10.1.4 Control & Instrumentation

- Instrument list, Instrument Schedule, Instrument Summary,
- Technical specification / catalogs for instruments.
- Instrument loop schematic drawing.
- Sizing calculation for flow elements and control valve.

- Dimensional drawings for control valves along with valve characteristics drawings.
- Logic diagram for protection and interlocking system.
- Interconnection diagram between instruments and control panel, JB grouping, cable schedule, loop drawings
- Control scheme and write up.
- Detailed List of Closed loop and open loops I/Os pertaining to the boiler and its auxiliaries including the Annunciation.

GA of local gauge panel and any other panel offered by the **SUPPLIER**

10.1.5 Civil & Structural

- Drawing showing the outline of foundation in plan and Section and loading details, pocket sizes etc.
- Point of action of static and dynamic loads in plan and elevation.
- Layout of Floor Plans
- For foundations subjected to vibrations, in addition to the above, the following shall be furnished.
    - Weight of rotating parts.
    - Unbalanced force to be considered for dynamic design along with its direction and points of application.
    - Max. allowable amplitude of vibrations in the vertical and horizontal direction.

11. LIST OF APPROVED MAKE OF COMPONENTS

MECHANICAL

11.1 ARC

a. SCHROEDAHL-ARAPP GMBH & CO. KG, GERMANY

11.2 BELLOWS

a. LONE STAR
b. MB METALLIC BELLOWS PVT. LTD.
c. SUR INDUSTRIES PRIVATE LTD.
d. PRECISE ENGINEERS (for metallic belows only)
e. FLEXICAN BELLOWS AND HOUSES (for metallic belows only)
f. EAGLEBURGMANN KE PVT LTD (for non metallic belows only)
g. KELD ELLENTOFT PVT LTD (for non metallic belows only)

11.3 BOILER FEED PUMP

a. KSB PUMPS LTD.

11.4 BUTTERFLY VALVES

a. DELVAL FLOW CONTROLS PVT. LTD.
b. SUSHIL ENGG
c. FOURESS ENGINEERING (I) LIMITED
d. INTERVALVE INDIA LTD.
e. STAFFORD CONTROLS
f. WEIR BDK VALVES

11.5 CBD & IBD VALVE

a. BHEL
b. INDITECH VALVES
c. Levcon
d. Hopkinson

11.6 CENTRIFUGAL PUMPS

a. KSB PUMPS
b. KIRLOSKAR BROTHERS LIMITED
c. MATHER PLATT

11.7 CONTROL VALVES

11.7.1 CL.900 & ABOVE

1. MIL CONTROLS LTD.

11.7.2 CL.600 & BELLOW

a. BOMAFA SPECIAL VALVES
b. CIRCOR VALVES
c. DEMBLA VALVES PVT. LTD.
d. EMERSON PROCESS MANAGEMENT
e. FORBES MARSHALL INDIA LTD.,
f. INDITECH VALVE
g. MIL CONTROLS LTD.
h. FLEX PERT BELLOWS, BELGAUM

11.8 DEAERATOR

a. OEM

11.9 DESUPERHEATERS

a. FORBES MARSHALL INDIA LTD.
b. THERMAX

11.10 COUPLINGS

a. EUROFLEX
b. EAGLE POONAWALA
c. FLEXI BOX

11.11 ELECTROSTATIC PRECIPITATORS

a. CLAIR
b. ALSTOM
c. BHEL
d. THERMAX

11.12 GATE, GLOBE & CHECK VALVES (HIGH PRESSURE), CL.900 & ABOVE

a. BHARAT HEAVY ELECTRICALS LTD.
b. KSB PUMPS LTD.
c. LARSEN & TOUBRO
d. WEIR BDK

11.13 GATE, GLOBE & CHECK VALVES (LOW PRESSURE), CL.600 & BELOW / CL.800

a. BHARAT HEAVY ELECTRICALS LTD.
b. HAWA ENGINEERS
c. KSB PUMPS LTD.
d. LARSEN & TOUBRO

e. MICON VALVES (HUBLI)
f. MICROFINISH VALVES
g. OSWAL INDUSTRIES
h. STEEL STRONG VALVES (INDIA) PVT. LTD.
i. WEIR BDK

11.14 GEAR BOXES

a. BONFIGLIOLI, PREMIUM (FOR PLANETARY GEARBOX)
b. ELECON
c. FMG
d. MAG TORQ LTD

11.15 ID, CR, FD AND SA FANS

a. BATLIBOI

11.16 INSULATION (SUPPLY & APPLICATION)

a. KAEFAR PUNJ LLOYDS LTD.
b. LLOYDS INSULATION (INDIA) LTD.
c. MINWOOL ROCK FIBRES LTD.
d. RAJA INSULATIONS & REFRACTORIES LTD.
e. MURUGAPPA
f. GOENKA ROCKWOOL

11.17 REFRACTORY :

a. SK GUPTA
b. CASTWEL IND
c. SHARDAA CERAMIC
d. CALDERYS REF.

11.18 LP, HP DOSING SYSTEM, EXCLUDING PUMPS

a. ENPRO INDUSTRIES (P) LTD.
b. GRUNDFOS PUMPS INDIA PVT. LTD.
c. HEIDELBERG PROMINENT FLUID CONTROLS (P) LTD.
d. MILTON ROY INDIA (P) LTD.
e. PSI ENGINEERING SYSTEMS (P) LTD.
f. METAPOW
g. RAVI INDUSTRIES
h. METACHEM

11.19 LP & HP DOSING PUMPS

a. MILTON ROY INDIA (P) LTD.

11.20 MECHANICAL SEALS

a. BURGMANN
b. JOHN CRANE

11.21 RELIEF & SAFETY VALVES

a. TYCO SANMAR (FOR ALL PRESSURE)

11.22 SILENCERS

a. THERMAX

11.23 SOOT BLOWERS

a. RR TECHNO (Only for LRSB&RSB))

11.24 SPRING HANGERS

11.24.1 VARIABLE LOAD SPRING HANGERS

a. BERGEN PIPE SUPPORTS (INDIA) PVT. LTD.
b. LISEGA
c. PIPE HANGERS & SUPPORTS (P) LIMITED
d. SPRING SUPPORTS, HOWRAH

11.24.2 CONSTANT LOAD SPRING HANGERS

a. BERGEN PIPE SUPPORTS (INDIA) PVT. LTD.
b. LISEGA
c. PIPE HANGERS & SUPPORTS (P) LIMITED

11.25 STEAM TRAPS

a. ARMSTRONG INTERNATIONAL
b. PENNANT ENGINEERING PVT. LTD.
c. UNIKLINGER LTD.
d. VELAN VALVES LTD.

11.26 STRAINERS

a. ABHIRAMI ENGINEERING
b. PERFECT SERVICES (MADRAS)
c. PROCEDYNE ENGINEERS
d. SUNGOV ENGINEERING PVT. LTD.
e. TRIVENI
f. GUJARAT OTOFILT
g. RIFOX

11.27 VALVE ACTUATORS (ELECTRICALLY OPERATED)

a. AUMA INDIA LTD.

ELECTRICAL

11.28 ACB, MCCB, MPCB & CONTACTOR

a. L&T

11.29 INSTRUMENT TRANSFORMER

a. NEWTEK
b. PRAGATI

11.30 CAST ALUMINIUM JUNCTION BOX

a. MATADOR
b. SCG
c. SHRENIK & COMPANY
d. VAISHNO

11.31 MASTER TRIP RELAY

a. ALSTOM T&D
b. ABB
c. SCHINDER

11.32 MCB DISTRIBUTION BOARDS, MCB AND ELCB

a. L&T
b. SIEMENS

11.33 MICROPROCESSOR BASED MOTOR OVERLOAD RELAY

a. L & T
b. SIEMENS

11.34 MOTOR PROTECTION RELAYS (NUMERIC / MICROPROCESSOR BASED)

a. L&T
b. SIEMENS

11.35 MCB DISTRIBUTION BOARDS, MCB AND ELCB

a. L&T
b. SIEMENS

11.36 LT XLPE CABLE

a. CCI
b. KEI

c. POLYCAB

11.37 LT PVC CABLE

a. CCI
b. POLYCAB
c. KEI

11.38 MOTOR CONTROL CENTER *

a. VEE VEE CONTROLS
b. IDEA ENGINEERS

*** Type** test certificates for temperature rise and short circuit having carried out within the last three years shall be submitted, in case, any alternate make is selected by the vendor.

11.39 LT MOTOR

a. ABB
b. SIEMENS
c. CGL

11.40 CABLE TRAY

a. ARUN
b. INDIANA
c. OBO BETTERMAN
d. PATNI
e. PEARL
f. PENTAX FERRO
g. PREMIER
h. RUKMANI
i. SILVERLINE
j. UCIC
k. VISHWA

11.40 A. C. VFD DRIVES

a. ABB
b. Yaskwa

11.41 LOCAL PUSH BUTTON STATION

a. TECHNIC
b. L & T
c. SIEMENS
d. SCHINDER
e. B C H
f. VAISHNO

INSTRUMENTATION

11.42 AIR FILTER REGULATOR

a. PLACKA INSTRUMENTS AND CONTROLS
b. SHAVO NORGREN (INDIA) PVT. LTD.,
c. NORQREN

11.43 DIFFERENTIAL PRESSURE TRANSMITTER

a. YIL
b. ABB
c. EMERSON
d. Rosemount

11.44 ELECTRONIC BAR GRAPH INDICATOR

a. MASSIBUS
b. YOKOGAWA

11.45 FLOW ELEMENTS (NOZZLE / ORIFICE /VENTURI)

a. DELTA ENGINEERING
b. STAR MECH CONTROLS

11.46 JUMBO DISPLAY INDICATING METERS

a. ACCSYS ELECTRONICS
b. MASIBUS

11.47 INSTRUMENT CABLES

a. CORDS CABLE
b. DELTON
c. ICON CABLES LTD
d. THERMOCABLES
e. TCL CABLES
f. GENERAL INSTRUMENTS
g. SBEE CABLES
h. ELKAY TELELINKS

11.48 LEVEL GAUGES

a. PUNE TECHTROL PVT. LTD.
b. CHEMTROLS ENGINEERS PVT. LTD.
c. SBEM.
d. NIVO CONTROLS
e. GIC
f. LEVCON
g. HI TECH (For Drum level gauges)

11.49 LEVEL SWITCHES

a. CHEMTROL
b. LEVCON
c. V-AUTOMAT
d. PUNE TECHTROL
e. SB ELECTROMECANICAL & WIKA

11.50 OXYGEN ANALYSERS

a. YOKOGAWA

11.51 POWER CYLINDERS

a. R.K. CONTROLS
b. ROTEX

11.52 PRESSURE GAUGES

a. WAAREE
b. GENERAL INSTRUMENT CONSORTIUM

11.53 PRESSURE SWITCHES

a. WAREE
b. GENERAL INSTRUMENT CONSORTIUM
c. SWITZER

11.54 PRESSURE TRANSMITTERS

a. YIL
b. ABB
c. EMERSON

11.55 RTD AND THERMO COUPLES

a. ELEIND ENGINEERING PVT.LTD
b. GENERAL INSTRUMENT CONSORTIUM
c. WAAREE INSTRUMENTS
d. PYRO ELECTRIC
e. DETRIV INSTRUMENTS
f. TEMPSEN INSTRUMENT

11.56 SOLENOID VALVES

a. ASCO
b. ROTEX
c. SMC PNEUMATICS
d. IMI NORGREN HERION

11.57 TEMPERATURE GAUGES

a. H.GURU INSTRUMENTS (SOUTH INDIA)
b. WAAREE INSTRUMENTS
c. PYRO ELECTRIC INSTRUMENTS
d. WAREE

11.58 DRAFT GAUGES

a. SWITZER

11.59 TEMPERATURE SWITCHES

a. WAREE
b. DANFOSS
c. GENERAL INSTRUMENT CONSORTIUM
d. SANMUR

11.60 HART COMMUNICATOR

a. EMERSON

11.61 DCS

a. ABB
b. YAKOGAWA
c. ALLEN BRADLEY