

**NLC INDIA LIMITED
NLC TALABIRA THERMAL
POWER PROJECT- 3x800 MW
JHARSUGUDA, ODISHA**

SPECIFICATION NO : 18A03-SPC-G-001

**SINGLE PACKAGES ENGINEERING, PROCUREMENT
AND CONSTRUCTION**

VOLUME: II-B

**TECHNICAL SPECIFICATIONS
FOR
STEAM GENERATOR AND AUXILIARIES**



**DEVELOPMENT CONSULTANTS PRIVATE LIMITED
CONSULTING ENGINEERS
BLOCK DG-4, SECTOR-II, SALT LAKE CITY
KOLKATA- 700 091, INDIA**

**JOB NO. : 18A03
DATED : NOVEMBER, 2020**



EPC Bidding Document

NLC India Limited
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Power Project- 3x800 MW
Jharsuguda, Odisha

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OVERALL CONTENTS

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**Vol. II-B
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VOLUME: II-B

**TECHNICAL SPECIFICATIONS
FOR
STEAM GENERATOR AND AUXILIARIES**



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**Vol. II-B
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VOLUME: II-B

SECTION-I

STEAM GENERATOR AND ACCESSORIES



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**Vol. II-B/Section-I
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VOLUME: II-B

SECTION-I

STEAM GENERATOR AND ACCESSORIES

1.00.00 GENERAL INFORMATION

Three (3) nos. once through supercritical Steam Generating Units from inlet of feed water check valve at economizer end up to HP turbine stop valves, complete with all the accessories shall be covered under this section of specification.

Each Steam Generator shall supply superheated steam to corresponding one number of 800 MW Steam Turbine. The steam generating units will be once through supercritical type, single (Tower type) or double pass as per Bidder's proven practice, using either spiral wound plain (inclined) or vertical rifled type water wall tubing in furnace evaporator portion minimum upto the combustion zone (Bidder shall provide the type of furnace wall for which he is qualified), semi-outdoor type, radiant furnace, single reheat, dry bottom, balanced draft and suitable for firing pulverized coal as main fuel.

2.00.00 CODES AND STANDARDS

- 2.01.01 In addition to the requirement spelt out in various Sections of Volume-II, including all requirements of the Indian Boiler Regulation/Act (1950 edition, with amendments up to the date of construction) and any other statutory regulations in force, the equipment to be provided under this section shall specifically conform to the latest editions of the following codes, standards, specifications and regulations.
- 2.01.02 The steel structure shall be designed for earthquake conditions as per IS-1893 (Zone as indicated in Volume-II-G/1) and to with stand wind loads as specified in IS-875.
- 2.01.03 Codes/Standards for integral piping and valve shall be ANSI B 16.34 and ANSI B 16.25 (valves), ANSI B 31.1 (for piping), ANSI B 31.3 (For Ammonia piping) and ANSI B 16.5 (flanges), ASTM-A-335/ASTM-A-106 (HP Piping), SA 210/SA 213 (High Pressure / temperature tubing). Wherever definite design stipulations are not available in the IBR, the ASME Boiler & Pressure Vessel Code Section - I shall be referred.
- 2.02.00 If the equipment supplied does not conform to the above codes and standards, but is manufactured in conformity to the standard and codes of Bidder's own country and such standard developed as a result of his experience, such equipment shall be clearly identified. The Bidder shall also present sufficient data to the Owner to support his design. The Bidder shall be responsible for proving that the standards offered by the Bidder meets the specification requirements. Only if the Owner is satisfied that sufficient experience exists with the design proposed, the design shall be accepted by Owner/Consultant.

2.03.00 In addition to the requirements of the above paragraphs, all equipment and procedures shall comply with all applicable laws, regulations and requirements of the state in which the project is located.

3.00.00 SCOPE OF SUPPLY

Each Steam Generating Unit shall include but not be limited, to the following:

3.01.00 Complete steam / water cooled furnace, water wall headers, steam generating tubes, risers, furnace bottom hoppers, drains, observation ports, inspection doors/manholes, sample connections, metal temperature measurement (MTM) thermocouples drain funnels, drain pipelines up to and including blow-down tank and necessary stubs for chemical cleaning and wet lay up. Two (2) numbers of retractable type temperature probes with duplex type elements at the furnace outlet, complete with all accessories like guiding supports, cooling arrangement, motor with position indicator etc.

3.02.00 Steam-water separators along with a drain collection vessel at the evaporator outlet. The separators / drain collector shall be of welded construction, along with safety valves, mountings, fittings, nozzles, instrumentation tappings, valves, drain etc.

3.03.00 Start-up recirculation and drain system (as applicable) comprising:

- a) 1x100% start-up boiler recirculation pump (BCP) - Gland less zero leakage type with overhung impeller, complete with submerged wet type motor and cooling water lines, connecting pipe work between separator / drain collection vessel and the pump. BCP shall be designed for maximum possible recirculation & drain flow under all possible normal, abnormal, upset and accidental conditions, with adequate margin as per proven design reference.
- b) Inlet feed water pipeline along with necessary separator / drain collection vessel level control valves.
- c) Double isolation (one motorised and one manual) valve at the suction, Motorised isolation, Electrohydraulic operated control valve and a non return valve on the discharge of the pump. Alternatively, Electrohydraulic operated control valve and a motor operated stop cum check valve is also acceptable, Pump minimum flow control valve and recirculation flow control valve (as required based on Bidder's proven practice).
- d) Mixing box (as required based on Bidder's proven practice) at pump suction, a non-return valve and motorized isolation valve upstream of the Mixing box on the recirculation line from separator, along with necessary piping and valves and piping between the mixing box and the feed water supply line with NRV on this line. Other proven standard systems with startup drain circulation pumps are also acceptable provided Bidder must have proven experience on

satisfactory performance of such system in supercritical units of similar capacity which are designed for variable pressure operation. In case Bidder offers startup circulation without mixing box, the Bidder shall furnish necessary data / information in support of provenness of system offered.

- e) Piping with necessary valves from separator / drain collection vessel to flash tank / flash tank's drain tank and drain piping from flash tank/ blow down tank to the condenser. For transportation of drain from flash tank drain tank to condenser, 2x100% condensate transfer pumps are to be provided. Drain system shall be sized to operate the unit during clean up, light up & low load for maximum possible drain with/without BCP in service and drain to condenser.
- f) Emergency drain piping from Flash tank up to drain sump pit and to be cooled by service water system by the Bidder. Emergency drain system shall be sized to operate the unit during clean up, light up for maximum possible drain with/without BCP in service and drain to ETP.
- g) All level controls, electro-hydraulically operated fast acting valve with safety features, their isolating valves, bypass/ non-return, drain valves etc. for the start-up circuit.
- h) Separator safety valves with drain pans.
- i) Vent pipe from atmospheric flash tank terminated above boiler roof level.

- 3.04.00 Complete superheater (SH) system including headers, connecting pipes, vents, drains, drain funnels, pipelines up to blow down tank, nitrogen connections for preservation, sampling connections, start-up lines, spring loaded type and pressure assisted type safety valves with drain pans etc.
- 3.05.00 Complete reheater (RH) system including headers, connecting pipes, vents, drains, drain funnels, pipelines up to blow down tank, nitrogen connections for preservation, sampling connections, start-up lines, spring loaded type and pressure assisted type safety valves with drain pans etc.
- 3.06.00 Start-up drain and vent regulating valves and isolating valves shall be provided with motor drives. All start-up vents, lowest set pressure spring-loaded safety valves and all Pressure Assisted Safety Relief valves at superheater and reheater outlets and lowest set pressure spring loaded safety valves on the water separators shall be provided with silencers. Safety valves exhaust pipes shall be routed to a level above boiler house roof.
- 3.07.00 Superheater and reheater desuperheating spray systems complete in all respects. The requirements indicated below for each leg of each stage of desuperheating spray system is for superheater spray system. Similar system shall be provided for reheater spray system also.

Each desuperheating spray system shall essentially consist of the following:

- i) Two (2) numbers pneumatically actuated spray control valves each rated for full duty.(Main and bypass of similar type)
- ii) One (1) number motor operated isolating valve upstream of each spray control valve.
- iii) One (1) number manual isolating valve downstream of each spray control valve.
- iv) Drain lines with individual isolating valves.
- v) Fast acting Pneumatically / Motor operated block valve at upstream of each spray control station in the common attemperation line (meeting the requirements of ASME TDP – 1 (2006).
- vi) Non-return valve in the common attemperation line near each water spray injection point.
- vii) Welded type attemperation water flow nozzle along with all accessories shall be provided on each spray water line upstream of the control station for flow measurements / controls.

3.08.00 Non steaming type in-line bare tube Economiser with connecting pipes, headers, recirculation piping (as required), drain pipes up to blow down tank, vents and sampling connections etc. with non-return valve and motor operated valves.

3.09.00 Two (2) regenerative Tri-sector type air pre-heaters (APHs) common for primary air and secondary air system. Each APH shall be complete with:

- i) One (1) x 100% peripheral AC VFD drive or One (1) x 100% central AC VFD drive, as per OEM's proven practice, connected to drive Air Heater along with Gear box and automatic clutching/declutching arrangement.
- ii) One (1) independent Air Motor drive along with automatic clutching / declutching arrangement.
- iii) Air receiver tank of storage capacity not less than 10 minute operation requirement of air motors (compressed air for driving air motor shall be drawn from service air system).
- iv) Piping and fittings, air filters, regulators including suitable solenoid valves for automatically admitting air for starting air motors in case of power failure, pressure transmitters on air line to air motor(s) etc.
- v) Air heater standstill sensing device with necessary logic components, accessories. The motion to be precluded up at appropriate location of the rotor shaft.

- vi) Permanent fire fighting equipment on both gas as well as air sides and also on both cold as well as hot end sides including, spray nozzles, valves and pipe work connected to fire water system.
- vii) Thermocouple type fire sensing device complete with accessories.
- viii) Dust hoppers with bracing, stiffeners, supporting structure, baffles, access door, mating flanges, expansion joints, level switches etc. and suitable approach platform for each hopper.
- ix) Oil carry over probe for detection of oil during oil firing for each RAPH.
- x) On load high pressure water-washing system with 2 x 100% HP pumps for each boiler along with water supply pipework with drainage piping and transfer system to effluent treatment system.
- xi) Common Off load water washing facilities (including pumps ,hoppers, water connections, drain pits, sump pumps etc.) with drainage connected to nearest station drain shall be provided.
- xii) Adequate number of thermocouples or platinum resistance temperature detectors (RTD) for measuring cold and hot end bearing metal temperature.
- xiii) Temperature elements on the bearings for interlock purpose.
- xiv) Forced lubrication system shall be provided for bearings and shall include 2x100% capacity oil pumps with motor, 2x100% oil coolers, 2x100% oil filters, one (1) oil tank etc. with necessary local temperature, pressure, flow gauges and transmitters.
- xv) On load cleaning system of RAPH element by steam soot blowing at cold and hot end with necessary isolation, automatic pressure control, temperature control remote operated valves, local pressure gauges, temperature gauges and transmitters.
- xvi) Any other equipment / accessories / instrument etc., to make the system complete for reliable and safe operation.

3.10.00 Two (2) Steam Coil Air Pre-Heaters (SCAPH) for secondary air one at each FD fan outlet bypass ducts (SCAPH for Two numbers for PA ,if required as proven practice of the bidder) with necessary dampers, drain pipe to blow down tank and necessary piping, valves, fittings, remote operated temperature control valve, motor operated isolating valve, steam piping, steam traps etc.

3.11.00 Boiler integral piping, valves and associated fittings, feed check valves, motorized isolating, motorized steam stop valves, motorized bypass valves, motorized start-up vent valves, Electromatic relief valves, spring loaded safety valves, safety valve escape piping & start up vent line with silencers extended above the roof of Boiler House Building, drip trays (together with

pipings and drain oil tank for oil system), shock absorbers etc.; complete steam and water sampling lines with sample coolers & collectors, cooling water distribution lines, chemical cleaning line, blowdown lines, vents, tanks, all necessary stub connections with isolating valves for chemical cleaning and lay up of Steam Generators including nitrogen capping connections, nitrogen piping system for capping of separator, superheater and reheater with pressure reducing and relief valves and all other accessories and fittings including nitrogen cylinders and manifold.

The Nitrogen gas shall be used for blanketing/ wet & dry preservation/ purging as applicable for Steam generators & Auxiliaries including Ammonia storage and handling system requirements. Nitrogen supply system shall be complete with nitrogen cylinders, manifold, rack, pressure reducing and relief valves, piping & valve, flexible hose, pressure gauge, required alarm etc covering all three boiler & its auxiliaries including ammonia storage and handling system. Bidder shall supply adequate number of completely filled Nitrogen cylinders including the quantity provided in manifold as per maximum anticipated requirement of One Steam generator's dry preservation requirement or as required for ammonia storage and handling system during start up/commissioning of one storage tank and its upstream/ downstream system, whichever is higher. Cylinders other than which are provided in manifold shall have proper storage arrangement with rack in boiler maintenance building. The water holding capacity of each N₂ Cylinder shall be 46.7 litres. Max. Gas Filling pressure at 15°C shall be 140 kg/cm² (g). Material of Cylinders shall be manganese steel.

- 3.12.00 Steam Generator refractory and insulating materials along with required fixing material for the equipment ducting etc. are included in the scope of this specification. This shall also include the cladding, lagging, reinforcement, wire mesh, cleats and supports for all the equipment except coal pulverizer, auxiliaries, ducting, dampers, coal piping (if applicable), piping and valves so as to ensure skin temperature of not more than 60 deg. C with ambient temperature of 45 deg. C and Steam Generator at 100% BMCR.
- 3.13.00 Boiler outer casing shall be of corrugated Aluminum sheets of 1.63 mm (16 SWG). Aluminium sheet casing / insulation jacket for equipment including hot air and flue gas ducts etc. shall be provided wherever necessary as per system requirement.
- 3.14.00 Complete air and gas duct work under draft plant with necessary expansion joints with protection against ash erosion, insulation wherever required, isolating, regulating dampers with operating gears, linkages and actuator assemblies with all accessories and duct supporting steel structures up to chimney.

All fly ash hoppers for economiser, air heater, ESP and the duct hoppers at SCR inlet. Stainless steel dip plates and shield plates with refractory shall be provided for bottom ash hopper.

- 3.15.00 Boiler roof mountings including access / inspection doors. Adequate numbers of access doors for boiler, furnace, air heater, economiser, fans and ducts. Penthouse with ventilation fans for the Boiler roof. Necessary access shall also be provided in the furnace for taking in the power operated maintenance platform (sky climbers and Quick erecting scaffolding), which shall be provided by the Bidder under this specification.
- 3.16.00 Bottom ash Hoppers below furnace
- 3.17.00 Complete soot blower system with drains, entire piping and fittings including control valves, MCC, control panel, local push button stations for soot blower motors, cabling & grounding, automatic steam pressure controlled system together with all actuators and accessories.
- 3.18.00 All drain lines including trap discharge outlet shall be supplied with drain funnels or drain receivers as applicable and the pipelines from the funnel discharge up to the nearest plant drainage system, as approved by the Owner / Consultant.
- 3.19.00 Suitable numbers and type of thermocouples with all accessories at the furnace outlet for furnace exit gas temperature measurement in-line with the requirements mentioned in Vol: II-E.
- 3.20.00 All supporting steel work for steam generator and its accessories and auxiliaries, foundation bolts and anchor plates etc, for all equipment supplied.
- 3.21.00 Gallery, Walkway, Platforms etc.

Galleries, walkways, platforms, hand rails, ladders etc. around the boiler, stair case on either side of boiler, auxiliary steel for piping support, "U" bolts and hangers for separators, super heaters, reheaters, furnace rear pass tubes and grating including the interconnecting platforms between the steam generator operating floors and main powerhouse buildings. Bunker Building shall be interconnected (1.5m clear width platform) with the respective steam generator at two elevations on either side of the steam generators (preferably at tripper floor level and feeder floor level) and in each level, floors shall be interconnected to boiler in front as well as in rear sides and two nos. (One on left and one on right side) for front or rear mill arrangement. Two (2) nos. of interconnecting walkways (minimum 2.0m clear width) between TG building and boiler (on both side of boiler) at four elevations (minimum) preferably at ground, mezzanine, Operating and PRDS / De-aerator floor level shall be provided by Bidder for side mill/rear mill arrangement.. In case of front mill arrangement the mill bunker building shall be interconnected with 2.0m clear width platform with TG building at two levels (with one level necessarily connected with TG Hall operating floor and other interconnection level shall be decided during detailed engineering). The interconnection shall be on both sides of boiler center line for each elevation.

Necessary access platforms, walkways, handrails, ladders and gratings for proper approach to the damper drives and other equipment which may require maintenance, operations, or inspection shall be provided.

Rigging points shall be provided for any removable equipment over 50 kg to allow safe maintenance.

- 3.22.00 Boiler roof arrangement of proven design & architecture shall be provided. The boiler main roof arrangement shall be provided with monitor for ventilation and light. The overlap between the monitor and the main roof should be such that it prevents ingress of rain to the steam generator casing/penthouse. The boiler roof shall be extended downwards all around the boiler to a level of atleast 2 meters below the penthouse casing roof. Suitable ventilation provision shall be provided in these side walls. All necessary sealing collars/wall boxes shall be provided where the pipes pass through the boiler roof or its extended side walls. Suitable rain/drain collector/piping shall be routed to plant drain system.

Roof sheeting and side cladding shall be permanently colour coated galvalume high tensile troughed zinc-aluminium alloy coated steel sheet having 0.8 mm TCT (min), Minimum 550 MPa yield strength corresponding to G550 grade as per AS 1397, Coating – Aluminium Zinc Alloy @ 180 gm/m² as per AS 1397, painting on internal & external surface shall be minimum 20 micron (Nominal) DFT for paint over 5 micron (Nominal) primer coat confirming to class 3 as per IS 14246, guard film of 40 Micron polyethylene. Painting colour code shall be decided during detail engineering by Owner/Consultant. Profile of the steel sheet shall be of depth 34.5 mm at 333 mm pitch. Sheeting material shall withstand extreme climatic and operating conditions.

The sheeting shall be supplied and installed with all matching accessories, fittings etc. to make the complete covering, with necessary ventilating louvers, rain water drainage etc.

- 3.23.00 Four (4) Nos. of trolley mounted pent house cooling fans (2 Nos. on each side of pent house) for pent house cooling.

- 3.24.00 Complete buck stays and tie bars.

- 3.25.00 Raw Coal Bunkers, Raw Coal Chutes and Bunker Shut off Valves

- i) Coal Bunker Capacity shall be minimum 10 hrs. requirement of the unit under BMCR condition with worst coal firing or at BMCR condition with design coal firing or at TMCR condition with design coal firing, whichever is maximum. For all above conditions, storage capacity of 10 hours shall be calculated based on number of operating mill/bunker as specified in Annexure-1 sl.no 5.10 c) of this volume.
- ii) Manually operated rod type isolating gate at bunker outlet, Motor operated (sliding gate type) Raw Coal Bunker shut off gate at the bunker mouth and manually operated gate at RC feeder inlet (All shall be for each coal feeder).
- iii) Chain wheel & chain for manual operation of bunker shut off and RC feeder inlet valve from the feeder floor.

- iv) Coal chute between bunker shut-off gate and RC feeder inlet.
- v) Coal chute between outlet of feeder and inlet of mill along with motor/pneumatic operated shut off gate at RC feeder outlet.

The chutes shall be made of minimum 12 mm thick Stainless steel of grade 410 material and shall be of fully welded construction. The chute between feeder outlet and pulverizer inlet shall have a Stainless steel lined hopper with suitable reinforcement. The provision shall be made for the insertion of poke rods in two directions right angle to each other at outlet of the bunker and inlet of the feeders.

- vi) Permanent facility of bunker emptying chute to enable unloading of bunkers on trucks at ground level. An arrangement with a temporary chute fitted on the bunker downspout along with a permanent chute from the feeder floor to the ground level shall also be acceptable. For this purpose, two (2 nos.) temporary chute shall be provided for each steam generator.

Necessary lifting/handling arrangement & suitable platform/approach shall be provided for quick installation and removal of the temporary chutes for each Bunker.

- vii) Suitable couplings (Dresser or equivalent) with 410 stainless steel liner ring one on each chute between RC feeder and mill and one on each chute between coal bunker and RC feeder.
- viii) Devices to detect choking/flow/no flow of coal in the coal chute between coal bunker and RC feeder to ensure minimum seal height at inlet to feeder and trip the feeder if the level of coal tends to be below the seal height.
- ix) Remote operated shut off gate between RC feeder and coal mill.
- x) A local access platform for maintenance/operation of bunker shut-off valves.

3.26.00 Weigh belt type Gravimetric microprocessor (with VFD control) based raw coal feeders having zipping facility, each one complete with motor, coupling, coupling guards, base plate, foundation bolts, sliding joints, paddle type switches to detect presence or absence of coal on feeder or choking of feeder, speed variator, auto declutching arrangement to high/low level, speed sensors, coal motion monitors, strain gauge type weight measuring system etc. with all instrumentation..

3.27.00 Minimum eight (8) nos. vertical spindle type medium speed coal pulverisers for each steam generator, each pulveriser complete with wear parts, grinding elements, dynamic classifier with Variable Frequency Drive, lubrication systems (comprising of 2x100% pumps, 2x100% coolers and 2x100% filters for each pulverizer), Hydraulic System (if applicable) comprising of 2x100% pumps, 2x100% coolers and 2x100% filters for each pulveriser, drive motors,

auxiliary gear, system instrument tapping points, proven fire detection and fire extinguishing system, platforms around the pulverizer and any other equipment necessary for safe and efficient operation of pulverizer.

- 3.28.00 Pulverized fuel piping from mills to burners including power operated shut off gate before each coal burner and a power operated flap/ knife gate type mill discharge valve at each classifier outlet on each pulverized fuel pipe and all necessary couplings and supports etc. with coal sampling device.
- 3.29.00 Pulverized fuel burners and wind box along with all required linkages and drive mechanisms.
- 3.30.00 Two (2) nos. axial type Primary Air (PA) fans with blade pitch control mechanism, drive motors, all necessary accessories including bearing lubrication system, couplings, coupling guard, base plates, foundation bolts, inlet box, inlet bird and trash screen, inlet rain water canopy, inlet cone, diffuser, silencer etc. and connecting ducts to mills.
- 3.31.00 Two (2) nos. Seal air fans, common for all the pulverisers of one Steam Generating unit, along with drive motors & self-cleaning filters connected piping to mills, base plates, foundation bolts, coupling, coupling guards, control dampers, suction filter, silencer, bird-screen and rain protection hood etc. The seal air fans shall take suction from either cold primary air header or the Bidder may take suction from atmosphere also.
- 3.32.00 Main fuel oil shut off valves with actuators and accessories as required for operation. The valves shall be 100% shut off type and of reputed make.
- 3.33.00 Lighting up and combustion stabilizing fuel oil (LDO/HSD) burners with high energy arc ignitor assembly, diffusers, tips extension pipes, atomizers, burner shut off valves, flexible hoses and all other ancillaries. LDO/HSD burners shall be designed to support flame stabilization upto 30% of BMCR Load with LDO/HSD alone.
- 3.34.00 Entire LDO/HSD unloading cum transfer system upto storage tanks, LDO/HSD storage system and onward fuel oil pressuring system upto boiler burner fonts, common for all the steam generators. LDO/HSD unloading cum transfer pumps and LDO/HSD pressuring pumps to be installed in common fuel oil unloading cum pressuring pump house. For further details, please refer Section-III of this volume.
- 3.35.00 Flame scanners with accessories and scanner cooling air system including scanner air fans & drives and starter panel.
- 3.36.00 Low NOx type Coal Burners with burner tilt mechanism, tilting drives, linkages and complete actuator assemblies, burner tilt position transmitters etc. Overfire air nozzles will be provided as per the proven and established practice of bidder, as per their estimation on its application for the range of fuel specified.

- 3.37.00 Two (2) nos. constant speed axial type Forced Draught (FD) fans with Variable Blade Pitch Control mechanism, base plates, foundation bolts & nuts, inlet bird and trash screen, suitable arrangement to prevent rain water entry to fan motor, coupling and coupling guard, acoustic silencer, drive motors and other accessories with foundation system as per Volume-II-G/1 of this specification.
- 3.38.00 Two (2) nos. Combined Induced Draught (CID) fans (to take care of FGD system resistance as well) of axial type with variable blade pitch control, drive motors, base plates, foundation bolts and nuts, inlet box, discharge case, coupling and coupling guards and suitable arrangement to prevent rain water entry to fan motor, and other accessories with foundation system as per Volume-II-G/1 of this specification.
- Alternatively, Bidder can provide separate Booster fans (for FGD system) along with ID fans as per their standard & proven practice.
- 3.39.00 Lube oil equipment assemblies as below: (Where applicable)
- a) One assembly for each CID/ ID/ Booster Fan.
 - b) One assembly for each FD Fan.
 - c) One assembly for each PA Fan.
 - d) One assembly for each Pulverizer.
 - e) One assembly for each regenerative air heater.
- Each assembly consists of tank, 2x100% pumps with motors, 2x100% coolers, 2x100% filters, valves and piping.
- Necessary local gauges, pressure & level transmitters and temperature elements for interlock purpose shall be provided.
- 3.40.00 Runway beams, lifting tackles and necessary hoists for maintenance of PA fans, FD fans, CID/ID/Booster fans, Mills, Seal air fans, BCP, SCR, for Air heater maintenance and for pressure parts coils.
- 3.41.00 One no. separator overflow Flash tank along with flash tank drain tank for each Steam Generator. 2 x 100% condensate transfer pumps to be provided for transferring the flash tank drain to condenser flash tank or also proven back-up system of Bidder which can cater the needs of start-up and low load circulation during non-availability of BCP. Additionally, one number of unit flash tank within power house of each unit to be provided, with all necessary drains, spray lines, overflow lines and vent pipes up to boiler roof along with drip tray, pipes, valves & fittings as required.
- 3.42.00 Sample cooler with entire stainless steel piping from sampling point up to and including a collecting rack positioned at operating floor shall be supplied for the following minimum services:

- a) Water and Steam Sampling at steam-water Separator.
 - b) Main Steam Sampling.
 - c) Feed water at inlet to Economiser Sampling.
 - d) Condensate Sampling.
 - e) HRH sampling.
- 3.43.00 Electrostatic precipitators with all controls and accessories as detailed in Section-II of This volume.
- 3.44.00 De-NOx system with all controls and accessories as detailed in Section-V of this volume.
- 3.45.00 Complete critical piping network comprising main steam (MS), cold reheat (CRH), hot reheat (HRH), feed water piping , SH & RH attemperation piping, HPLP bypass piping. All start up drain lines from Main steam lines and HRH lines as well as drain from CRH drain pot shall be routed upto inlet drain manifold of atmospheric flash tanks.
- 3.46.00 Steam Generator auxiliary steam system including steam pressure reducing and de-superheating station, spray control station. HT & LT auxiliary steam header and downstream distribution piping up to equipment are covered under Volume-II-D1, Section-I of this section.
- 3.47.00 Passivated Demineralized closed cycle cooling water supply & return piping along with necessary valves, drains, vents etc. for cooling purpose of all heat exchangers under steam generator package with necessary Auxiliary cooling water system and plate type heat exchangers. For further details, refer Volume II-IA of this specification.
- 3.48.00 LP piping distribution network comprising of instrument air, service air, service water, potable water, fire water, Nitrogen, Ammonia, DM water & auxiliary cooling water piping with system boundary as detailed in Volume-II-D2 of this specification.
- 3.49.00 Supports for all piping system covered under the scope of supply of this section including supply of all secondary steel members, clamps, U-bolts, springs, etc.
- 3.50.00 Auxiliary boiler (common for all three steam generators) with accessories as detailed in Section-VI of this Volume II-B.
- 3.51.00 Air conditioning and ventilation system for all related buildings under this package. For further details, refer Volume II-J of this specification.
- 3.52.00 Miscellaneous Cranes, Hoists and elevators for the facilities for Steam Generator & auxiliaries. For further details, refer Volume II-K of this specification.

- 3.53.00 Valves & dampers with actuators for all the systems under steam generator & auxiliaries including approachable platforms, manholes etc.
- 3.54.00 Thermal insulation and refractories as necessary for the system.
- 3.55.00 Painting of all equipment as detailed in Section-XII of Volume-II-A.
- 3.56.00 Complete Pipe cum cable rack under this package. For further details, refer Section-IV of Volume II-A.
- 3.57.00 The scope of Electrical shall be as elaborated separately in Volume-II-F/1 & F/2 of this specification.
- 3.58.00 The scope of Instrumentation and Control shall include but not be limited to the following as elaborated in Volume-II-E:
- a) Complete hardware and software, pushbutton stations, Man-Machine interface (MMI) station, local panels etc. for boiler control system.
 - b) Burner management system
 - c) Boiler Protection
 - d) Soot Blower Control
 - e) Primary & Secondary Air damper control
 - f) Sequential control.
 - g) Boiler stress analyzer (to be realized in PADO).
- 3.59.00 Acoustic steam leak detection system for boiler shall be provided by the Bidder.
- 3.60.00 One (1) no. Steam Generator maintenance cradle (sky climber), common for all the three steam generators as specified in Tools & tackles.
- 3.61.00 One (1) no. Furnace Scaffolding (minimum), common for all the three steam generators as specified in Tools & tackles.

4.00.00 STEAM GENERATOR RATING AND SPECIFIC DESIGN CRITERIA

- 4.01.00 Salient data for design and sizing of the steam generator and its auxiliaries under different operating conditions, coal and ash characteristics, and component-sizing criteria are laid down under "Specific Design Criteria" in Annexure-I of this section. In case of difference between this section and Specific Design Criteria the stipulation under Specific Design Criteria shall prevail.

- 4.02.00 The Steam Generator shall be provided with HP-LP bypass system for smooth start-up, fast loading and house load operation of the unit. When unit trips or Steam turbine trips under full load, HP-LP bypass system shall come into service with superheater flow of 65% BMCR capacity. For such condition, economizer shall be suitably designed to take thermal shock of sudden change of feed water temp from rated value(s) to the saturation temp corresponding to deaerator pressure. The superheater and reheater outlet steam temperatures during such operation shall be maintained at the rated value.
- 4.03.00 The BMCR rating of steam generator shall be as specified in "Specific Design Criteria, Annexure - I of this section.
- 4.04.01 The design of Steam Generator shall be such that it does not call for any oil support for flame stabilization beyond 40% BMCR load while firing any coal from the range specified, with any combination of mills / adjacent mills (to Owner's choice) in service. This shall be guaranteed and demonstrated by the Bidder.
- 4.04.02 Stand-by equipment of all the auxiliaries which have direct impact on operation and safety of the plant shall be designed for auto start up, on failure of running equipment with minimum time delay and without runback on unit load.
- 4.05.00 **Operation under H.P. Heaters Out Condition**
- The steam generator shall be designed for continuous operation with all the High Pressure Feed Water Heaters out of service, when the feed water temperature at economizer inlet is low, 1% cycle make up, and normal auxiliary steam requirement being tapped from the Cold Reheat line, to generate maximum output without overstressing turbine components. The power output of the unit operating condition shall not be less than 800 MW. The Economiser shall be suitably designed to take a thermal shock of sudden change in feed water temperature, under such conditions. However, during cold start-up feed water temperature may go down to 140 Deg. C, and even less at the time of black start (i.e. in absence of auxiliary steam). The superheater and reheater temperature control system shall be designed to maintain the rated steam temperature with the HP heaters out of service from 50% TMCR to 100% BMCR. Further, during such operation the metal temperature of various pressure parts shall not exceed the limits stipulated in their design/ selection.
- 4.06.00 **Low Load Operation**
- The steam generator and all interconnected piping shall be designed for full load operation as base load. However, plant and equipment shall be capable to operate continuously up to a reduced load of 40% BMCR with coal without oil support.

4.07.00 **Low Frequency Operation**

The Unit shall operate in parallel with the interconnected Grid for which the frequency may go as low as 47.5 Hz. This criterion shall be considered while sizing the steam generator and its auxiliaries.

4.08.00 **Cyclic Load Capability and Adoptability for Sudden load changes/Load Throw Off**

4.08.01 To match the desired plant operating capabilities, the steam generator shall also be designed for regular cyclic/two shift operation. The total number of start-ups during 25 years of design life shall be as specified in Volume – II-A (Lead Specification), Section-V. The design of steam generator and auxiliaries shall cover adequate provision for quick startup and loading of the units to full load at a fast rate.

4.08.02 Under the above conditions, no portion of the steam generator and the associated systems shall be stressed beyond acceptable safe stress and fatigue levels and the design of steam generator and its pressure parts shall take care of above without affecting the life of equipment and pressure parts adversely.

4.08.03 Steam generator shall also be capable of satisfactory, stable and safe operation in case of rapid load changes in downward direction due to external disturbances or equipment malfunction. Under such condition the system shall stabilize itself through proven concepts and within the recommendations of NFPA.

4.08.04 In case of sudden load throw-off, in worst case from 100% BMCR, the steam generator shall be capable of automatically bringing down the steam generating capacity to match with HP-LP bypass capacity of 65% BMCR. The unit shall be capable to operate at house load conditions during short turbine outages or export load rejection, with a view to save fuel and reduce heat losses. The boiler design shall ensure balanced draft condition; avoid overheating of reheater tubes and such other conditions that jeopardize the safety and life of boiler.

Note : Bidder to furnish the boiler run-back curves (with clearly indicating steam parameters) to boiler minimum stable load with once through operation for :

- 1) Boiler single operation (Turbine trip condition).
- 2) House Load operation.

4.08.05 In-line with automatic runback capability of the unit load on loss of critical auxiliary equipment, the steam generator equipment and systems shall also ensure smooth and stable runback operation. Bidder shall furnish run back load for each auxiliaries/equipment along with load reduction rate.

4.09.00 The steam generator shall be designed for constant pressure operation up to 40% TMCR and modified sliding pressure operation (from 40% TMCR to 100% TMCR Load) with throttle margin which can cater 5% load variation and

Constant Pressure between 100% TMCR and VWO Load. Also the steam generator shall be designed for pure sliding pressure operation from 40% TMCR to 100% TMCR.

Further, the steam generator shall be designed for the following capabilities also:

- a) Sliding pressure operation from the rated pressure down to 40% of rated pressure with as well as without any throttle reserve.
- b) For modified sliding pressure condition, at any operating load, the throttle reserve shall be sufficient so as to achieve an instantaneous increase in turbine output by 5% of the corresponding load by opening turbine control valves wide open. However, the output after instantaneous increase shall be limited to 105% of TMCR load. The throttle reserve shall be 0% for pure sliding pressure mode of operation.

Thermal design of the steam generator and the selection of materials of pressure parts shall be suitable for both the operational modes.

4.10.00 The steam generators shall be designed for minimum rate of loading/unloading mentioned below without compromising on design life of pressure parts:

a)	Step load change	Minimum $\pm 10\%$ per minute
b)	Ramp Rate	Minimum $\pm 3\%$ per minute (above 30 % to 50% load)
		Minimum $\pm 5\%$ per minute (50% to 100% load)

4.11.00 Temperature variation for Boiler & pressure parts shall match that of Turbine as specified in Clause no. 5.07.00 of Vol-II-C, Sec-I of this specification.

The plant shall be suitable for load cycling which implies that it should be designed to operate continuously under two shift mode (daily start stop with one shift off) and load follow mode as specified. The design would cover adequate provision for quick start-up and loading of the units to full load at a fast rate. The unit shall have minimum rate of loading or unloading of 5% per minute above the control load (i.e. 50% TMCR). Plant shall be capable of minimum N1 number of daily load cycles (N1 shall not be less than 2) from load variation from 100% to 50 % (and vice versa) of TMCR with a minimum ramp rate of 5% per minute without affecting the design life of boiler and turbine systems. In addition, the plant shall also be capable of minimum N2 number of daily load cycles (N2 shall not be less than 1) from 50% TMCR to boiler minimum once through load (and vice versa) with a minimum ramp rate of 3% per minute without affecting the design life of boiler and turbine systems. Bidder shall fill the values of N1 and N2 in the relevant Attachment of the Bidding document and shall demonstrate the same during initial

operation. The main plant and its auxiliaries with their controls would be designed to permit operation of the units on house load without there being any necessity to shut down the units in the event of sudden loss of total load due to tripping of transmission lines or any other grid disturbances. The design of the plant equipment and control system would permit participation of the plant in automatic load frequency control.

4.12.00 **Limits of NO_x Emission**

The Bidder shall guarantee that the maximum NO_x emission from the unit will not be more than as specified in Section-V of this Volume. The total NO_x shall not be exceeded during the entire operating range of Steam Generator for the complete range of specified coal.

The Bidder shall bring out the special measures incorporated in the steam generator design to keep the NO_x emission within the specified limit value in the proposal.

4.13.00 **Flue Gas Desulphurization (FGD) System**

A Flue Gas Desulphurization (FGD) system will be installed by the Bidder to meet the SO₂ emission requirements of pollution control.

For technical details of FGD system, please refer Volume-II-H3 of this specification.

4.14.00 For the purpose of design, the ambient air temperature and relative humidity shall be as specified in "Salient Design Data", Section-XV, Volume-IIA (Lead Specification) unless specifically mentioned otherwise, for designing and sizing of individual equipment/auxiliary of steam generator. Reference ambient conditions for Performance tests shall be as mentioned in Volume II-A.

4.15.00 The steam generator and auxiliaries shall perform continuously within the noise limit as specified in Volume II-A and Vol-I-B of this specification.

4.16.00 The design and materials for various equipment/auxiliaries etc. shall be selected keeping in view capital overhaul of units once in two (2) years, such that no major repairs/replacements, requiring shutdown of the unit, are needed in between the capital overhauls.

5.00.00 **DESIGN AND CONSTRUCTION**

5.01.01 The Steam Generator shall be designed and constructed according to reputed, internationally accepted standard and shall fully comply with the requirements of "Indian Boiler Regulation" (1950 edition with amendments up to the date of construction). It shall be the responsibility of the Bidder to get boiler design approved by IBR and the Bidder shall arrange all the necessary documents required for such approval.

The material and the design of pressure parts shall be approved by concerned "Chief Inspector/ Director of Boilers" and shall be inspected and certified by inspecting authorities approved by I.B.R. during fabrication and construction. The Bidder shall submit to the Owner and the Directorate of Boilers the calculations of all pressure parts showing that the requirements of the relevant code have been fulfilled.

5.01.02 The steam generator design shall comply with the following limiting parameters with design coal (refer Vol-IIA, Section-XV) firing, under stipulated ambient air condition i.e. 27.5 deg. C temperature and 66% relative humidity:

- i) Excess air at economizer outlet @100% TMCR load : 20% (minimum)
- ii) Excess air for Design of Draft system : 20%
- iii) Excess air for design of Ducting : 20% excess air at 100% BMCR and considering leakages as specified in Annexure-1 Sl.no.5.18
- iv) Flue gas temperature at air-heater outlet : 125°C (minimum).
(Corrected) at 100% TMCR load
- v) Loss due to unburnt carbon in ash at all loads : 1% *.

* Boiler shall be designed assuming 1% loss due to unburnt carbon in ash at all loads. However during operation, actual loss due to unburnt carbon in ash at all loads shall not exceed 1% at any circumstance.

Bidder to note that no credit shall be given in the bid evaluation or in the evaluation of the results of the guarantee tests or performance predictions etc. if the values considered by the Bidder for parameters as specified at clause no 5.01.02 i). iv) & v) of this chapter above are lower than those specified in this clause.

However, Bidder shall also indicate in their bid proposal the envisaged design excess air & actual un-burnt carbon loss anticipated.

The steam generator guarantees shall, however, be as per the conditions stipulated in Section-B of Volume-I.

5.01.03 The equipment, components, piping and associated supporting structures shall be designed considering the effect of Earthquake as specified under "Structural Steel" of this section.

5.01.04 The quality parameters of main steam and reheat steam shall be as per requirement of the turbine manufacturer.

5.01.05 The Steam Generator(s) shall be designed for the following minimum operational requirements at all loads and for the specified range of coal(s).

	PARAMETER	REQUIREMENT
1)	Soot Blowing Frequency	Once daily (max.)
2)	Preferred mill combination	Any combination of mills (to Owner's choice without any restriction)
3)	Max. coal flow unbalances in coal pipes from same mill	5.0% with use of fixed orifices in coal pipes & Further balancing with the use of online coal balancing system
4)	Slagging	
	a) Inter burner	Nil
	b) In furnace/ash hopper/water wall areas	Nil
5)	Control range of boiler	50% TMCR to 100% BMCR
6)	Maximum permissible Reheat Spray Water Flow with rated steam temperature at Reheater outlet	3% of Reheater flow under at emergency condition (0% under normal operating conditions)
7)	Min. load without oil support	40% BMCR with range of coal specified
8)	Maximum gas temperature variation across furnace width and depth.	30°C (Max.)
9)	Maximum steam side temp. imbalance in the LHS & RHS at boiler outlet (with the average)	10 deg C (max.)

5.02.00 **Furnace and water walls**

5.02.01 Furnace shall be of membrane wall construction and shall be made from seamless tubes. Lower portion of the furnace/evaporator shall be formed using spiral wound/ inclined plain water-wall tubing or vertical rifled wall tubing up to combustion zone (minimum) for which the Bidder is qualified.

5.02.02 The furnace shall be designed conservatively with sufficient volume to provide complete and efficient combustion of fuel. For arriving at furnace cooling factor, the calculated Effective Projected Radiant Surface (EPRS) shall be reduced by at least 10% to account for deterioration of furnace walls surface condition due to fouling/ slagging etc.

5.02.03 The height of furnace bottom shall be suitable to accommodate a water Impounded hopper to store bottom ash for eight (8) hours at BMCR with worst coal and ensuring installation of all bottom ash handling equipment above the ground. Minimum height of furnace bottom ring header shall be 10.25 m from ground. Design of Boiler and its supporting structure shall be considering 50% ash/clinker loading in furnace bottom hopper and corresponding to ash density of 1350 kg/m³. Further load cells shall be installed in the furnace roof enclosure to give indication of ash build up in the furnace bottom hopper with 'Hi & Very Hi' alarm.

- 5.02.04 At all loads there shall be no flame impingement on any part of the furnace walls and no accumulation of slag on the walls, burner tubes, or hoppers that will interfere with continuous satisfactory operation of Steam Generator. Design of Maximum flame temperature in active burning zone considering all load ranges with given fuel range shall be such as to prevent any water wall slagging. During detail engineering, Bidder shall provide predicted gas temperature plot for furnace zone from lower level burner up to first SH/RH coil placed in the furnace in gas flow direction. This curve shall be plotted with respect to Design, best and worst coal for BMCR, TMCR, 60% BMCR and 40% BMCR.
- 5.02.05 The gas velocities shall be selected considering ash content of the fuel. For two pass boiler, the gas passages shall be designed to ensure a smooth flow without any abrupt change in direction. Erosion problems in tubes shall be taken care of by providing low gas velocity and least nos. of baffles, screens etc. The erosion allowances considered in tube design shall be clearly indicated.
- 5.02.06 The gas temperature at furnace exit shall be minimum 60°C less than ash initial deformation temperature (IDT) of lower limit given in specification / considered by Bidder whichever is lower, so as to minimize possible surface fouling/slagging due to ash sticking at all load ranges with given fuel range. Furnace exit plane is defined as the plane, vertical for two pass Steam Generator and horizontal for single pass (tower type) Steam Generator, above the furnace nose tip or the plane beyond which the transverse tube pitching is less than 600 mm whichever is positioned first in the flue gas path in the case of tower type boiler. Further, all the predicted/guaranteed gas temperature including FEGT indicated by the Bidder shall be the actual MHVT value and not the HVT values. MHVT Value is the flue gas temperature as measured by a Multi Shielded High Velocity Thermocouple (MHVT).
- 5.02.07 Headers shall be located external to gas path to the extent possible and as per the manufacturer's standard practice. All the headers shall be completely drainable.
- 5.02.08 Minimum 10% thinning allowance over calculated thickness as per IBR shall be provided wherever there is bend in the tubes of furnace and water walls.
- 5.02.09 Steam Generator headers shall be provided with suitable openings with welded caps for inspection and chemical cleaning. Adequate numbers of furnace observation and tapping points shall be provided for local instruments, gauges, temperature elements, transmitters, test pockets etc.
- 5.02.10 Maximum allowable tube skin temperature for evaporator section shall be 40°C below oxidation limit for tube metal.
- 5.02.11 Provision for future installation of additional Soot Blowers shall be made in furnace so that after commissioning of unit, the same can be installed, if the operational experience warrants the same. For this purpose, the furnace construction shall preferably be provided with wall box openings. Necessary space provision in layout for providing approach and platform for future soot blowers shall be kept in the original design itself so that the same can be

installed whenever the future soot blowers are required. The loads for these platforms shall be considered in the boiler structure design. In case of such a necessity of installation of additional soot blowers within warranty period, the bidder shall supply & install these soot blowers with associated access and platforms without any cost implications.

5.02.12 Water wall material shall be selected to withstand thermal stress, erosion due to wall blower operation with adequate protection or additional tube thickness in that area as per proven practice. Water wall tubes shall be designed to withstand fatigue/ creep due to any upset/ normal/cyclic load requirement as in CI No .4.11.00 above/abnormal condition for minimum 25 years.

5.02.13 To prevent ash erosion in S-panel of furnace bottom hopper, extra thickness for minimum 1.0 mm or suitable erosion prevention measures as per proven OEM standard to suit worst fuel's ash conditions specified shall be provided.

5.03.00 Enclosures

5.03.01 The steam generator shall be constructed to form an air and gas tight chamber from air inlet to flue gas outlet to prevent infiltration of extraneous air in to the combustion chamber and gas passes. The boiler casing shall be designed and constructed to withstand the maximum internal positive or negative pressure produced by draft plant control or explosion/implosion and complete combustion trips. In addition, furnace structural design pressure shall not be less than recommended by NFPA 85.

5.03.02 The enclosure integral with boiler shall be formed by water/steam cooling tubes using welded wall construction on all the four sides, roof and bottom.

Where use of refractory is unavoidable, minimum 4mm thick steel plate behind refractory shall be provided to form enclosure and any penetration (s) into the steam generator enclosure shall be sealed for gas tight integrity. The refractories shall be strong enough to withstand the forces generated in the boiler without rupture or damage. It shall be chemically inactive towards alkalis, iron or silica and shall pose no health hazards to the working personnel and should not have any explosion properties. The refractories shall be strong enough to withstand the forces generated in the boiler without rupture or damage. The refractory shall be capable of withstanding service temperatures of the order of 1700°C.

5.03.03 Furnace bottom header designed for water sealing shall be with sealing plates having minimum thickness of 6 mm of material Stainless steel type 430 or better for corrosion and erosion resistance. The seal plate shall be immersed in water trough of the water-impounded hopper provided at bottom.

5.03.04 Adequate number of access and observation openings / doors shall be provided at various levels and positions in the furnace, superheaters, reheaters and other enclosed parts. Doors shall be hinged and air tight and meet all safety requirements by Statutory regulations. Approach platform for each observation port / opening along with ladders from nearest platform level shall be provided. The minimum sizes for manhole in ducts and boiler are

600 x 600 mm or 600 mm diameter hole. For the inspection hole the minimum size should be 150 mm x 300 mm.

- 5.03.05 Access shall be adequate for taking power operated maintenance cradle/quick erect scaffolding within the furnace, either in assembled or dismantled condition. Adequate openings on roof and fixing arrangements as required shall also be provided.
- 5.03.06 The entire furnace shall be suspended from a suitable supporting structure to allow free expansion of surfaces and to prevent its distortion and dislocation of insulation. Thermal expansion of the furnace wall shall be in the downward direction.
- 5.03.07 Leak test shall be carried out in air / gas path before commissioning the boiler and before fixing of external insulation.
- 5.03.08 Dissimilar Metal Welds (DMW) between martensitic and austenitic steels, martensitic and ferrite steel shall be avoided inside the boiler enclosure for the pressure parts, which are exposed to hot flue gases. However, if such DMW are unavoidable, same can be permitted at shop provided manufacturer has previous experience of such DMW and appropriate heat treatment is done after welding.
- 5.04.00 **Separator/Mixing Chamber/Pressure Parts/Headers**
- 5.04.01 Adequate number of steam separators along with a drain collection vessel shall be provided at the evaporator outlet. The Separator and Drain vessels shall be of fusion-welded construction with welded hemispherical dished ends. All weld joints shall be properly heat-treated and 100% radiographed during manufacture.
- 5.04.02 The design of all pressure parts shall be as per the requirements of Indian Boiler Regulations (IBR) or other equivalent International Codes.
- 5.04.03 The design pressure shall be at least 1.05 times the maximum operating pressure or as required by IBR / International Codes, whichever is higher. The design temperature shall be as per the IBR requirements.
- Further, the maximum operating pressure for the pressure parts up to the separators inlet shall be arrived at by adding a margin for increased pressure drop in the evaporator tubing due to scaling during operation over a period of time.
- This margin shall be equal to at least 5% of the maximum operating pressure with evaporator tubing without scaling or actual expected increase in pressure drop in water wall / evaporator section, whichever is higher.
- 5.04.04 The separators / drain collectors shall be equipped with suitable nozzles for steam / water connections, tapings for instrumentation, sampling and other mountings / fittings etc. The tapings and nozzles shall comply with heat treatment, weld and other requirements as per ASME Section-I / BS 5500. Relevant requirements of IBR shall also be satisfied.

5.04.05 The separators, drain collectors and headers shall be fitted with machined holes for inserting tube stubs and weld end nozzles. All nozzles shall be welded in the shop and designed to extend through insulation where applied.

5.04.06 The circulation system shall ensure adequate circulation during start up and low load operation of the system.

5.05.00 **Start- up Recirculation and Drain Water System**

5.05.01 Steam Generator start-up and drain system with start-up water circulation pump shall be provided to ensure adequate circulation during start up and low load operation. The system shall comprise of 1 × 100% start-up water re-circulation pump, complete with connecting pipe work between separator / drain collection vessel & the pump and pump & the inlet feed water supply pipeline along with necessary separator / drain collection vessel level control and isolation valves.

The start-up drains shall also be routed to the main condensers of the steam turbines through flash tanks, valves etc. The system shall be of proven design and shall comply with the following:

Piping with necessary level control valves from separator(s) / drain collection vessel to start up flash tank and flash tank drains to condenser. A start-up and emergency electro hydraulic type drain control valve upstream of flash tank with a motorised isolation valve upstream of drain control valve shall be provided.

Vent pipe from start up flash tank as well as from flash tank drain tank shall be routed to atmosphere, above roof of boiler house.

Initial drains of 100% capacity from start up flash tank and it's drain tank with drain piping may be connected to ETP/station drains. This drain shall be cooled minimum up to 60 degree C by service water before discharge. After attaining required purity the drains from flash tank shall be routed to condenser with the aid of 2x100% condensate transfer pumps. Capacity of flash tank drain tank shall have at least 10 minutes retention time considering boiler start up without the aid of start-up recirculation pump and one number of condensate transfer pumps are in operation.

5.05.02 The system shall provide for maximum possible re-circulation and drain flow considering all operating conditions and shall be adequate for fast start-up and cyclic load operation of the Steam Generators.

Double isolation (one motorised and one manual) valve at the suction, Motorised isolation, Electrohydraulic operated control valve and a non return valve on the discharge of the pump. Alternatively, Electrohydraulic operated control valve and a motor operated stop cum check valve is also acceptable.

A pump minimum flow control valve & a re-circulation flow control valve shall be provided at the discharge of start up recirculation pump (as required based on Bidder's proven practice).

5.05.03 The Recirculation Pump shall be hermetically sealed glandless type without requiring any external sealing arrangement.

The pump and motor shall be hermetically sealed, of heavy-duty design and construction shall be provided with necessary handling arrangement and shall be suitable for the maximum operating pressure and temperature.

The pump-motor sets shall be submerged in Steam Generator water and shall be mounted on the steam generator recirculating system. The motor shall be mounted below the pump.

The impellers shall be one-piece casting secured to the shaft in overhung position on the extended motor shaft. The impeller mounting shall allow the hub to freely expand and contract independent of the shaft.

The bearings of the set shall be lubricated by liquid in motor cavity.

The entire pump and motor shall be enclosed in a pressure tight casing, motor being protected from the high temperature fluid inside the pump casing by a suitably designed thermal throttle. The motor shall be of Wet Stator Construction. The liquid inside the motor shall be circulated by an impeller mounted on the motor shaft in a closed cycle and shall be cooled by external high-pressure indirect water / water heat exchanger.

The temperature of the water leaving the motor cavity to the cooler shall not exceed 60°C. The cooler shall be adequate to reduce the temperature to below 50°C.

Motor windings shall be of non-hygroscopic material and shall withstand continuous water pressure and temperature variation. Cooling water for the heat exchanger shall be tapped off from Bidder's own cooling water system. A high temperature motor cavity alarm / trip shall be provided. The alarm and trip temperatures shall be adjustable. Emergency cooling water supply to coolers in case of power failure shall be provided, if required.

5.05.04 Pump design and installation shall be so as to ensure adequate NPSH under all operating condition of the steam generator including cold start.

5.05.05 Adequately sized Journal and thrust bearing shall be provided for the pump and motor assembly being suitable for self-lubrication and cooling by the boiler water.

5.05.06 The material of construction of pump and motor shall be suitable for continuous operation with chemically conditioned boiler quality water normally encountered in such service and shall ensure long service life. The materials shall be suitable to withstand the possible effect of erosion, corrosion, electrolytic effect etc.

5.05.07 The stator windings in the motor shall be cooled with suitable insulation impervious to water. The insulation shall have sufficient dielectric strength to withstand the rated phase-to-earth voltage in slot portion and phase-to-phase voltage in end windings.

The insulation material shall not have any tendency to plastic deformation even under extreme operating condition like the conductor temperature mechanical forces, vibrations etc.

5.05.08 The power and instrumentation leads shall be taken out of the motor through properly sealed water-tight glands, shall run through flexible metal conduits or metal cable sheathing and shall have adequate provisions of differential expansion of pump casing and conductor.

5.05.09 Motor design and construction, in addition to the features described above shall meet the requirements specified in Volume IIF of this specification.

5.05.10 The Bidder shall indicate the safety protections and interlock scheme provided for the circulation water pumps. The motor shall be protected against external heat exchanger cooler leakage and against possible heat conduction during idle operating condition. The safety features adopted under such condition should be elaborated.

5.06.00 **Superheaters**

5.06.01 The Steam Generator shall be equipped with suitable superheaters of sufficient capacity and surface area to superheat the steam to the required condition.

5.06.02 The superheater shall be a combination of convection and radiant type. Design shall take into account the abrasive nature of coal, ash as well as the slagging / fouling possibilities.

5.06.03 Superheater tubes, banks and sections shall be made from seamless tubes and shall be completely drainable for tower type boiler construction, while for two pass boilers, it shall be drainable to the maximum possible extent. Minimum tube thickness shall be as per I.B.R. with allowances as applicable. Material of the tubes shall be appropriate for the most adverse operating conditions and shall not be inferior to those mentioned in Specific Design Criteria, Annexure-I of this section. For leading tubes of the tube bank in superheater, erosion allowance of 1.0 mm (minimum) will be provided over and above the calculated thickness as per IBR formula. For balance of tubes of the tube bank in superheater, erosion allowance of 0.6 mm (minimum) will be provided over and above the calculated thickness as per IBR formula. In addition to above, +10 % thinning allowance (minimum) on the bends to be provided.

5.06.04 Spacing of superheater elements shall be selected with specific reference to the ash in coal particularly in the high temperature sections. Uniform spacing shall be maintained between the elements to prevent gas bypassing.

Stainless Steel Erosion shield for all bends of outer most tube / coil of all superheater sections and hanger tubes. Stainless steel erosion shields shall be provided with minimum 3.0 mm thick for leading tubes of each tube bank of Super heater. Also, erosion shields are to be provided for the zones which encounter erosion due to soot blower. Baffle plate shall be provided below

entry of all the tube banks. For the pendant tube sections, the erosion shields on the leading tubes and where else considered necessary by the Bidder as per their proven practice shall be provided.

- 5.06.05 Superheater headers shall be located outside the gas path to the extent possible and shall be fully drainable. Wherever locating the headers in the gas path becomes unavoidable, these shall be suitably protected with erosion shields.
- 5.06.06 Provision shall be made on superheater outlet pipes for fitting separate test pressure gauges to facilitate adjustment of setting of safety valves.
- 5.06.07 Superheater outlet temperature shall be maintained at rated value within specified tolerance by attemperation from 50% TMCR to 100% BMCR load by means of remote manual and automatic control devices.
- 5.06.08 Spray system for attemperation consisting of valves, pipelines and accessories shall be adequately sized for the maximum requirement. Suitable 24V DC solenoid operated pneumatic/_motor operated block valves (meeting the requirements of ASME TDP -1 (2006)) shall be provided to close in the event of unit trip out to prevent any water leakage. Arrangement of desuperheating shall ensure complete evaporation of spray water and avoid water carryover in the superheater with thermal liners. Location of spray water tapping from the feed water system shall be from downstream side of HP heaters or intermediate banks of economizer or economizer outlet. Tapping of spray water from upstream of top HP heater is not allowed. Total maximum SH spray quantity shall not exceed 8% of main steam flow under BMCR condition for complete control range of boiler with range of coals specified. However, SH Spray system control valves shall be designed for minimum 12% of rated main steam flow under BMCR condition or as per the maximum anticipated design value for all the load range and given fuel range of boilers.
- 5.06.09 For continuous monitoring of tube metal temperatures of superheater and reheater elements, minimum number of thermocouples as per the following shall be provided:
- i) Minimum 450 nos. of Chromel-Alumel thermocouples located outside the gas path for measurement of tube metal temperature covering all stages of Superheaters and Reheaters
 - ii) Minimum 80 nos. of Acromat/K -type thermocouples located inside the gas path for measurement of gas side metal temperature covering all stages of Superheaters and Reheaters
- These thermocouples shall be wired by the Bidder up to the control room.
- 5.06.10 A thermocouple type retractable temperature probe shall be provided at the suitable location to enable controlling the firing rate at start up so that the flue gas temperature can be contained within a limit when there is no steam flow through the reheater tubes.

The probe shall be interlocked to be retracted upon loss of cooling air or when the temperature of the flue gas exceeds the safe limit of operation of the probe.

- 5.06.11 Superheater elements shall be provided with adequate number of vents and drains. All pressure parts (water side, SH & RH) vents and drain lines shall have butt weld with header drain / vent stub. The top most headers shall be provided with stubs for nitrogen capping. Drainage slope as per Bidders proven practice shall be provided on the superheater header.
- 5.06.12 Power operated Safety Relief valves / Electromatic Safety Relief valves shall be provided on SH outlet considering a relieving capacity of 15% of total Main steam flow at BMCR, complete with solenoid valve assembly, pressure sensing device, impulse piping, accessories, necessary instrumentation etc. A remote operated motorized isolation valve shall be provided on upstream side of each power operated Safety Relief valve. Spring loaded safety valves shall be provided as per the requirements of IBR. The capacity of power operated Safety Relief valves and spring loaded safety relief valves shall be as per stipulations of ASME Section-I or 100% BMCR whichever is higher.
- 5.06.13 The superheater sections shall be so arranged that it will facilitate temperature equalization of gas flow and avoid uneven temperature distribution.
- 5.06.14 The design of the superheater elements shall have provision for easy maintenance. Minimum 1500 mm clear cavity height between two sections/ banks of heat transfer surfaces shall be provided for personnel access. For vertical surfaces, minimum clearance between the two banks shall be 600 mm. Access opening, of minimum size 600 mm x 600 mm, shall be provided along with air/ gas tight hinged door for approach to above maintenance spaces without any hindrance from hanger tubes.
- 5.06.15 The superheater and reheater supports shall be of heat resistant material suitable for long service under the service conditions encountered.
- 5.06.16 Maximum depth of tube banks/sections in the direction of gas flow shall be 2.0 meters or maximum soot blowing radius, whichever is lower.
- 5.07.00 **Reheaters**
- 5.07.01 The boiler shall be equipped with suitable reheater sections of sufficient capacity and surface to reheat the steam to the required condition as specified elsewhere.
- 5.07.02 The reheater outlet steam temperature shall be maintained at specified value from 50% TMCR to 100% Boiler MCR. Reheat steam temperature control system shall utilize Burner tilting/ Spray water attemperation / Gas biasing. Flue gas recirculation for reheat temperature control is not accepted.
- 5.07.03 Spray system design shall incorporate in common header a 24V DC solenoid operated pneumatic block valve to avoid water leakage in the reheater during normal operation as well as after trip out.

The valves shall be of leakage Class-V as per ANSI FCI 70-2. However, no reheat attemperation water flow should be required except during an emergency.

- 5.07.04 Tubes shall be selected in the same philosophy as for superheaters. Flow distribution shall be as uniform as possible. Differential expansion shall be taken care of while arranging supports, spacers etc. Tube spacing and gas velocity shall be adequate to prevent any fouling. The reheater shall be designed such that a sudden closure of one or more of the turbine interceptor valves at MCR conditions shall not damage the reheater either due to over pressure or over temperature.
- 5.07.05 In addition to spring loaded safety valves, Power operated Safety Relief shall be provided on RH outlet considering a relieving capacity of 20% of total Reheater steam flow at BMCR, complete with solenoid valve assembly, pressure sensing device, impulse piping, accessories, necessary instrumentation etc. A remote operated motorized isolation valve shall be provided on upstream side of each power operated Safety Relief valve. Combined relieving capacity of safety valves shall not be less than 105% of reheater steam flow at BMCR.
- 5.07.06 For attemperation purposes spray water shall preferably be taken from BFP interstage discharge. Desuperheaters shall have thermal liners. Maximum spray quantity should not exceed 3% of Reheater flow under at emergency condition (0% under normal operating conditions). However, RH Spray system & control valves shall be designed for minimum 8% of rated Reheater steam flow under BMCR condition or as per the maximum anticipated design value for all the load range and given fuel range of boilers..
- 5.07.07 Alloy steel / Stainless steel for superheater and reheater tubes shall contain both molybdenum and chromium as alloying elements. The selected material shall be proven for the temperature and pressure conditions to be encountered by the super heater and reheater. Alloys containing molybdenum only shall not be accepted.
- 5.07.08 The reheater shall be provided with isolators both at inlet and outlet to facilitate isolation of reheater during hydraulic tests with before and after drains and vent in upstream. All around approach platform shall be provided for Isolator.
- Required proven creep measurement points shall be provided in SH/RH piping with all around approach platform.
- 5.07.09 Stainless Steel Erosion shield for all bends of outer most tube / coil of all reheater sections and hanger tubes shall be provided. Stainless steel erosion shields shall be provided minimum 3.0 mm thick for leading tubes of each tube bank of Reheater. Baffle plate shall be provided below entry of all the tube banks. For the pendant tube sections, the erosion shields on the leading tubes and where else considered necessary by the Bidder as per their proven practice shall be provided.
- 5.07.10 Maximum depth of tube banks/sections in the direction of gas flow shall be 2.0 meters or maximum soot blowing radius, whichever is lower.

- 5.07.11 The design of the reheater elements shall have provision for easy maintenance. Minimum 1500 mm clear cavity height between two sections/banks of heat transfer surfaces shall be provided for personnel access. For vertical surfaces, minimum clearance between the two banks shall be 600 mm. Access opening, of minimum size 600 mm x 600 mm, shall be provided along with air/ gas tight hinged door for approach to above maintenance spaces without any hindrance from hanger tubes.
- 5.07.12 Provision of space shall be kept for at least 10% addition of additional reheater surfaces in future. This space provision shall be over and above the gap provided between two banks of heat exchanger for the purpose of maintenance. Structure / hanger design shall be suitable for loads due to these additional surfaces.
- 5.08.00 **SH and RH Temperature Control**
- 5.08.01 The outlet temperature of SH and RH shall be guaranteed to be maintained within $\pm 5^{\circ}\text{C}$ of the rated temperature condition from 50% TMCR to 100% BMCR including conditions of the HP heaters out of operation and HP - LP bypass operation.
- 5.08.02 Bidder shall clearly indicate the scheme for reheater protection. Bidder shall also indicate the maximum boiler load for no flow through reheaters.
- 5.09.00 **Economiser Section**
- 5.09.01 The economiser shall be arranged in sections and be provided with tube elements, headers, connecting tubes, casing and accessories required for complete installation.
- 5.09.02 The economiser shall be of non-steaming type.
- 5.09.03 The maximum skin temperature of the economiser tubes shall not exceed the oxidation limit as applicable to the material.
- 5.09.04 Provision of space shall be kept for at least 20% addition of additional economizer surfaces in future. This space provision shall be over and above the gap provided between two horizontal banks of heat exchanger for the purpose of maintenance. Structure / hanger design shall be suitable for loads due to these additional surfaces (filled with water) also.
- 5.09.05 Stainless steel erosion shields shall be provided minimum 3.0 mm thick for leading tubes of each tube bank of economiser. If the Steam Generator has the flue gas down flow section with horizontal tube banks, the top most two rows shall be shielded to reduce erosion. In addition minimum 5.0 mm thick sturdy cassettes baffles shall be provided for all front side and rear side bends of the economizer banks. The cassette baffles shall cover complete bends and additional 300 mm straight tube length.

- 5.09.06 Superheater, Reheater & Economizer Tubes shall be supported by steam / water-cooled hanger tubes / headers forming part of steam circuit such that the failure of even 50% of hanger tubes shall not to cause any dislocation / damage to the tube banks/setting. The stress in the hanger tubes under such condition also shall not exceed the maximum permissible limits as per the IBR.
- 5.09.07 Headers shall be located external to gas path and shall be completely drainable. If locating headers in gas path becomes unavoidable, then suitable erosion shields must be provided. The header shall be provided with drains and suitable opening with forged weld on caps for internal inspection and chemical cleaning.
- 5.09.08 Ash hoppers along with high ash level switches / alarms shall be provided below the economiser section.
- 5.09.09 The cavity height between two sections / banks of the economiser shall be minimum 1500 mm for maintenance access. Maximum depth of tube banks/ sections in the direction of gas flow shall be 2 Meters or maximum soot blowing radius, whichever is lower.
- 5.09.10 Access / Opening for each tube banks along with air / gas tight hinged doors shall be provided.
- 5.09.11 For Two pass Boiler, arrangement (structural steel / runway beams, motorised hoists, walkways platform along with runway beams etc.) for removing, handling and placement of tubes banks / section at ground level for repair/replacement shall be provided. The size of platforms shall be adequate to store minimum 6 economiser assemblies as well as adequate space for handling them. For Tower type Boiler, suitable arrangement and platforms for handling & maintenance of Economizer assembly as well as tube banks shall be provided as per proven practice of Bidder.
- 5.09.12 Arrangement for off load water washing with necessary drainage connected to nearest station drain shall be provided for economizer located in second pass.
- 5.09.13 For Economiser tubes, erosion allowance of 1 mm will be provided over and above the calculated thickness as per IBR formula. In addition to above, +10 % minimum thinning allowance on the bends to be provided. Finned tubes are not acceptable.
- 5.10.00 **Air Preheaters (APH)**
- 5.10.01 The air preheaters shall be designed to cater to following requirements:
- | | |
|--------------------------|--|
| a) Type | Regenerative type. |
| b) No. of air preheaters | Two (2)x60% Tri-sector type APH per steam generator at BMCR with worst coal and maximum moisture content |

- | | |
|--|---|
| c) Rated air temperature at APH outlet | Adequate to provide combustion air at required temperature to furnace at all loads. |
|--|---|

Air Preheaters are to be provided with the following:

- i) Soot blower.
- ii) High Pressure washing to dislodge ammonium sulphate and ammonium bi-sulphate deposition considering SCR operation. For High pressure on load washing, 2x100% High pressure booster pumps shall be provided for each boiler, which will take suction from service water header near APH area.
- ii) Common off load water washing system shall also be provided, which shall be employed for APH fire fighting system as well. Necessary water for this off load washing shall be made available.
- iv) Necessary openings and fittings shall be provided to enable collection of representative samples of the flue gas to be taken both at inlet and outlet and also from both left hand (LH) & right hand (RH) side of each Air preheater, for flue gas analysis and flue gas temperature.

5.10.02 The air pre heaters shall be of rotary regenerative, Lungstorm or approved equivalent type with axis of rotation as vertical. The construction of air pre heaters shall conform to the following:

- a) Heating Elements
 - Cold end : Corten steel, minimum 1.2 mm thick
 - Hot/ intermediate end : Carbon steel, minimum 0.8 mm thick

Entire cold end elements of APH shall be designed such that Ammonium sulphate and Ammonium bi-sulphate (ABS) deposition is minimized, considering plant operation with SCR and corrosion resistance is enhanced. Cold end tier of element shall be of Corten steel only, which shall be designed deep enough to encapsulate any Ammonium Bi-sulphate (ABS) and acid condensation fouling within the cold end tier. Minimum average cold end metal temperature at 100% BMCR (with SCAPH out of service) shall be 76°C.

Sufficient space provision at hot end side for future installation of minimum additional 15% of APH heating surface area shall be made in the design so that the same can be installed, if required. The bearings, supports, casing, drives for APH etc as well as APH supporting structure and foundation loads are designed to take care of all the requirements due to the above addition of heating surface. APH design shall be easy modular installation of heating surfaces including 15% additional surface.

Air preheaters with counter flow arrangement shall be enclosed in a gas tight insulated casing and are provided for the efficient recovery of heat from the flue

gas stream. The design shall be such that one air heater shall be able to cater to 60% BMCR requirements of the steam generator. Air heater exit flue gas temperature for complete range of coal firing shall be at least 5°C above acid dew point of flue gas considering minimum ambient air temperature. Minimum Air heater flue gas exit temperature (corrected) at 100% TMCR with design coal shall be 125°C.

- 5.10.03 The design of the air and flue gas ducts at inlet and outlet of the air heater shall be aero dynamic to ensure uniform flow distribution across the duct sections at all loads. For collection of ash, the air heaters shall be provided with hoppers having eight (8) hrs storage capacity operating at 100% BMCR, with worst coal firing condition.

Off-load water washing facilities including hoppers, water connections etc. shall be provided with drainage connected to the nearest station drain.

- 5.10.04 Air heater seals

- The seals shall be of externally adjustable and easily replaceable type.
- The maximum air-in-leakage to flue gas after 3000 hours continuous operation of the Steam Generator shall be guaranteed and demonstrated. The Contractor shall also demonstrate that the drift in air heater leakage (percentage change in air-in-leakage) does not exceed 1%, one year after demonstration of above guaranteed air-in-leakage. Within this period of operation till all air heater leakage demonstrations are completed, only external adjustments of seals without needing any shut down for replacements or internal adjustments shall be allowed. The seal design/construction shall be such that the above requirements are satisfied.
- Seals shall have a design life of not less than 2 years (with leakages not exceeding 10%)

- 5.10.05 Air heater drive system

One (1) x100% peripheral AC VFD drive or One (1) x100% central AC VFD drive, as per OEM's proven practice, connected to drive Air Heater along with Gear box and automatic clutching/declutching arrangement.

The drive system shall consist of One (1) AC VFD drive fed from the Emergency Bus also, with gear box and automatic clutching/ declutching facility, one (1) no. independent air motor drive with its gear box and automatic clutching facility for rotation during non-availability of AC drive system. A suitable air receiver having a storage capacity of not less than 10 minutes operational requirement without any external source of air, shall be provided with all necessary interconnecting piping, valves and fittings to enable the air heater to be rotated at a suitable reduced speed. Standby drives shall be provided with auto start facilities. The air system shall have isolating drain valves along with auto drains for water removal. The air preheater shall have provision to enable the rotor to be positioned manually or otherwise when replacing elements.

All necessary interconnecting piping, air filter regulators incorporating suitable solenoid valve, which shall automatically admit air to, the air motor (in case of failure of power supply to the drive motor) supplied from the station service air system. Necessary pressure transmitter shall be provided in the air motor airline. The Bidder shall also provide the air heater rotor stand still sensing device. The equipment shall have potential free contacts when air heater comes to stand still condition. The necessary logic components, accessories and indicating lights shall be housed in the enclosure and motion pick-up shall be at suitable location of the rotor shaft. The system shall be complete in all respects and shall be subject to Owner/Consultant's approval.

- 5.10.06 Adequate number of thermocouples or platinum resistance temperature detectors (RTD) for measuring cold and hot end bearing metal temperature / oil sump temperature if Oil Sump Lubrication is provided

The thermocouple leads shall be extended and terminated at a suitable junction box outside the air heater casing. The number of thermocouples and their fixing and terminating arrangements shall be subject to the approval of the Owner/Consultant.

The temperature elements shall also be provided on the air heater bearing for interlock. Suitable sight flow indicators and lube oil temperature indicators shall be provided at suitable locations on lube oil piping. Lube oil flow measurement shall also be provided for each bearing with necessary interlock/alarm.

Facilities (access platform etc.) / openings along with the grids for flue gas sampling and gas temperature measurement on both the inlet and outlet sides of APH(s) shall be provided

- 5.10.07 Each air heater shall be complete with all equipment, ducting, dampers, actuators, primary sensing devices, local instruments and accessories required for a complete unit. It shall generally include the items such as rotor housing, cylindrical rotor, support and guide bearings, oil reservoirs, gear box with drive, lube oil system with pumps, local gauges, sensors, transmitters, duplex thermocouples or platinum resistance temperature detector (RTD), to Owner's / Consultant's approval, for each bearing, water cooler and other accessories, observation port and lights, soot blower system and stationary washing devices. The rotor shaft shall be mounted in oil cooled and lubricated bearings designed for radial and thrust loads.

The air heater shall be supported by a spherical roller thrust bearing on cold end and radial guide bearing on hot end. Local locking device shall be provided to facilitate maintenance.

- 5.10.08 Maintenance facilities:

- a) The arrangement of walkways, platform, and runway beams, trolley, hoists etc. as required, shall be provided for replacement, Conveying, lowering and placement of elements/baskets to ground level.

- b) Hinged access doors shall be provided in the housing for internal inspection, cleaning, maintenance and replacement of elements without dismantling air heaters.
- c) Galleries and platform around each air heater and access to observation ports/access doors etc. shall be provided. Platforms shall be capable of taking load and storing elements of respective layer, for at least two sector of the each air pre heater.
- d) Special T&P kit shall be provided for removal of bearings and for replacement of shaft. For further details refer the relevant section of Vol-IIA.

5.10.09 Steam soot blowers, complete with the necessary pipe work, isolation valves, drain temperature control valve (TCV) and fittings, shall be provided to enable effective on-load cleaning and cleaning during the start-up period of the air heater.

5.10.10 Permanent fire-fighting equipment including sprays, pipe work and valves shall be provided. The air heaters shall be provided with thermocouple type fire sensing device and redundant temperature elements for each bearing and oil sump and the fire fighting system shall be complete with accessories, panels and adequate number of potential free contacts suitably terminated outside the casing for connection to the Control and Instrumentation System. Fire fighting facilities on cold end and hot end of the air preheaters shall be provided and the fire fighting facilities shall cover both flue gas & air sides of air preheaters.

Necessary water draining system, connected to station drains shall also be provided.

5.10.11 The heating elements shall be removable in groups and serviceable. The necessary basket removal gear shall be provided. A suitable structural steel framing for handling the heater element basket shall be provided to cater the space for atleast two sectors of each type, for each Air preheater and the floor shall be the operating floor for basket removal. This shall include a trolley beam extended beyond the platform to enable lowering of elements to the ground floor. A hoist and trolley shall also be furnished.

5.10.12 A complete forced lubrication system for bearings of the air heaters, and if required for gear boxes also, shall be furnished including two (2) x 100% capacity oil pumps, transmitters for alarm and trip, sight flow indicators on oil and water lines, complete piping, valves, fittings and base plates with foundation bolts for the assembly. Only metallic hoses shall be used for bearing cooling and lubrication. Rubber hoses shall not be acceptable. The scheme of the lube oil system shall be subject to Owner/Consultant's approval. Alternately Oil Sump Lubrication with 2x100% oil pumps, oil filters and oil coolers can also be provided

5.10.13 Alarm facilities for failure of drives and lubricating system shall be provided and suitably terminated for connection to annunciation system.

5.10.14 High Pressure water on load washing system shall be provided complete with 2 x 100% high pressure booster pumps and piping system with suitable drain piping to the nearest drain, which shall be for each boiler.

5.10.15 Steam Coil Air Preheater (SCAPH)

- a) The Steam Coil Air Preheater (SCAPH) shall be provided to maintain cold end mean metal temperature 10°C above acid dew point during start-up, low load operation and abnormal operation.
- b) SCAPH and connected air ducts shall be designed to handle air flows corresponding to 60% BMCR loads with one of the two streams working without any undue noise/ vibration.
- c) Heating steam shall be tapped from appropriate location with air temperature control valves (with necessary isolation valves) separately for both streams & Condensate from SCAPH shall be led to blow down tank.
- d) SCAPH shall have modular construction with adequate tube spacing to avoid choking by contamination in the entering air.
- e) SCAPH shall be located in the bypass duct at the outlets of each FD fans. Facility shall be provided for complete isolation of SCAPH from the air flow path.
- f) The construction shall be of side entry type to facilitate removal of SCAPH modules by sliding out of modular frame.
- g) Proper approach to the side entry and adequate facility (platform, runway beam, hoist etc.) for removal and placement of SCAPH modules on ground level shall be provided.

5.11.00 **Ducts and flues**

5.11.01 Loads for design of ducts and structures:

The duct design shall take into account following loads all occurring together:

- a) Wind load as specified.
- b) Dead weight including weight of insulation, lining, wash water and vertical live load.
- c) Horizontal flue gas ducts shall be designed additionally for minimum 25% ash load between Boiler & ESP and 10% ash load between ESP and chimney on the surface or for maximum possible accumulation of fly ash in the duct work, under all normal, upset or abnormal operating conditions, whichever is higher. The ash density for the purpose of loading shall be at least 1350 kg/m³.

- d) Expansion joint loads.
- e) Load due to expansion of duct.

5.11.02 Interconnection ducts shall be provided in air & flue gas system for flexibility of Plant and equipment operation, as necessary, shall have suitable slope with respect to horizontal so that any chance of accumulation of ash particles in the duct can be avoided under all normal, upset or abnormal conditions.

5.11.03 Material of construction:

a)	Duct plates, turning vanes perforated plates	ASTMA 36 or equivalent (For ducts operating above 400°C gas temperature, suitable Alloy Steel material shall be provided to Owner's approval)
b)	Structural shapes	ASTMA 36 or equivalent
c)	Pipe struts, trusses tracing	ASTMA 53 or equivalent
d)	Erection bolts for ducts	ASTMA 307 or equivalent
e)	Bolts for connection to structural steel	ASTM A 325, AISIA 325 (friction type) or equivalent
f)	Stainless steel	ASTM A 316 L
g)	Gaskets	High density, braided& high silica content, meant for high temperature application and having good abrasion resistance.
h)	Access and inspection doors	Reinforced steel plate

5.11.04 Insulation and lagging

- a) All air ducts handling air above ambient temperature shall be suitably insulated and lagged to suit the design requirements.
- b) Thermal insulation shall be applied to all air/gas ducts to meet the specification requirements.
- c) Acoustic insulation shall be used on air and gas ducts to restrict the noise level to 85 dB (A).

5.11.05 Ducts shall be properly reinforced and be of welded construction for gas and air tightness. Suitable supports, expansion joints and access doors with bolted and hinged covers shall be provided in all ducts where required.

Hangers for ducts and connections to the supporting steel for ducts and hoppers shall be included.

Ducts shall have bolted connections to equipment, expansion joints and access doorframes. While designing hangers/supports adequate dust load shall be considered. Required ladder/staging for maintenance work inside shall also be included.

- 5.11.06 Design shall ensure uniform distribution to various sections and prevention of accumulation at any point. Turning vanes, splitter plates etc., shall be used, if required to streamline the flow.
- 5.11.07 Ducting from I.D. fans to stack shall be done taking into account other service facilities, trenches etc.. The height of this duct shall be adequate to allow 50 T maintenance crane to pass. Material of construction and other requirement of flue gas ducting/damper at FGD outlet to stack inlet and duct portion at downstream of FGD bypass damper shall be as per Volume-II H3.
- 5.11.08 Specific requirements:
- a) The stiffeners provided on the ducts wall shall be of such a design and layout that no rain water can accumulate on the duct / insulation cladding surfaces.
 - b) The flanges at the bolted joints shall have adequate stiffeners to avoid damages to the flanges.
 - c) All necessary wall boxes and floor collars shall be provided where the duct work pass through walls, floor and roof.
 - d) The floor collars shall be fitted with a high combing to prevent water and dust falling through the hole.
 - e) The duct work shall be fitted with a steel hood to cover the opening.
 - f) Weather proof flashing shall also be provided wherever necessary.
 - g) The configuration and design of ducts shall be coordinated with the pulveriser parts removal requirement.
 - h) Internal bracings are not accepted for air and flue gas duct.
 - i) Duct plates shall be designed for one-way beam action over stiffeners and considered fully continuous over all supports.
 - j) The deflection of the plate, assumed continuous, shall be less than one-half the plate thickness.
 - k) The entire flue gas ducting thickness from downstream of SCR shall be crosschecked with additional pressure drop across SCR corresponding to BMCR operation with worst coal.

- I) Minimum flue gas duct thickness shall be 6 mm. Minimum thickness of air duct shall be 5 mm. A corrosion allowance of 1.5 mm shall be considered for stress calculation for the flue gas ducting.

5.11.09 Expansion joints

- i) The design, material, construction, manufacture, inspection, testing and performance of the expansion joints shall comply with the currently applicable requirement of EJMA and all statutes, regulations and safety codes.
- ii) Expansion joints shall be used as necessary in all air and gas ducts to allow for expansion and contraction. The expansion joints shall be fabricated and shipped as complete one-piece units, wherever possible.
- iii) The expansion joints shall be of metallic type suitable for the service conditions. For expansion joints at FGD outlet gas exposed duct areas please refer Volume-II H3.
- iv) Expansion joint shall not support the duct work.
- v) The materials for joints shall be tested as per IS/ASTM/DIN or other international standards.
- vi) The outer cover shall preferably be elastomer coated for better corrosion and abrasion resistance and weatherability.
- vii) The minimum trouble free operational life of expansion joint shall not be less than 40000 hours of operation from the date of commissioning.
- viii) All expansion joints shall be provided with protection plates inside the ducts (both air & flue gas) against erosion.
- ix) Shipping bars shall be installed on the expansion joint to maintain the proper shipping length. Shipping bars shall be painted yellow.

5.11.10 Blanking plates

Bolted plates or other positive closure means shall be provided in order to permit pressure testing of steam generator enclosure.

5.11.11 Dampers

- i) Power operated gas tight isolation dampers along with their drives shall be provided at all locations required for carrying out internal repair and maintenance of pulverisers, RAPH, SCR, electrostatic precipitators, ID fans, PA fans, FD fans when the steam generator is under operation. Interconnecting dampers shall be provided where necessary. As a minimum, the following locations shall be provided with power operated gas tight dampers:

- a) Inlet and outlet of each ESP gas stream.
 - b) Before and after each ID/CID fan.
 - c) At outlet of each regenerative air pre heater (RAPH) on flue gas side.
 - d) After each RAPH, SCAPH bypass duct & after each SCAPH on air side
 - e) At discharge of each FD fan.
 - f) At each Economizer by pass duct.
 - g) Before SCR.
 - h) Interconnecting duct dampers as necessary.
 - i) SCR Outlet.
 - j) In each hot air and cold air duct to each of the mills (pneumatically operated only).
 - k) At discharge of each PA fans.
 - l) At each SCR bypass duct.
- Note- For all Constructional and technical requirements of FGD bypass/inlet/outlet dampers & ID booster fan (if applicable), please refer Volume-II H3.
- ii) Heavy duty multi louver type isolation dampers shall be provided at following locations not requiring tight shut off duty :
 - a) Before each SCAPH on air side.
 - b) In addition to gas tight isolation damper at discharge of each of PA fans as per 5.11.11(m), a fast acting pneumatically operated Bi-plane damper shall additionally be provided between isolation damper & PA fan to save the unit when one PA fan trips and unit has to run back part load, with other PA fan in running condition.
 - c) Flue gas biasing damper in boiler second pass (if applicable).
 - iii) Pneumatically operated control dampers shall be provided at the following locations as a minimum:
 - (a) Hot and cold air inlet to each mill.
 - (b) At each economizer bypass duct after isolation damper.

- iv) Type of power operated gas tight dampers at various locations shall be as follows:

a)	Guillotine gate type	:	at locations mentioned under i) above except c) & d), .
b)	Double Multi louver (Biplane) type	:	at locations mentioned under i) c) & d) and iii)-b) above.
c)	Multi louver type		at locations mentioned under ii) a)

- v) Damper gas tightness:

The dampers mentioned under clause iii) a) above shall have a guaranteed gas tightness efficiency (on flow) of not less than 99.95% at rated duct pressure along the duct as well as from the duct to atmosphere or from atmosphere to duct depending on the pressure in both the damper open and damper closed condition without the use of seal air fans of the damper and 100% with the use of sealing air.

- vi) Pressurization fans

- a) All dampers at ID fan discharge, Primary and secondary APH outlets on air side , APH inlets on flue gas side and in hot air ducts to mill inlet shall be provided with 2x100% pressurization fans to achieve 100% sealing efficiency.
- b) The location and scheme for pressurization system shall be subject to Owner's acceptance.

- vii) All dampers shall be designed to withstand the operating air and flue gas temperature without distortion.

- viii) The multi louver damper shall be capable of effectively stopping the flow when in closed position and while in full open position shall cause minimum pressure drop. The isolating damper design shall provide positive shutoff when closed.

- ix) All regulation dampers, vanes, blade pitch controls coming under auto regulation shall be able to meet the relationship between percentage opening and the flow as per process requirement.

- x) The auto regulating dampers shall be capable of being operated between 20% to 85% opening as per the optimal requirements of control systems to achieve stable, steady and smooth automatic control of the plant and processes under all operating conditions.

- xi) There shall not be any backlash, play etc. with linkage mechanism, actuator and final control element.

- xii) Thermal expansion of ducting shall not produce stress in louvers, linkage arrangement etc.

- xiii) Outlet dampers of scanner air fans and emergency dampers of scanner air shall be pneumatically operated, suitable for remote manual operation. The dampers shall be provided suitable mechanism for locking in closed position.
- xiv) All pneumatically operated interlocked dampers actuators shall be provided with solenoid valves.
- xv) Guillotine dampers:

All guillotine dampers shall be located in horizontal duct to avoid fly ash build up when in closed position and shall be of top entry type.
- xvi) Multi louver dampers:
 - a) The damper shall be of heavy duty construction and shall operate without bind or fluttering under operating conditions.
 - b) The damper louver shaft shall be rigidly constructed to prevent bending and shall be suitably insulated to protect from overheating.
 - c) The spindles shall be adequately sized and bearings suitably insulated to protect overheating.
 - d) The shaft bearings shall be mounted outside the damper box channel and arranged for convenient inspection.
 - e) Stuffing boxes shall be provided on all damper blade shafts.
 - f) The shaft shall be horizontal wherever possible.
 - g) For preventing hot air or gases from escaping around damper shaft, double gland type stuffing boxes with graphite impregnated packing material shall be provided on all damper blade shafts.
 - h) The dampers in flue gas paths shall be so located that the build-up of grit behind the damper blades is reduced to a minimum.
 - i) The damper sealing efficiency shall be minimum 99.5% on flow without seal air.
- xvii) Diverter dampers/ flap dampers (if provided)
 - a) Dampers shall be single flap/double flap construction with flexible duplex seals mounted on the flap itself. The seals shall have minimum life of 3 years. The seal material shall be high nickel alloy equivalent or better than hastelloy C276 (ASTM B575, UNS 10276) or Inconel 625.

- b) The diverter damper shall ensure efficient sealing arrangement without the use of seal air. To provide man safe isolation for on-line maintenance of air pre heater, 2x100% seal air fans per damper shall also be provided to attain 100% gas tightness.
- c) The diverter flap shall be totally out of flue gas flow path in order to avoid any erosion from ash.
- d) The damper design shall prevent ash accumulation when in closed position.
- xviii) Weather hood to prevent rain water entry and accumulation shall be provided at damper top.
- xix) If grease lubrication is required, grease connection shall be accessible and suitable platforms etc. shall be provided.
- xx) Dampers operation
 - a) All dampers shall be arranged to facilitate local manual operation also from a gallery or floor level. Open and closed positions shall be clearly marked on the dampers. Mechanical position indicator shall be provided in order to check the position of the damper.
 - b) The force required to operate the damper shall be limited to 35 kgs (maximum) at the rim of the hand wheel.
 - c) The operating gear shall be fitted with a graduated indicator and shall be designed such that the damper may be retained in any position. The isolating dampers shall additionally be fitted with locking devices to permit locking in the fully open and shut positions.
 - d) All powered dampers shall also have provision for manual operation during emergency and maintenance along with graduated local position indicator.
 - e) Suitable all-around approach and platform shall be provided for manual operation of dampers and for carrying out maintenance on damper.
 - f) All bearings for spindles for damper operating gear shall, be arranged for efficient grease lubrication. Grease lines of copper/ steel shall run from all greasing points on each damper to a convenient and easily accessible location adjacent to the respective damper and terminated with suitable clamps and grease nipples on a steel frame to facilitate easy lubrication.

5.11.12 Sections of duct requiring disassembly for regular maintenance of any part of steam generator shall be sized conveniently. Bolted joints wherever used shall be made leak proof using suitable gaskets and sealing compounds.

- 5.11.13 Gas and air ducts shall be designed for wind loads as specified and dead weight including weight of insulation and lining. Proper drainage of ducts shall be ensured by pitching and lagging.
- 5.11.14 All flue gas ducts, air duct and wind box shall be designed either for a design pressure ± 660 mm wc or for maximum conceivable pressure of the relevant fans, whichever is higher, at 67% yield strength of material.
- 5.11.15 All Gates & Dampers of each size shall be shop tested.
- 5.12.00 **Fly Ash Hopper**
- 5.12.01 The Bidder shall provide all necessary Bottom, Coarse and Fly Ash Hoppers for Steam Generator, economizer, air heater, SCR including air heater wash down hoppers as required. The capacity of each hopper (including any dust hopper) shall not be less than 8 hrs. storage when the boiler is steaming at maximum continuous rating. The capacity of the hoppers shall be calculated with ash content of coal as specified in Volume – II A.
- 5.12.02 All hoppers shall be equipped with proper flanged pipe connection for attaching to fly ash removal piping system and the hopper slope shall not be less than 60 Deg.
- 5.12.03 Ash hoppers shall be provided, wherever necessary, below the vertical portion of the ducts where ash may accumulate. However, care shall be taken in the design of ducting arrangement so as to minimize the necessity of such hoppers.
- 5.12.04 Hoppers shall be in welded steel plate construction. The lower 1500 mm of each ESP hopper shall be lined with 16 gauges or heavier, type 304 stainless steel.
- 5.12.05 Hopper should have free passage so that ash pipe can go down directly to ash handling plant without facing any structural obstacles.
- 5.13.00 **Brickwork, Insulation and Casing**
- 5.13.01 The Bidder shall design and furnish all refractory, insulating and other material including metal cladding as required for the complete setting, including necessary stiffeners, supports etc. as necessary.
- 5.13.02 The refractories shall be strong enough to withstand the forces generated in the boiler without rupture or damage and taking care the erosive nature of silica in ash.
- 5.13.03 The refractory shall be capable of withstanding service temperatures of the order of 1700°C.
- It shall be chemically inactive towards alkalis, iron or silica and shall pose no health hazards to the working personnel and should not have any explosion properties.

- 5.13.04 It shall have sufficiently high bulk density, and minimum moisture content.
- 5.13.05 Insulation material to be used shall be as per accepted International Standard. For details about the insulation, please refer Section-II, Volume-II-D1 (Specification for Power Cycle & other piping, valves and specialties) of this specification.
- 5.14.00 **Soot Blowing System**
- 5.14.01 Adequate soot blowing arrangement as regards number, type and location of soot blowers shall be provided to ensure that the heating surface of the boiler and air preheaters can be kept free of fouling, and the conditions of operation and the guaranteed gas outlet temperature can be maintained continuously. Soot blowers shall be provided for the furnace, superheaters, reheaters, economizer, SCR and air heater, complete with all piping and accessories, including valves, controls and control panels. The type of soot blowers to be provided for different sections of the boiler shall be as below;
- Valves for soot blower operation shall include pneumatically operated pressure reducing control valves, (one control valve of 0-100% capacity for all types of blowers taken in service in any combinations, one standby 0-100% capacity motorised inching valve with position feedback, drain valves), isolating valves with motor drives up stream of each of pressure control valves, all other valves and steam supply lines as required for soot-blower operation
- i) For furnace chamber : Short rotary, single nozzle, retractable type.
 - ii) For SH, RH, Economiser : Long Retractable Soot Blowers.
sections
 - iii) Air pre-heaters : Power driven swinging arm soot blower or retractable multi-nozzle soot blower.
- 5.14.02 The design of air pre- heater soot blowing system including piping, valve and fittings shall allow use of high temperature steam from high temperature auxiliary steam header during start-up. A check valve and/or motor operated valve shall be provided on this high temperature line to prevent normal soot blowing steam from entering auxiliary steam header.
- Safety valve of adequate capacity and setting pressure shall be provided on the soot blowing lines. The location of elements, travel and nozzle angles shall be such that maximum cleaning is obtained with a minimum of flowing medium. The soot blowing system design shall be of self-draining type.
- 5.14.03 Soot blowing system elements shall be manufactured from extra heavy seamless tubing of high temperature alloy steel. Heat, corrosion and erosion protection shall be provided for parts in permanent contact with hot gases.
- 5.14.04 Soot blower nozzles shall be single or multiple row of nozzles welded to prevent falling out during service. Venturi or straight bore nozzle shall be installed as per system requirement.

- 5.14.05 Retractable soot blowers (RSB):
- i) RSBs shall be retractable even during emergencies such as drop in steam supply pressure and low steam flow etc.
 - ii) Long RSBs shall be half of steam generator width on each side.
 - iii) RSBs shall be controlled from Plant DDCMIS and shall be actuated by electric motors. Dual electric drive shall be provided.
- 5.14.06 DDCMIS controlled soot blower control system shall be provided for sequential operation of all soot blowers, soot blower steam pressure control and drain temperature control etc. All soot blowers complete with all necessary transmitters, indicators, limit switches, alarm etc. shall be furnished. The control shall be so designed that it shall permit operation of any group of soot blowers repeatedly in sequence as necessary and also shall permit omission of any soot blower (s) in a cycle. Bidder shall refer Volume – II E of this specification for other details.
- There shall be clear indication in the DDCMIS HMI mimic as to which blower in sequence has completed operation and which blower is in service. Suitable mimic diagram shall be provided with indicating lamps showing position of each soot blower.
- 5.14.07 All soot blowers shall be suitable for local and remote automatic sequential operation. Emergency hand crank shall be provided for each.
- 5.14.08 Motor Control Centre (MCC) for soot blowers shall be draw out type, multi-tier, compartmentalised, double front type suitable for bottom entry of cable and shall be subject to approval of Owner / Consultant. For more details, refer Volume-II-F/1 & F/2 of this specification.
- 5.14.09 Warming- up of complete piping system before the start-up of soot blowing operation shall be facilitated by providing adequate number of pneumatic drain temperature control valves. Each pneumatic temperature control valve shall have bypass line with adequately sized orifice plate for draining the system when the valve is closed. Temperature detectors shall be provided on the drain lines to ensure satisfactory warming-up and initiation of blowing operation.
- 5.14.10 Provision shall be made to maintain the soot blower heads free of deposits during the periods when they are retracted and are not in operation.
- 5.14.11 The soot blowers shall be accessible from local operation platform and platforms/galleries etc. shall be provided at and around the soot blowers to facilitate maintenance and inspection.
- 5.14.12 Adequate number of wall blowers shall be provided for the furnace walls capable of cleaning the wall surfaces.

- 5.14.13 The Bidder shall supply steam and drain piping network of the complete soot blowing system including pressure control station, isolating valves for maintenance as required, sectionalizing valves, automatic drain valves suitable for remote sequential operation having instrument and control for soot blower panel.
- 5.14.14 The location of the steam source shall be decided by the Bidder to suit the requirement. Necessary valves to reduce steam pressure to the pressure required for blowers shall be provided by the Bidder.
- 5.14.15 The lubricants used for the soot blowers shall be suitable to withstand hot conditions. The Bidder shall submit relevant details of such lubricant.
- 5.15.00 **Coal Preparation and Firing Equipment**
- 5.15.01 Coal preparation and firing system shall commence with motor operated shut off gate at bunker outlet and include pulverisers, feeders, slide gates, primary air, seal air fans, coal pipes, pulverized fuel burners and associated auxiliaries.
- 5.15.02 The coal preparation and firing system design shall ensure complete safety of the plant, equipment and the personnel and shall be in compliance with the latest NFPA (USA) requirements and other requirements specified
- 5.15.03 Circular bunkers one number for each mill shall be provided. For other requirements of bunker, the Bidder shall refer Annexure-I of this section. For each Steam Generator, Coal Mills shall be arranged on each side or front or rear of the boiler as per proven practice of bidder without altering boiler pitch and D-row to chimney length as specified in specification.
- 5.15.04 Coal shut off gates / valves and coal chutes
- i) Bunker shut off gate(s) and coal feeder inlet gate(s) shall be provided with the following features:
 - a) Size of gates / valves shall be suitable for round bunker opening of minimum 914.4 mm diameter.
 - b) Shut off guillotine gates / valves shall be motor operated, with double rack and pinion drive arrangement and shall be of non-jamming type.
 - c) Gate / valve design shall ensure dust tight enclosure and shall be of self-cleaning type.
 - ii) All components coming in contact with coal and the roller bearing of motorized rack-pinion drive shaft shall be of stainless steel material.
 - iii) Shut off valves / gates shall be designed to operate with "bunker full of coal" condition without its motor getting overloaded. Normal motorized as well inching operation of these shut off gates / valves should be

possible from the feeder floor. For manual operation from feeder floor level, wheel and chain shall be provided for each gate / valve.

- iv) The chutes between bunker outlet gate and inlet to the coal feeder shall not have internal diameter less than 914.4 mm. The chute between feeder outlet and pulverizer inlet shall not be of internal diameter less than 600 mm.
- v) The chutes shall be made of minimum 12 mm thick Stainless steel of grade 410 material and shall be of fully welded construction. The chute between feeder outlet and pulverizer inlet shall have a Stainless steel lined hopper with suitable reinforcement. The provision shall be made for the insertion of poke rods in two directions right angle to each other at outlet of the bunker and inlet of the feeders.
- vi) Suitable coupling shall be provided for chute connection(s) at outlet of feeder and pulverizer with SS 410 inner ring.
- vii) The arrangement of permanent bunker emptying chute along with necessary coal flow diversion valve shall be provided between each bunker and Raw Coal feeder. Necessary access shall be provided for operation of coal flow diversion valves. The emptying chute shall enable for unloading of bunkers on trucks at ground level. An arrangement with a temporary chute fitted on the bunker downspout along with a permanent chute from the feeder floor to the ground level shall also be acceptable.
- viii) Suitable indicators shall be provided in the downspout between bunker and feeder to detect presence of coal flow to ensure minimum seal height at inlet to feeder and trip the feeder if the level of coal tends to be below the seal height.

5.15.05 Raw Coal Feeders

- i) The raw coal feeders shall be of Gravimetric Belt feeder, composite type having automatic tensioning feature or Gravimetric belt type feeder. Minimum size raw coal (RC) feeders shall be of 914.4 mm (36") ID. Each RC feeder shall be sized for 1.2 times the maximum capacity of coal pulveriser. The feeder casing shall be designed for not less than PA fan shut-off pressure and shall withstand an explosion pressure of 3.5 kg/cm²(g). Operating pressure of 0.14 kg/cm² capability as per NFPA norms.
- iii) The RC feeders shall comply with all the stipulations of NFPA.
- iii) The feeder belt shall be of multi-ply reinforced rubber of single piece construction with arrangement for tracking and to prevent spillage. The width of the belt shall have sufficient margin while operating in conjunction with feeder inlet opening. Suitable arrangement shall be provided to adjust belt tension.

- iv) All components coming in contact with coal (except belt) shall be made of stainless steel.
- v) All site equipment shall be suitable for 70°C ambient temperature and other environment conditions envisaged.
- vi) Detection for “No coal” flow shall be provided to stop the feeder when no coal is detected on the conveyor and when pluggage occur at feeder outlet. Paddle type coal alarm switch shall be provided for this purpose over the feeder conveyor for indication of loss of coal flow and near the feeder discharge to stop the feeder in the event of coal pluggage at the feeder outlet.
- vii) The Coal feeder shall be minimum of two nos. of load cells validating continuously each other. In case of deviation/malfunction of either of the load cells the controls shall automatically switch over to volumetric mode without any operator intervention but alarm contacts shall be generated.
- viii) Feeder shall be complete with all field instruments and feeder speed drives (VFD) which is suitable in all respects for continuous service under all conditions of pulverizer operation. The Coal feeder shall be automatically operated by the control and monitoring (such as feed rate, totalized weight, motor RPM, feeder speed, material density) functions for coal flow and feeder speed in the unit operating station.
- ix) Each feeder shall have an adjustable rate of feed from a minimum to the maximum pulverizer capacity. The feeder control function shall permit variable adjustment in feed rate, either automatically or manually by the operator, while the feeder is in operation and without interrupting the supply of coal to the pulverizer. Approved type of suitable indicators shall be provided in the downspout between bunker and feeder to detect presence or flow of coal to ensure minimum seal height at inlet to RC feeder and trip the RC feeder if the level of coal tends to be below this seal height.
- x) The feeder control system shall be microprocessor based. Coal weighing shall be automatic and shall include local and remote indication for rate of flow and totaliser counter. The feeder control cabinet shall be located in control equipment room (CER).
- xi) The weighing accuracy of the feeder shall be + 0.5% with repeatability of 0.1%. Facility for in-built calibration shall be provided.
- xii) The following facilities shall be provided for the feeders:
 - a) Spraying water inside the casing.
 - b) Providing purge air to the feeder.
- xiii) Feeders shall be provided with adequate number of manholes for quick and easy release of the feeder jamming. Easy access to any part of the

feeder internals shall be possible without dismantling the complete casing.

5.15.06 Coal Pulverisers (Mills)

i) Pulverizer type:

The coal pulverizers shall be of vertical spindle type. The pulverisers offered by the Bidder can be Bowl mills or Roller mills or Ball & Race mills or approved equivalent type.

For the number of mills and the capacity of each milling system refer Specific Design Criteria, Annexure-I of this section.

ii) Classifier design:

- a) The classifier design shall be of dynamic type with variable voltage variable frequency drive and shall be capable of maintaining rated conditions of fineness under all conditions of operation, load changes and specified fuels. Further, the classifier vanes shall be adjustable externally and shall be lined with suitable wear resistant material to ensure the guaranteed wear life.
- b) The dynamic classifier shall ensure reduction in particle of 50 mesh without increasing 200 mesh percentage to ensure uniform sizing and distribution of particles. Fineness adjustment shall be possible while the mills are in service. However, expected output from pulverizer shall be 75% thru 200 mesh (75 microns) and 99% thru 50 mesh (300 microns), even for total moisture content as high as up to 15% in coal or maximum range of moisture as per contract, whichever is higher.
- c) Outlet of the classifier shall have aerodynamic shape to prevent eddies. The classifier vanes and cones shall be lined with wear resistant material to ensure the guaranteed wear life.
- d) Proven fire detection and fire extinguishing systems in line with the standard practice of the manufacturer shall be provided. In case of CO₂/N₂ based system, the scope of supply shall also include the required cylinder/piping and valves network etc. In case, the proposed type of mill requires inerting during start-up/shut-down of the mill to ensure safety of operation, suitable system along with all piping, valves, instrumentation, interlock system etc. shall also be provided.

iii) Mill noise level:

The mill noise level shall not exceed the specified values in Vol-II-A and Vol-I-B of this Contract. While selecting lagging, background noise from adjacent mills, drive system and other secondary and stray noises shall be taken into account.

iv) Mill seal air system:

- a) 2 x 100% seal air fans common for all the mills shall be provided for each steam generator unit. The fans shall preferably be located at ground floor. For selection of seal air fans, the Bidder shall refer Annexure-0I of this section.
- b) The sealing system shall prevent ingress of any dust into the bearings and leakage of coal-air mixture to atmosphere.
- c) The seal air fans shall take their suction from atmosphere or PA fan discharge common header. Silencers shall be provided, if required, at the suction of the fans to restrict noise level within permissible limits.

v) Mill gear box:

The gear box shall be of planetary type. The gear box design shall ensure that there is no ingress of coal dust into gear box under all conditions of operation. The gear box shall give trouble free operation of not less than 100,000 hours of mill operation.

vi) The mill motors shall be adequately sized and selected motor capacity shall enable restart of the mill after a trip with mill full of coal. Such restart shall not call for any emptying of the mill.

vii) Inlet coal pipe between RC feeder and the mill shall not have any reduction in section throughout the length, including at entry point on top of the mill.

viii) Each mill shall be fed with coal by an independent coal feeder.

ix) Materials of construction:

- a) The material of construction of wear parts shall be selected taking into account highly abrasive nature of coal resulting from coal contamination with silica sand and alpha-quartz.
- b) The grinding rings/ race shall be made of material having hardness of minimum 550 BHN at the surface with adequate chilled depth. The grinding balls/ rolls shall be of material with minimum hardness 350 BHN. Minimum difference between hardness of rings/race and balls/rolls shall be 100 BHN.
- c) The classifier cone shall be lined with minimum 15 mm thick ceramic tiles on both inside and outside surfaces of the cone. The classifier vanes shall be lined with suitable material to provide minimum specified wear life.

x) Lubrication system:

The design of lubrication system shall ensure continuous operation of mill bearings. Suitable arrangement shall be provided for readily determining the oil level in the gear box(es) and all other lubricated parts. Each pulverizer shall be provided with necessary lubricating system comprising of 2x100% lube oil pumps, 2x100% lube oil coolers and 2x100% filters.

xi) Pulverized coal sampling:

a) Tapping points shall be provided with ball valves on each pulverized coal pipe at mill outlet and shall be suitable for coal sampling as per ISO 9931. The sampling provisions shall be complete with screwed plugs, compressed air purging connections at tapping points, heating arrangement and other requirements as per ISO 9931.

b) Minimum one (1) no. of Rota probe shall be provided for each steam generator for coal sampling as per ISO 9931. Further, adequate nos. of Dirty Pitot tubes shall be provided on individual coal and air pipe(s) for each steam generator for measurement of coal-air velocity suitably.

c) Convenient approach/access from nearest platform floor shall be provided for coal sampling/ measurement points.

xii) Mill outlet temperature control shall be capable of achieving and maintaining rated temperature for adequately drying the specified coal range for all unit loads.

xiii) The flap/gate of power operated mill discharge valves shall be totally out of coal path during operation of the mill.

xiv) All mill wear parts shall be arranged so as to facilitate easy replacements without total dismantling of mills.

xv) The mill shall be capable of running at part loads and ensure minimum turn-down ratio of 3:1.

xvi) The pulverizer shall be designed to facilitate easy handling of the heavy parts for maintenance purpose. Mill bay crane with motorized hoists shall be provided for lifting of heavy parts. A set of torque wrench, erection cradles, jacks etc. required for maintenance shall also be furnished.

xvii) Adequate numbers of access doors/windows with access ladders shall be provided to facilitate access to various parts of mill. The access doors shall be suitable for on load inspection and maintenance of the mill. The oil pumps and filters shall be readily accessible.

- xviii) Necessary ladders and approach platforms for mill bay hoist shall be provided at one end/ corner to carry out any maintenance activity on hoists. Access platform shall also be provided for each Mill Discharge Classifier.
- xix) Mill handling arrangement complete with crane and handling facilities along with removal space shall be provided. In case of Front / Rear Mill arrangement contractor shall provide two number of hoist/crane for Mill handling arrangement. Monorail /structure shall be extended in both side so that one hoist/crane shall be parked at either side while working with another hoist. For side mill arrangement, one bay shall be provided as maintenance space on each side. For front mill and rear mill arrangement, one maintenance bay shall be provided on both side of mill bunker building. The mill maintenance bay shall be of minimum 7.0 m width.

5.15.07 Minimum Guaranteed Life of Coal Pulverizer Wear Parts

The guaranteed life of different mill components in “equivalent hours” of continuous mill operation at its rated capacity, while firing the specified range of coals and without requiring any in between repair or replacement shall be as under :

Sl. No.	Item	Minimum Life in Equivalent Hours
1.	Seals	20000
2.	Grinding Elements (Rolls & Rings)	10000
3.	Mill Discharge valves	15000
4.	Classifier cone and other items lined with Ceramic materials	25000
5.	Classifier vane	25000

The Bidder shall indicate YGP (Yancey, Geer and Price method) index considered for design of wearing components, and shall furnish curves along with his offer indicating the variation in guaranteed wear life with variation in YGP index of coal fired. Separate curves for different wear elements of mill shall be furnished i.e. grinding rolls, balls, rings etc. The curve shall be subject to Owner's / Consultant's approval.

5.15.08 Pulverized Coal pipes

- i) In addition to sizing and design criteria elaborated for pulverized coal pipes in Annexure-I of this section, the following requirements shall also be adhered:
 - a) The design and arrangement of fuel pipe, with fixed orifice installation, shall ensure uniform distribution of coal air mixture between all burners served by one pulverizer under all operating

conditions. The life of the fixed orifice assembly shall not be less than 20000 hrs.

- b) The coal air mixture velocity in the coal pipes shall not be lower than the critical fallout velocity under all conditions of mill operation from start-up of boiler onward.
 - c) The fuel pipe shall preferably have no horizontal run and if horizontal run is necessitated due to layout constraints it shall tilt either towards mills or burners.
 - d) Calculated static loading of each support of the pulverized coal pipes shall be increased by at least 25% to arrive at the design load, to take care of the shock loading, occurring in the pipe work under abnormal conditions of operation.
 - e) Maximum permissible design stress shall be yield or 0.2% proof stress.
 - f) Mill discharge valve on pulverized fuel line shall also have provision of manual operation mechanism locally and provision of its external local position indication.
 - g) Fuel pipes shall be arranged and supplied so that they are easily replaceable.
 - h) Coupling and toggle section arrangement for fuel piping shall be provided to take up the furnace expansion.
 - i) The guide plates, wherever provided in the coal pipe, shall be removable and access to them shall be obtained through detachable cover. The guide plates shall be made up of suitable abrasion resistant material.
 - j) Purge air connections shall be provided after the mill discharge valve to clean pulverized coal pipes of any deposits etc.
- ii) The guide plates, wherever provided in the coal pipe, shall be removable and access to them shall be obtained through detachable cover. The guide plates shall be made up of suitable abrasion resistant material.
 - iii) Purge air connections shall be provided after the mill discharge valve to clean pulverized coal pipes of any deposits etc.
 - ii) In addition to fixed orifice as specified above, for on load coal flow balancing adjustable valve/orifice of erosion resistant/ceramic coated material suitable for highly abrasive pulverised coal applications. The adjustable valve/orifice shall be provided on each PF pipe at pulverizer outlets. On load coal flow balancing in PF pipelines shall be for range of coal and complete operating load range.

- 5.15.09 Mill Reject Handling System as required (For details, refer Volume-II B, Sec-IV) to be provided by the Bidder.
- 5.15.10 Mill Inerting System (with steam) shall be supplied by the Bidder.
- 5.15.11 Coal Burners
- a) Burners design
 - i) Turn down ratio of coal firing system shall be 3:1 (minimum).
 - ii) The coal burner design shall ensure a steady log mean density of coal air mixture distribution as it enters the combustion zone, without allowing the coal dust to settle down. Capacity of coal burner shall be such that it can cater 100% BMCR with any of specified fuel firing within range.
 - iii) The burner design shall minimize erosion.
 - iv) The burner shall be designed to ensure smooth variation in the fuel flow without affecting the air to fuel ratio. Burners shall be capable to ensure 40% BMCR load output without oil support.
 - v) The air to fuel ratio around the burner shall be optimized to ensure low emission of NO_x considering reagent consideration. Low NO_x Burner of proven design with matching furnace design along with necessary over-fire air arrangement and dynamic classification shall be suitable to restrict NO_x emission at economizer outlet within 325 mg/Nm³ at 6% excess oxygen (dry) for 40% BMCR to 100% TMCR load condition for range of coals specified.
 - vi) Burners shall be provided with Burner management system / FSSS control with flame scanner and safety protection.
 - b) Burners construction
 - i) Each coal burner shall be served by one separate coal pipe and shall be provided with one knife edge type gate valve at burner inlet. The valve shall be power operated and hooked up to burner management system.
 - ii) The material and construction of burner shall withstand radiation from the furnace and shall not be damaged when not in use.
 - iii) The parts subjected to high temperature which cannot be protected by other means shall be made of heat resistant alloy steel (A297 Gr. HH or equivalent). Further, burners parts subject to abrasion that may require replacement at frequent intervals shall be easily removable.

- iv) Burner design shall ensure freedom from deposits and distortion under all operating condition in the furnace. Further, burners shall not require adjustment to maintain flame shape.
- v) Minimum operating life of burner parts without requiring any maintenance and replacement shall be guaranteed for minimum 16,000 hours.
- vi) Burner shall be removable or replaceable from outside the steam generator without entry to the furnace.
- c) Air register (if applicable) construction shall be such that tangential air vanes are always free to move. The support bearings shall preferably be located outside. In case the support bearings are located inside, minimum period of operation shall be 20000 hours without calling for maintenance of any sort during this period.
- d) The angle at confluence between the coal burner primary air and secondary air shall be such that the inherent carbon monoxide produced is removed by scrubbing action without any significant reduction in velocities of the air stream.

5.16.00 Primary Air (PA) Fans

- 5.16.01 Primary Air (PA) fans shall be constant speed, two stage, horizontal axial flow type with variable blade pitch control.
- 5.16.02 The PA fans shall be suitably designed to cater maximum capacity of the pulverisers. The Bidder shall provide two (2) nos. primary air fans for each steam generator. The fans shall meet all the criteria specified in Annexure-I of this section.
- 5.16.03 The fans shall take suction from atmosphere. The fan characteristics shall be compatible with pulverized coal system resistance and boiler operation from start-up to rated load. Fans shall have stable characteristics suitable for parallel operation and sharing of the load equally without hunting over the entire load range. The fans shall be so selected that the best efficiency point lie close to the 100% TMCR operating with design coal.
- 5.16.04 Fan flow control shall be by hydraulically operated blade pitch control mechanism.
- 5.16.05 The rotor assembly shall be supported on splash or forced oil lubricated bearing assemblies consisting of antifriction/sleeve bearings. Where forced oil circulation system is provided, the same shall consist of two (2) lube oil pumps and two (2) oil coolers (one set working and the other standby) with oil reservoirs, piping, valves, duplex strainers, sight glasses, local & remote instruments etc. for each fan.

Each oil reservoir shall be furnished with non-breakable type direct level gauge, drain connection with cock for full draining of oil into a receptacle etc.

- 5.16.06 Fan impellers shall be balanced in the manufacturer's shop, statically and dynamically to eliminate vibration at all operating speeds. The balancing may be checked at site and adjusted, if necessary. Fan vibration monitoring pads shall be provided.
- 5.16.07 The fan design shall be simply supported type. The layout of fans shall ensure interchangeability of the respective impellers. Similar fans shall have same direction of rotation.
- 5.16.08 The fan casing shall be split type to provide easy removal of the fan wheel or impeller for replacement or repairs. Access doors shall be provided in each suction chamber and casing. The casing section shall have gasketed joints to ensure air-tight sealing. Drain connections shall be provided at the bottom most point of fan housing.
- 5.16.09 The suction shall be provided with rigid bird and trash screen assembly and shall have suitable arrangement to avoid rainwater directly entering the fan. The suction hood shall be so located that entry of dust is minimized.
- 5.16.10 Fans shall be provided with silencers as necessary in order to limit the noise level as specified in Lead Specification Volume-II A, Section-IV.

5.17.00 **Fuel Oil Firing System**

5.17.01 General

- a) The oil firing system shall include LDO/HSD system to be used for startup and load carrying purposes up to 30% (minimum) BMCR load without Coal firing. High-energy arc igniter shall be provided.

The design of LDO/HSD burners shall be suitable for proven practice of air atomization to facilitate cold start-up of the boiler. Necessary service air compressor capacity for air atomization shall be considered. All LDO/HSD burners shall be with air atomization with same gun and different set of burner valves for Air atomizing system. The system shall include piping, valves including control valves, strainers, burners, control & instrumentation etc.

The Bidder shall indicate the pressure, flow and temperature requirements for adequate sizing of the system. Bidder shall review the sizing / losses in the fuel supply pipeline so as to ensure that the required flow and pressure at the burner end is met.

- b) The burners shall be arranged for automatic advancement and retraction under interlock. The burner shall be air cooled type using station service air.

The burner shall be arranged for ease of operation and withdrawal and shall be supplied complete with tips, extension pipes, atomizers, burner shut off valves, flexible hoses and accessories.

- c) Connection of oil pipe to burners shall be such that no leakage can enter the furnace when the burner is not in use. For this purpose, the oil header shall be at a lower level compared to the burners.
- d) The oil burner unit shall be supplied with necessary igniters complete with wiring, transformers, local push button station for actuation and all accessories for ignition of light diesel oil, HEA Igniter, flame monitoring equipment with necessary interlock with igniters and oil valves, instrument controls and any other accessories.
- e) The material used for the burner tips shall be resistant to corrosion by fuel oils and fuel oil ashes containing sodium, vanadium, chlorides, sulphur etc. and shall be capable of withstanding at least 16000 hours of operation without any maintenance. The burner tip shall ensure leak tightness.
- f) All surfaces of the atomiser shall have a minimum Vicker's hardness number of 400. This hardness shall be retained even at 400°C
- g) Fixed drip trays with easy means of emptying shall be provided at each oil burner to contain any oil leakage. Oil drain from the drip trays shall be piped up to a common dirty drain oil tank (one number per boiler) located suitably near the boiler.
- h) Flame monitoring system shall be complete in all respects to scan both oil fire and Coal fire separately.
- i) Local control panel for the Fuel oil firing system shall be supplied by the Bidder, complete with its engineering in respect of cable schedule and interconnection chart covering the entire system.
- j) All oil drain valves shall be lockable (with a padlock) type. Oil gun cleaning station and the facility for blow off of the oil guns using auxiliary steam. For this purpose auxiliary steam tapping with necessary isolation valves and necessary hose connection shall be provided. Service air connection for cleaning the oil gun nozzles shall also be provided.

5.17.02 The design of fuel oil system shall ensure that compliance with the following operational requirements:

- i) Facility for Auto start and shutdown of drain oil pumps in conjunction with level in the drain oil tanks. The discharge of SG area drain oil tank shall be routed to FOPH drain oil tank.
- ii) Separate flame viewing opening/facility for boiler operation and for flame monitoring at each burner from outside of the boiler viewing heads to have provision:
 - (a) To keep it cool below 75°C.

- (b) To keep optical system clean during firing / non-firing by pressurized air.

5.17.03 Complete Fuel oil system shall also be capable of firing High Speed Diesel Oil (HSD) on sustained basis.

5.18.00 **Cooling system for scanner**

The proposed equipment shall consist of two (2) numbers (2x100%) of scanner air fans (one working and one standby, one connected in emergency bus.

The suction for the scanner air fans shall be tapped off from the cold air Interconnecting duct at FD Fans outlet. Pneumatic isolation dampers at the suction side of each scanner air fan shall be provided. The outlet of the fans shall be connected to a common "Auto Transfer Damper". The drive motors for these fans shall be furnished. Complete ducting/piping with dampers, air filters, supports/hangers from the suction point to the scanner air fans and from the fans to the scanners and complete equipment required for the operation of scanners shall be provided.

An emergency air supply duct from a separate source (atmosphere) with a damper shall also be provided for supply of cooling air to scanners, in case the FD Fans trip.

5.19.00 **Forced and Induced Draft Fans and Drives**

5.19.01 The Bidder shall provide two (2) nos. Forced Draft (F.D.) fans and two (2) nos. Combined Induced Draft (I.D.) fans or ID fans with separate booster fan for each steam generator. The fans shall meet all the criteria laid down in Specific Design Criteria, Annexure-I of this section.

5.19.02 F.D. fans shall be of the horizontal, constant speed, axial type, with variable blade pitch control. I.D. fans shall be of two stage, horizontal, constant speed, axial type employing variable blade pitch control. Fans shall be so designed that the critical speeds are not less than 125% of fan's maximum operating speed. Fans shall be driven by constant speed induction motors.

5.19.03 The fans shall be capable of maintaining balanced draft condition in the furnace over the entire load range and with any one or both F.D fans and anyone or both I.D. fans in operation while burning fuel as specified. Fans shall have stable characteristics suitable for parallel operation and sharing of the load equally without hunting over the entire load range.

5.19.04 Fan impellers shall be balanced in the manufacturer's shop, statically and dynamically to eliminate vibration at all operating speeds. The balancing may be checked at site and adjusted, if necessary. Vibration monitoring pads shall be provided. For I.D. fans, abrasion and wear resistant, high BHN steel having minimum 8.0 mm thickness or 8 mm mild steel with liner of thickness 10mm (min.) or fan casing thickness of 22 mm (min.) of Mild steel shall be provided. The ID fan components such as blades, hubs, casing etc. shall be chosen to encounter the high dust burden of the order of 250 mg/Nm³ in case of failure of

one ESP. Also, ID fan internals shall be suitable to take care of temperature surge of about 300⁰ C for about 30 minutes, due to failure/outage of any one of the air heater.

- 5.19.05 The rotor assembly shall be supported on splash or forced oil lubricated bearing assemblies consisting of antifriction or sleeve bearings. Where forced oil circulation system is provided, the same shall consist of two (2) x 100% lube oil pumps and two (2) x 100% oil coolers (one set working and the other standby) with oil reservoirs, piping, valves, duplex strainers, sight glasses, local & remote instruments etc. for each fan.
- 5.19.06 Each oil reservoir shall be provided with non-breakable type direct level gauge, drain connection with cock for full draining of oil into a receptacle etc.
- 5.19.07 The flow control of axial flow fans shall be achieved by variable blade pitch control. Outlet shut-off dampers shall also be provided for the fans.
- 5.19.08 The fan design shall be simply supported /over hung type. The layout of F.D. and I.D. fans shall ensure interchangeability of the respective impellers. Similar fans shall have same direction of rotation.
- 5.19.09 The fan casing shall be split type to provide easy removal of the fan wheel or impeller for replacement or repairs. Bidder shall also provide rolling diffuser / inlet box instead of split type casing for on-site maintenance. Diffuser (in case of single stage and two stage fans) and inlet box (in case of two stage fans) are mounted on rails for ease of maintenance of hubs and blades. Access doors shall be provided in each suction chamber, casing and diffuser. The casing section shall have gasketed joints to ensure air-tight sealing. Drain connections shall be provided at the bottom most point of fan housing.
- 5.19.10 The F.D. fan suction shall be provided with rigid bird and trash screen assembly and shall have suitable arrangement to avoid rainwater directly entering the fan. The suction hood shall be so located that entry of dust is minimized.
- 5.19.11 Fans shall be provided with silencers as necessary in order to limit the noise level as specified in Volume-IIA of this specification
- 5.19.12 For type of foundation for ID and FD fans, the Bidder shall refer to Volume-II-G/1 of this specification.
- 5.20.00 **Structural Steel**
- 5.20.01 The boiler framing as a whole and all component members shall be designed in accordance with relevant "Indian Standards". The steel structure shall be designed for earthquake conditions as per IS-1893 and also to withstand wind loads as specified in IS-875. The same earthquake considerations shall apply to the boiler components and piping. Structures shall be capable of accepting seismic loading in addition to other loadings including dead weight load, wind forces etc.

5.20.02 The unit shall be carried on a self-contained steel framework completely separated from Power House building structure. The Bidder shall furnish all structural steel required to support the equipment covered under this section - the steel structures including columns, base plates, HT bolts, anchor channels, girders, beams, pipe supports, hangers and other steel necessary for the proper supporting of the boiler accessories. The shop connections can be welded. Field connections shall be bolted with high strength bolts. Required structure for the side cladding and roofing are also included in the scope of supply.

5.20.03 Walkways, Platforms and Stairs etc.

The exact requirements of the access platforms, walkways, stairs etc., depending upon the layout and location shall be subject to Owner's approval during detailed engineering. Contractor shall furnish detail floor plan drawings covering all platforms and shall clearly indicate all the dimensions of platforms and clear platform floor area in each drawing.

- a) Walkways, platforms and staircases shall be provided (without any interruption from the intervening pipes, columns, actuators, instrument enclosures, racks etc.) in accordance with following clear width requirement)
 - i) Operating platforms and maintenance access walk ways : 1500 mm.
 - ii) Other walk ways : 1000 mm.
 - iii) Staircase : 1200 mm.
 - iv) Ladders shall be acceptable only in such cases where it is not possible to provide stairs and shall be subject to specific approval of client except at places where ladders have been specifically specified. Ladder minimum clear width shall be 400mm.
- b) Platforms with necessary access shall be provided at all burner levels and all around the furnace to facilitate operation, service and maintenance of all burners and associated auxiliaries. The platforms shall extend upto minimum 3 m from furnace walls.

However, where there are layout constraints, it shall be minimum 2.7 m.
- c) Platforms shall allow complete burner withdrawal. The platforms at each burner elevation shall be continuous and run at same level without any interruption from intervening steps and obstructions etc. Adequate space shall be provided for placing local instrument enclosure/ racks and for performing maintenance work including enough space for door opening.
- d) The burner platforms within 200 mm of igniter shall be welded steel chequered plate with edges welded-in place to prevent oil spillage from spreading.

- e) Storage platforms for storing of scaffoldings, APH baskets and other maintenance item during overhaul of steam generator(s).

5.20.04 Personnel access requirements:

Personnel access shall be provided for Class I, Class II and Class III areas as per following:

i) Class I area

These are regularly attended access areas such as operating platforms which are fully accessible from an elevator landing. Elevator landings shall be envisaged to access the important areas.

- a) Burner platforms shall have direct access to elevator unless levels are so close together that the 3500 mm minimum elevator door spacing does not permit separate elevator opening at each level. In such case, access stairs shall be provided for each burner level.
- b) Observation ports, lubricated equipment, bearings, soot blowers, instruments, Analyzer Panel/shelter, LIE/LIR, Junction Box, PDB, valves actuators and equipment requiring access during operation and for normal day-to- day inspection and maintenance shall have adequate platforms for access.
- c) Ash hoppers requiring fly ash removal by the ash handling system shall have adequate platforms for access to fly ash intakes/isolation dampers.
- d) Boiler scaffolding inspection door shall be accessible from elevator landing.
- e) All field control and instrumentation equipment.

ii) Class II area

These are maintenance access areas such as furnace access doors, superheater and reheater access doors, safety valves actuators, instruments, valves & Dampers and actuators, mechanical equipment, all expansion joints etc. and other areas requiring access only monthly or annually. These shall have access platforms of adequate size to permit two people to work (approximately 1.5 m²) with access ladders and maintenance access walkways for reaching the platforms. Access shall be provided on both sides of safety valves.

iii) Class III area

These are maintenance access areas where access is only required for painting, re-insulation or replacement of components which have a service life of 10 years or more. These shall have facilities to enable the Erection Bidder to erect scaffolding, temporary ladders, platforms and

safety nets to safely perform the work involved other than for the low temperature superheater and economizer requirements brought out elsewhere.

5. 20.05 Access platforms etc. shall also comply with the following requirements:

- i) Platform at same elevation on each side of steam generator shall have a walkway connecting the two sides.
- ii) Platforms requiring access from the elevator shall extend to the elevator entrance and shall be attached to the elevator steel as required.
- iii) All type of Soot blowers shall have operating platforms along the entire length of retractable blowers and adequate space for removal, handling and maintenance of rotary blower elements shall be provided.
- iv) Provide escape ladders from any platforms having dead ends at the rear of the steam generator.

Platforms of minimum clear width of 1500 mm shall be provided on at least three sides of the control station/ equipment. The platforms shall be all along the length of soot blower control station, Fuel oil control station, SH & RH spray control stations, for all steam & water vent and drain stations, safety valves, SCAPH control station, steam/water sample coolers, APH lube oil station, all levels of SCR etc. Access through Elevator, staircase and main access walkways for reaching the platforms shall be provided.

- v) All LRSB's shall have minimum 1500 mm wide platforms on both sides along the entire length of soot blowers. Platform width should provide adequate space and service area for removal and handling of blower elements in one piece. Access through Elevator/staircase and main access walkways for reaching the LRSB platforms shall be provided.
- vi) For soot blower locations which are envisaged / identified for future installation, provision shall be kept in the layout space and their loads shall be accounted for in the structure design so that the necessary access/platforms, as required, can be installed in future.
- vii) All manholes, all access doors, all observation ports, all instruments including flame scanners, flame cameras & ash level indicators/, Junction Boxes for control and instrumentation, all instrument test/sampling points & coal sampling points shall be accessible from main access walkway/platforms. In case the lowest point of the manhole/access door/ exceeds 800 mm and of observation ports & coal sampling points/instruments exceeds 1200 mm from the nearest walkway/platforms level then suitable intermediate platform to each of the above access doors, observation port, sampling points, instruments etc. along with suitable approach from nearest platform level shall be provided. Minimum height of the observation port shall be 500mm from the platform/intermediate platform.

- viii) Platform should be provided for removal and handling of startup drain re-circulation pump, motor, cooler. Adequate Clear space around BCP handling to be provided with electric operated handling system for handling of BCP from ground level. Direct access through Elevators without use of stairs for reaching the platforms shall be provided.
- ix) Annular platforms of 1200 mm clear width accessible by stairs/ladders shall be provided for Mill discharge valves & Bunker outlet gates.
- x) Continuous platforms of minimum clear width of 1500 mm shall be provided all around Furnace seal trough level. Access to these platform levels will be by staircase.
- xi) The interconnection between two platforms/floors at different elevations shall be through proper staircase. Ladders shall be considered only in exceptional case where provision of staircase is not possible.
- xii) Hand railings and toe guards of minimum 150 mm height shall be provided for all walkways, platforms, openings, staircases etc. complying with the requirements specified.
- xiii) If material is stacked or stored on a platform or walkway, or near a floor opening, kick plate/toe guard must be increased in height or solid or mesh panels of appropriate height must be installed to prevent the material from falling.
- xiv) All areas subject to lube oil or chemical spills will be provided with curbs and drains.
- xv) Gratings shall comply with all requirements as specified below
 - (a) Floor grating for floors, platforms, stair landings, any other locations will have minimum 5 mm thick bearing bars on 40 mm centers, 32 mm deep.
 - (b) Cross bars will be spaced 100 mm on centers and electro-forged into the bearing bars to provide a non-slip surface.
 - (c) The gratings will be made of steel conforming to IS: 2062 and hot dip galvanized.
 - (d) Galvanization will be done as per IS: 2629 and IS: 4759. Weight of galvanization will not be less than 610 gm/m².
 - (e) Grating will also be designed for a minimum live load of 500 kg/m².
 - (f) Floor grating will be neatly cut and banded around all openings. Unless otherwise indicated, banding will from a 100 mm high curb.

- (g) Grating to head of stair runs will have an applied chequered plate or cast iron abrasive surfaced nosing similar to that specified for stair treads.
- (h) Grating panel will be removable type and will have the bars of adjacent panels aligned.
- (i) Grating will be anchored to support with bent clip fasteners secured to threaded stud field welded to supporting members. Two clips at each end of each panel and one clip (staggered) at each intermediate support will be provided.
- (j) Penetrations through grating and floor plates that are not shop fabricated (generally opening under 500 mm in nominal size pipes and for conduits etc.) are to be cut in the field as required.
- (k) Such opening will be neatly trimmed, concentric with penetration or as required for movements.
- (l) Generally, 50 mm clearance will be left over insulation and 25 mm clearance at bare metal over and above the expansion requirements in those regions.
- (m) Openings may be ganged where accepted by the Owner / Consultant.
- (n) Openings less than 150 mm in maximum dimension may be squared off. Large openings will be suitably shaped. All grating opening will be kick plates or banded to match the shop fabricated work. All grating for a given area will be positioned and aligned before the stud bolts are located and welded to the supporting members

- 5.20.06 Two main stairways with clear width of minimum 1.2 m shall be provided, one on each side of the steam generator. One stair way shall extend continuously from grade to the highest operating level and the other shall extend continuously from grade to the boiler roof. Steel framing for penthouses for each stairway shall be provided. The portion of main stairway within the enclosed portion of the building, if any, shall be designed for one hour smoke/ fire proof requirements.
- 5.20.07 Runway beams with supporting structures and suitable hoist blocks for easy maintenance shall be provided for each of the equipment like ID, FD & PA fans, mills, Air heater, coal feeders and other equipment as required.
- 5.20.08 Garbage Chute: A garbage chute of minimum 500 mm dia and made from minimum 10 mm thick mild steel pipe shall be provided for each Steam Generator, from pent house level to ground level for disposal of debris & scrap generated during erection, operation and maintenance. The chute shall be provided with branch connections with doors & approach platforms at all platform levels. Garbage collection trolleys shall also be provided at the ground level.

5.20.09 For meeting the above requirement in respect of platforms the Bidder shall provide platform area of minimum 20,000 m² (clear of all intervening pipes, columns, actuators, instrument enclosures, racks etc. and excluding area covered by stairways). However bidder shall provide adequate platform over and above the minimum requirement based on system requirement without any cost implication. Bidder shall furnish detail floor plan drawings covering all platforms and shall clearly indicate all the dimensions of platforms and clear platform floor area in each drawing.

5.21.00 **Integral Piping, Valves, Fittings and Mountings**

5.21.01 All integral piping, fittings, valves and mountings required for safe and efficient operation of the Steam Generator and for compliance with applicable boiler regulations shall be provided. All integral piping, valves, fittings and mountings shall meet the Consultant's approval regarding their location, type, quantity, make and size. The Bidder shall furnish schedule of valves with their parameters etc. Valves/Dampers/Drives shall be accessible having minimum head room of 2.2 m and side room of 1.2 m.

5.21.02 Valves

- a) High pressure valves shall have integral bypass valves for pressure equalization wherever required. The final requirement for integral bypass requirement shall be worked out, as per process requirement, during detailed engineering. All motor operated high pressure valves shall each have motor-operated integral bypass.
- b) The start-up vent lines shall each be provided with one motorised isolating valve and one motorised regulating valve. Start-up vents shall be sized for a minimum flow of 15% TMCR corresponding to steam pressure at turbine startup curve.
- c) A non-return valve shall be provided on feed water line close to Economiser.
- d) Motor operated (M.O.) main steam stop valves shall be provided with M.O. integral valve at superheater outlet.
- e) Motor operated valve & HOV shall be provided at Steam Separator Drain.
- f) All drain, vent, air release, instrument root, isolation drains and sampling lines shall be provided with two valves in series if the pressure is equal to or above 40 Kg/cm²(a) or temperature is above 300 degree Celsius. However, single isolating valve shall be acceptable in the other case.

5.21.03 Air release valves and drain valves shall be provided wherever necessary. Drain valves (two in series, one manually operated isolation and other motorised regulating) shall be provided for draining furnace walls, Separators,

drain vessels, flash tank, drain tank, superheaters, reheaters, economiser and feed water lines. The arrangement of drain system shall comply with the following requirements :

- i) Drain lines upto and including drain valves and drain valves shall be designed for the maximum operating parameters of main process line to which it is connected.
- ii) Drain system shall be sized to enable draining of complete pressure parts in maximum one (1) hour.
- iii) The drain valves shall be of low noise and erosion resistant type. The limiting noise level for regulating drain valves shall be as per Vol-IIA and Vol-I-B of the Contract.
- iv) Plugging/ locking arrangement with chain and lock system shall be provided for each isolating valve.

5.21.04 Valves shall have locking keys and shall be located at appropriate location for convenient operation. The piping from drain valves shall be connected to flash tank.

5.21.05 All remote operated control valves shall be provided with the following:

- i) 100% bypass control valves, remote operated and exactly identical to main control valve.
- ii) Separate power operated isolation valve on upstream side of each of main and bypass control valve.
- iii) Separate manual isolation valve on downstream side of each of main and bypass control valve.
- iv) Pressure gauge at inlet and outlet of each respective control station in the common line of main and bypass control valve.

5.21.06 An electrically operated isolating valve and control valves on the soot blower steam supply line and all other valves as required for operation of soot blower system shall be provided. Steam for soot blowing shall be drawn from an intermediate superheater header or as per Bidder's standard practice. Manual operated isolation valves shall be provided for each elevation's soot blowers of RHS and LHS side.

5.21.07 Regulating/isolating valves and related pipe work for superheater and reheater temperature controlling stations shall be provided.

- 5.21.08 The codes/standards to be followed for integral piping and valve shall be as indicated below:
- a) Valves : ANSI B 16.34 and ANSI B 16.25 or equivalent, as applicable.
 - b) Piping : ANSI B 31.1 power piping and Section-I of the ASME Boiler and Pressure vessel code or equivalent as applicable.
 - c) Flanges : ANSI B 16.5 or equivalent.
- 5.21.09 The integral H.P. piping shall be as per ASTM A 106 Gr. C, ASTM-A-335, P-11/ P-12/ P-91 and/or, SA 210 A and/or SA 213 T-12/ T-22/ T-91 or approved equivalent. For design metal temperature 400°C and below, carbon steel piping ASTM A-106, Gr. B or C Seamless. ASTM A-105/ A-234 WPB/WPC shall be used. Above 400°C and up to 540°C, Chromium-Molybdenum alloy steel piping and tubing (A-335, P-11/P-12/P-22/P-91) or (ASTM A-182 F-11/F-22/F-23; A-234 WP-11/WP-22/WP-23) shall be used. For temperature above 540°C up to 601°C, Chromium-Molybdenum alloy steel (P-91/T-91) or equivalent may be used. For temperature above 601°C upto 610°C, Chromium-Molybdenum alloy steel (P-92/T-92) material or equivalent may be used. For temperature above 610°C, Super 304H, TP 347 HFG or equivalent austenitic stainless steel shall be used. Pipe sizes shall be selected taking into account proper economic velocity, as specified in Volume-II-D/1, Section-I of this specification.
- 5.21.10 The selection of process parameters for Steam Generator as well as the corresponding metallurgy shall be proven and the Bidder shall establish the provenness with sufficient documents and data.
- 5.21.11 Pipe wall thickness shall be designed based on I.B.R. The piping system shall have adequate flexibility so as to limit the stress range within allowable limits.
- 5.21.12 All valves performing similar duties shall be inter-changeable with one another unless otherwise approved.
- 5.21.13 All gate valves shall be of the full way type. When in the full open position the bore of the valves shall not be obstructed by any part of the gate.
- 5.21.14 Globe valves shall have curved or spherical seating and the disc shall be free to revolve on the spindle.
- 5.21.15 All non-return valves shall have an arrow cast or embossed on the side of the valve body to indicate the direction of flow. For severe service conditions, cushioned check valve shall be preferred to obviate the valve chatter.
- 5.21.16 Valves shall be of the outside screw and yoke type unless approved otherwise.
- 5.21.17 The number, size, location and setting of safety valves on separators, superheaters and reheaters shall be as per IBR. The safety valves shall be

provided on all steam lines including soot blowing lines, auxiliary PRDS lines and the steam lines, wherever pressurisation may take place. The escape piping shall lead to the nearest convenient point on boiler house roof.

The safety valves and relief valves shall meet the minimum discharge capacities as per the requirement of IBR.

The noise level during lifting of safety valves of separators, superheaters and reheaters shall not exceed the allowable noise limit as specified in Volume-IIA & Volume-I-B of the Contract with the provision of silencer on the lowest set pressure safety valve.

5.21.18 Tapping points shall be provided for all the instrumentation and controls as required for performance guarantee tests. All the valves shall have approach and operating platform.

5.22.00 **Separator & Drain System**

5.22.01 The Separator system to be provided for each steam generator shall comprise of an atmospheric Flash Tank and drain receiving vessel. 2x100% condensate transfer pumps shall be located in boiler area and shall be complete with necessary valves, piping, fittings and level control system. The atmospheric flash tank shall be sized to receive the following:

- i) Maximum possible start up recirculation & drain flow under all possible normal, abnormal, upset, accidental conditions and even with start-up recirculation pump out of service.
- ii) All drains and blow down from Steam Generator such as drains from water wall headers, attemperators headers, water separator, superheater and reheater drains etc.
- iii) Drains from main steam lines, CRH lines, HRH lines, heater steam line and SCAPH drains.
- iv) Drains from Aux. steam system etc.
- v) Other drains from power cycle piping.

5.22.02 Tank design shall not allow discharge of any free water from vent. Water drops leaving vent pipe shall have sizes not more than 0.127 mm. The steam velocity through the vent pipe shall not exceed 90 m/s. Vent pipe size shall be so selected that no pressurisation takes place in the blow down tank.

5.22.03 Drain receiving vessel shall be sized to receive drains from atmospheric tank and shall have storage for at least 10 minutes.

5.22.04 2x100% condensate transfer pumps with minimum recirculation system, Pneumatic drain tank level control valve at common discharge with upstream & downstream manual isolation valve shall be provided for the blow down system. For arriving at the size of pump all drains as indicated above shall be

considered. This pump shall be used for transfer of condensate from drain receiving vessel to main condenser through condenser flash tank located in TG area/ Alternate proven system of transferring condensate directly from separator drain vessel to condenser in addition to boiler side flash tank, drain tank and atmospheric drain system valves shall also be provided. The drain system shall facilitate, cold/ hot clean up, to run the Boiler during start up and low load even during non availability of BCP and to enable light up the boiler even without vacuum in the condenser during black start with BCP in service.

5.22.05 Constructional features:

- i) Tanks shall be designed and fabricated as per requirements of IS 2825/ BS 806.
- ii) Drain valves and drain piping shall be provided at the bottom of the tank. All drains from the tank shall be cooled to a temperature not exceeding 60°C.
- iii) Manholes on the tank shall be provided with hung on hinged type bolted doors.

5.23.00 **Auxiliary Steam Pressure Reducing and Desuperheating Stations (PRDS)**

5.23.01 General

To meet the continuous and startup auxiliary steam requirements, two numbers auxiliary pressure reducing and desuperheating stations (PRDS), one taking tap off from main steam line (high capacity PRDS) and other taking tap off from cold reheat line (low capacity PRDS) shall be provided per unit.

A high temperature unit header with tentative steam parameters as 16 Kg/cm² (abs) and 310°C shall be provided and shall draw steam from above two PRDS stations. A low temperature unit header with tentative steam parameters as 16 Kg/cm² (abs) and 250°C shall also be provided and shall draw the steam from high temperature unit header through a desuperheater. The auxiliary steam systems of the three units shall be interconnected. A branch connection along with isolating valve(s) and a blanking flange(s) shall also be provided for interconnection with the future units on both high and low temperature station headers. Output steam of the auxiliary boiler shall be connected to the high temperature station header.

High Capacity PRDS (HCPRDS)

The bidder may offer combined pressure reducing cum desuperheating valve or a pressure reducing valve with separate desuperheater, as per bidder's proven standard practice. HCPRDS shall comprise of following as a minimum:

- a) One electro-hydraulically/electro pneumatically operated steam pressure reducing valve (either combined pressure reducing valve cum desuperheating or pressure reducing valve with separate desuperheater) rated for full duty with a motorised isolation valve with integral bypass at the upstream and one number non-return valve and one number manual

isolating valve at the downstream. Control valve downstream up to isolation valve shall be designed for upstream pressure & Temperature

- b) Spray control station comprising of one number of electro hydraulically / electro-pneumatically operated temperature control valve or one number each of pressure and temperature control valve, as the case may be, on the desuperheating spray water line rated for full duty with a motorised isolation valve at the upstream and one number non-return valve and one number manual isolating valve at the downstream.
- c) Spray control station shall be provided with 100% capacity bypass arrangement with necessary isolation valves upstream (MOV) and downstream (HOV).
- d) One pneumatically operated quick acting block valve (with solenoids) upstream of the Desuperheating spray water control station in common line.
- e) One flow element upstream of PRDS to measure total auxiliary steam flow through H CPRDS

Low capacity PRDS (LCPRS)

LCPRS shall comprise of following as a minimum:

- a) One electro-hydraulically/electro pneumatically operated steam pressure reducing valve rated for full duty with a motorised isolation valve at the upstream and one number non-return valve and one number manual isolation valve at the downstream. Control valve downstream up to isolation valve shall be designed for upstream pressure & Temperature.
- b) 100% capacity bypass arrangement with motor operated pressure reducing valve with isolation arrangement as indicated at (a) above.
- c) One flow element upstream of PRS to measure total auxiliary steam flow through LCPRS. If PRDS valves are provided with electrohydraulic actuators, the required oil pumps, accumulators, E/H converter instrumentation and other accessories to make the system complete shall be provided. The oil pumps and accumulators shall have redundant facility.

If steam for the steam generator unit auxiliaries is required at pressure/temperature other than that of the auxiliary steam headers, suitable arrangements shall be made by the Bidder in design of the steam generator to meet such requirements.

5.23.02

High Capacity PRDS of each unit shall be suitably sized for meeting auxiliary steam requirement of 190 TPH (minimum). However, the exact capacity shall be finalized during the detailed engineering stage. High capacity PRDS shall be generally sized to cater to the auxiliary steam requirements for following:

- i) Steam Coil Air Pre-Heaters.

- ii) Continuous and intermittent requirement of the unit and station.
- iii) Startup requirement of other unit.
- iv) As standby to low capacity PRDS station.
- v) Air heater soot blowing.
- vi) Deaerator pegging.
- vii) Turbine gland sealing.
- viii) Motive steam & Gland sealing for BFP drive turbine.
- ix) Mill fire fighting (if required).
- x) Capable of delivering at least 25 tonnes per hour steam to low pressure auxiliary steam station header.

5.23.03 Low Capacity PRS shall be suitably sized for supplying steam for normal continuous requirements of its own unit. However, the exact capacity shall be finalized during detailed engineering stage, subject to minimum 35 TPH. Low capacity PRDS shall supply steam for normal requirements as detailed below.

- i) SCR Vaporizers and SCR system soot blowing.
- ii) Vapour Absorption system.
- iii) For FGD system, if required.

5.23.04 Sharing of load requirement between high temperature header to low temperature header shall be done in case low capacity PRDS is unable to meet auxiliary steam requirement on its own.

5.23.05 Low capacity PRV shall be capable of supplying continuous requirement of auxiliary steam to the unit. The change-over of control from high capacity PRDS to low capacity PRV and vice versa shall be automatic with manual override facility.

5.23.06 In case each unit is provided with only high temperature auxiliary steam header as per manufacturer's standard and proven practice, auxiliary steam requirement at lower parameters shall be met with PRDS stations provided for individual application. Further, connections with individual PRDS shall also be provided to meet the auxiliary steam requirement of other systems such as VAM etc.

5.24.00 **Drive Motors**

All drive motors shall be as specified in Volume-II F/1 of this specification.

5.25.00 Instrumentation and Control

For specification of Instrumentation and Control system including Burner Management system, the Bidder shall refer Volume-II E of this specification.

6.00.00 TESTING AND INSPECTION

Testing and inspection procedure of the steam generating unit shall meet all the requirements spelt out in different applicable sections of Volume: II including the requirements of IBR (1950 edition, with amendments up to the date of construction). In addition to that the following tests are also to be conducted:

SHOP TESTS FOR STEAM GENERATOR:

6.01.00 Pressure parts

The material which can be identified against mill sheet or manufacturer test certificate only shall be used in the manufacture of pressure parts. Material shall meet all the mandatory requirements (and supplementary checks if asked for) of specified specification.

All Plates above 40mm & all bar stock / forgings above 40mm diameter shall be ultrasonically tested. For pressure parts, plates of thickness equal to or above 25 mm shall be ultrasonically tested.

6.01.01 Separator

- (a) Each plate shall be subjected to a 100% normal ultrasonic at the mill to meet the minimum requirements of EN 10160 1999 / equivalent ASTM standards. Elevated temperature tensile tests shall also be carried out on plate material for each heat.
- (b) After cutting to size and removal of cut outs, the plates shall be subjected to magnetic particle test or LPT along the edges of the plate and on areas adjacent to the cutouts.
- (c) All forged connections shall be examined by 100% UT before machining.
- (d) Fully machined connecting pieces of internal diameter 100mm and above, shall be subjected to magnetic particle examination.
- (e) Mechanical tests shall be carried out on specimens prepared from the production control test plates of the longitudinal welds.
- (f) Mechanical tests shall be conducted on the specimens from manhole cutouts of dished ends. If the forming is done by established procedure, no tensile test on manhole cut outs is envisaged.

- (g) All butt welds shall be subjected to 100% radiographic examination before stress relief except for Gr.91 & 92 which will be subjected to RT after stress relief.
- (h) On completion of welding, the entire Separator shall be subjected to stress relieving in the furnace.
- (i) All butt welds shall be subjected to 100% ultrasonic and magnetic particle examination after stress relief
- (j) All full penetration welds shall be subjected to ultrasonic examination after stress relief.
- (k) After stress relieving (SR) all welds, internal and external shall be examined by MPI methods depending on size and accessibility and all butt welds shall be subjected to 100% radiography.
- (l) All connecting tubes & pipes shall be subjected to UT prior to fabrication as per relevant material standards / ASTM E 213 with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.)
- (m) **Hydraulic Test and Pneumatic Test :**

Complete Separator shall be subjected to hydraulic pressure test and all compensating pads to be pneumatically tested.

6.01.02

Headers

- (a) Raw material for headers shall be subjected to UT prior to fabrication as per as per relevant material standards / ASTM E213 on pipes & tubes of thickness >3.6mm. For thickness ≤ 3.6 mm, Eddy Current Testing will be done instead of UT.
- (b) All butt welds shall be subjected to RT examination. Also MPI after SR.
- (c) All full penetration nozzle and attachment welds shall be subjected to UT prior to stress relieving.
- (d) All nozzles, branches, stubs and load bearing attachment shall be examined by MPI techniques after the toes of the weld have been ground smooth and stress relieved.
- (e) Non-load bearing welds shall be examined by MPI techniques after the toes of the welds have been ground smooth and stress relieved.
- (f) Completed closed end headers shall be subjected to hydraulic pressure tests and all compensating pads to be pneumatically tested.
- (g) All weld joints in alloy steel headers of P 91, X20 and X22 & other material of P5B group and above shall be checked for Hardness. 5%

hardness check shall be carried out on welds of other alloy steel Headers.

- (h) Boroscopy examination shall be carried out for those header which will be interconnected with other headers by welding.

6.01.03

Tubes & Tube Elements

- a) Raw material pipes/ tubes for water wall, superheater, reheater, Economiser, riser, supply and connecting tubes including nozzle/stubs, connections, headers Pipe work etc. shall be subjected to 100% UT prior to fabrication as per EN 10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3 mm min. and 1.5mm max.) shall be adhered to. UT will be done as per relevant material standards / ASTM E213 on tubes of thickness > 3.6mm. For tubes of thickness ≤ 3.6 mm, Eddy Current Testing will be done instead of UT.
- b) All bent tubes/stubs shall be checked for ovality and thinning by ultrasonic method on first off and random checks on subsequent pieces.
- c) Flash butt-welded, Straight Tube butt welded Tubes and Fusion welded panels will be checked by Steel ball test. Fin welded panels are inspected with sponge. These are not applicable for stubs.
- d) Finished butt welds shall be subjected to RT or UT. Wherever the code/standard/process specifies random sampling, the same shall be minimum 20%. Flash butt Welds are not amenable for NDE and hence tested by Destructive test on first of shift sample and visual examination.
- e) Minimum 10 % of the fillet joints shall be subjected to MPI/LPI. However Fillet welds of material grades P 5B and above or any other equivalent new material grade subject to the acceptance by Client/ Consultant shall be subjected to 100% MPI/ LPI.
- f) Tubes and fabricated panels/coils shall be subjected to hydraulic pressure test excluding loose tubes but including burner panels, reheaters, superheaters & economizers.
- g) 10% hardness survey on butt welds of P5B material group and above.
- h) In case of RT of tube welds with DWDI (elliptical view) number of exposure shall be as per relevant code/ plant standard and will not be less than two exposures for each weld.
- i) Panel/Coils: In case of spiral water wall design, trial assembly of complete wall of each side including hopper shall be carried out.

6.01.04 **Boiler Piping**

- a) All raw materials used shall have co-related mill test certificate meeting material specification.
- b) All pipe lengths shall be subjected to 100 % ultrasonic examination as per EN 10246:7 1996 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to.
- c) All bent pipes shall be checked for ovality and thinning by UT on first off lot & on random samples for subsequent pieces. Outer surface of bends shall be subjected to MPI/LPI.
- d) The edge preparation for shop and site welds in stainless steel /alloy steel shall be subjected to a dye penetrant check. Non-destructive examination of welds shall be carried out after post weld heat treatment, if any. If the edge preparation for shop and Site welds is made by machining, dye penetrant test may not be envisaged.
- e) All butt welds in alloy steel piping of P91, X20 and X 22 shall be checked for RT/ UT and MPI after SR. UT shall be of Digital Recordable Type.
- f) All weld joints in alloy steel piping of P 91, X20 and X22 & other material of P5B group and above shall be checked for Hardness. For PWHT Induction Heating shall be deployed. However PWHT can be done in furnace also. 3% hardness check shall be carried out on welds of other alloy steel piping.
- g) All load bearing attachment welds shall be subjected to MPI after SR.
- h) Non-destructive examination of welds shall be carried out in accordance with the relevant design/manufacturing codes or IBR requirement. However, as a minimum, the following requirements shall be met. Further statutory requirement, wherever applicable shall also be complied with.
 - i). Temperature > 400 Deg. C and/or pressure exceeding 71 bar.
 - 100% RT/UT on butt welds and full penetration branch welds.
 - 100% MPI.
 - ii). Temperature > 175 Deg. C upto 400 Deg. C and/or pressure exceeding 17 bar and upto 71 bar.
 - 100% RT/UT on butt welds and full penetration branch welds for pipe diameter more than 100 NB.

- 10% RT/UT on butt welds and full penetration branch for pipe diameter upto 100NB.
 - 100% MPE.
- iii). For all other pipes not covered above, shall be subjected 100% MPE/ DPT in case of underground pipes and 10% MPE/DPT in case of piping above the ground. Further, 10% of butt welds of underground piping shall be subjected to RT.
- Wherever SR/PWHT is envisaged for alloy steel, above NDTs shall be after SR/PWHT.

6.01.05 Fittings

- a). Raw material of all forged fitting shall be ultrasonically tested. All mother pipes used for formed fitting shall be ultrasonically tested as per BS 3602 or equivalent with longitudinal calibration notch of depth 5% of wall thickness (0.3mm min. and 1.5mm max.) shall be adhered to. UT may also be done as per relevant material standards / ASTM E213.
- b). Fittings shall be subjected to suitable NDT as per applicable standards. However, following minimum. NDE requirement shall also be applicable / met.
- i). 100% RT/UT shall be carried out both on alloy steel fittings and on carbon steel fittings.
 - For use above 71 bar design condition.
 - For use above 400°C design condition.
 - ii). For fittings X20, P-91 and material group 5B & above
 - 100% MPI &
 - 10% hardness check &
 - For fittings of 200 NB & above 100% UT/RT
 - iii). 100% UT/RT for fittings of 200 NB & above for boiler feed discharge, recirculation and spray piping of boiler feed system.
 - iv). 100% UT/RT for fittings of all other piping of size OD 508mm & above.

6.01.06 Valves

- a) Pressure retaining parts of valves shall be subjected to (min.) NDT as per Table A.
- b) Hardened/stellitted valve disc and seat are to be subjected to LPI and hardness check.
- c) Colour matching of valve disc/plug and seat shall be carried out to ensure min. 80% contact and no through passage.

- d) Hydraulic pressure test and seat leak test shall be carried out as per ANSI 16.34/ IBR.
- e) Air seat leak test shall be carried out as per applicable Standards/Codes.
- f) Functional testing shall be carried out on each valve to check the following as per the approved valve data sheet.
 - Smooth operation
 - Valve travel, closing and opening time.
 - Current drawn by actuators.
- g) Springs for safety valves shall be tested with suitable NDT and for spring rate.
- h) Safety and safety relief valves shall be tested for performance.
- i) All forgings rounds above diameter 40 mm shall be ultrasonically tested.

Hardness testing on seat/disc may be performed on a sample test coupon (PTC) instead of actual seat. The Sample test coupon will undergo same process as that of actual seat material and the hardness of this test coupon will be measured. As the hardness test on actual seat creates indentation on seat, which may become a leak path in the feature during the valve operation. Colour matching may not be performed if the valve shall be subjected to seat leak test which will ensure the required contact area Owner to confirm the acceptance.

Table – A

**NDT REQUIREMENTS FOR PRESSURE
RETAINING COMPONENTS OF VALVES**

Valve size NB in mm	ANSI Class upto 300	ANSI Class above 300 upto 600	ANSI Class above 600	ANSI Class 900 & above & below 4500
Less than 50	Visual	Visual	Visual	MPI
50 & above but below 100	Visual	Visual	MPI	MPI & RT (on 10% of valves on 100% area)
100 & above but less than 300	Visual	MPI	MPI & RT (on 10% of valves on changes of section & weld ends)	MPI & RT (on 100% area)
300 and above	MPI	MPI	MPI & RT (on change of sections & weld ends)	MPI, RT (on 100% area)

Note:

- For body and bonnet forgings UT with MPI may be adopted in place of RT.
- For austenitic steel MPI may be replaced by LPI.

6.02.00 Non Pressure Bearing Attachments

Load bearing welds shall be subjected to examination by ultrasonic testing (UT) and magnetic particle inspection (MPI) techniques after stress relief (SR). No load bearing welds shall be subjected to MPI after stress relief. The toes of the welds adjoining the separator shall be ground smooth prior to stress relieving before carrying out this examination.

6.02.01 Soot Blowers

- a) Butt weld between nozzle and lance tube shall be subjected to 20 % radiography tests.
- b) Hydraulic test on valve body
- c) Soot blower shall be subjected to operational checks as below:
 - Smooth operation
 - Long Tube travel, closing and opening time.
 - Current drawn.

6.02.02 Steam Generator Boiler Start up Drain Re-circulation Pump

Raw material for casing, shaft and impeller shall be tested for high temperature physical properties, apart from mandatory & supplementary check of material specification.

- a) All forging and castings shall be subjected to 100% UT/RT and MPI/DP check.
- b) Static and dynamic balancing of the rotary parts shall be carried out.
- c) Hydraulic pressure test shall be conducted on pumps casing at min. 1.5 times the Design Pressure.
- d) Interchangeability shall be maintained and checked.
- e) Each pump shall be subjected to a performance test at the manufacturer's works under as near actual site conditions as possible.
- f) Following test shall be carried out on assembled units : -

Type Test:

- NPSH test
- Temperature rise test.
- Under voltage test.

- Quality assurance proof test.
- Tests to establish unit functioning of pump at temp and pressure.
- Hot standstill and start up tests.

Routine Test:

- Hydrostatic test of complete unit.
 - Over speed test.
 - Tests to determine unit characteristics
 - Pump performance.
 - Unit run at rated voltage
 - Starting current at rated voltage.
 - Cold start up test.
 - Endurance test of motor windings, joints and terminal seals
 - Noise level.
 - Inspection of dismantled unit.
 - High voltage test.
- For heat exchanger for these pumps, butt welds on pressure parts shall be tested with RT/UT and all other welds shall be tested with MPI/LPI. Hydraulic test shall be carried out both on tube side as well as shell side at min. 1.5 times the design pressure. Butt welds on heat exchangers and other tubing will 10% RT/UT tested.

All equipment / cables shall be of proven design and type tested as per relevant standards. Type test certificates / specific type tests shall be furnished / conducted, if asked for with reference to any specific equipment in the respective sub-section of the specification. Type test certificates shall not be older than ten (10) years from date of contract. If the Bidder is not able to submit report of the type test(s) conducted or in the case of type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests free of charge to prove the design in the presence of the Owner and submit the reports for approval.

Hydraulic Test

- a) All components which are to be subjected to fluid pressure shall be tested to minimum of 150% of the design pressure. In determining the value of the maximum attainable pressure for any component the Bidder shall take in to account all relevant factors (e.g. safety valve blow off pressure, fluid surges, etc.) which may cause an elevation in the pressure. The Bidder shall furnish details of the basis of the calculation of maximum attainable pressure tests. The duration of the pressure tests shall be sufficient, as approved by the Engineer, to show any leakage paths and to permit a thorough examination of the component whilst under pressure.

- b) The temperature of the fluid used for the pressure test shall be such as to avoid any possibility of brittle fracture at a low temperature and the same to be modified and submitted to the Engineer for approval, before commencing the test.
- c) The fluid used shall be of a sufficient purity and where relevant, inhibits to avoid excessive corrosion and /or damage to temporary parts either during the test or prior to drying and cleaning.
- d) All pressure parts & valves shall be hydro tested at shop as per mutually agreed quality plans. However, all pressure parts and valves will be hydro tested at site after erection and assembly.

6.02.03 Pneumatic Test of Compensating Pads:

All compensating pads shall be provided with two-threaded weep holes to test welds at 0.5Kg/sq.cm (g) with soap solution and "no leakage" shall be ensured.

6.03.00 Rotating and Other Equipments/Items for Steam Generator

- a) The material which can be identified against mill sheet or manufacturer test certificate only shall be used in the manufacture of pressure parts. Material shall meet all the mandatory requirements (and supplementary checks if asked for) of specified specification.
- b) For sleeve bearing, UT shall be carried out on the babbitting of bearing. Dye penetrant check shall be done on edges.
- c) Blue matching is to be performed between components.

6.03.01 Air Preheater

- (a) Forged shafts coming under air preheater like stub shaft, main rotor forging, housing hub shall be subjected to 100% UT at mill and magnetic particle inspection after machining.
- (b) For non-modular design trial assembly is to be carried out at shop prior to despatch to site.
- (c) Critical welds of rotor post shall be subjected to radiographic examination.
- (d) Trial run of Air preheater Rotor drive assembly (Gear Box + pinion + Electric motor + air motor) needs to be carried out at shop. Trial run at shop is not envisaged if it will be done at Site after erection.

6.03.02 Fans: Induced Draft, Forced Draft and Primary air fans

- (a) Rotor components i.e. shaft and hub shall be subjected to ultrasonic test at mill and magnetic particle examination after rough machining.
- (b) 10% of Butt and fillet welds both in rotor and static components of the fan shall be subjected to MPI /DPT after stress relieving.
- (c) Fan impeller shall be balanced dynamically to quality grade 2.5 of ISO: 1940.
- (d) Bidder shall take care for the natural frequency of the fan in design stage and furnish the natural frequency calculation during detailed engineering.
- (e) Full range performance test shall be carried out on one fan of each type and size as per BS 848, Part-1.

6.03.03 Fans: Scanner air fans and Seal air fans

Rotor components i.e. shaft and hub shall be subjected to ultrasonic test at mill and magnetic particle examination after rough machining.

- a) 10% of Butt and fillet welds both in rotor and static components of the fan shall be subjected to MPI / DPT after stress relieving.
- b) Fan impeller shall be balanced dynamically to quality grade 2.5 of ISO: 1940.
- c) Full range performance test shall be carried out as per BS 848, Part-1.
- d) Fans & pumps which are not mentioned in other clauses above shall be dynamically balanced and functionally tested at Manufacturer's works. Complete performance tests shall be carried out on first pump/fan of each type and capacity to verify its output against total head, power input, efficiency, vibration and noise level. Head/volume, efficiency and power input curves corrected for site conditions shall be furnished.

6.03.04 Mills, Pulverised Coal Ducting and Burners

Raw material for shaft, coupling and other rotating components shall be subjected to UT. MPI/LPI shall be carried out to check surface soundness.

Wear-resistant parts shall be UT/ RT tested to check soundness after suitable heat treatment. Check for chemical composition, hardness and microstructure shall be carried out.

Butt welds in the body casing of the mill shall be tested by RT and MPI. All other welds shall be tested by MPI/LPI for acceptance.

Fabricated pipe welds should be examined by MPI.

Ceramic/basalt lined piping/bends shall be checked for proper layout.

Weldments on burner components shall be checked with suitable NDT. The burner assemblies shall be tested for operation at shop.

Trial assembly (stacking) of at least two Mill complete with all major components needs to be carried out at shop.

6.03.05

Coal Feeders

- a) Type tests including degree of protection and routine tests shall be done as per relevant Indian Standards or equivalent International Standards. If the tests are already done for the similar design/size/capacity of 800 MW supercritical boilers then, reports will be shown and tests will not be repeated. Else, tests will be done.
- b) All major items like plates for casings, head pulley, tail pulley, Pulley shaft and major castings shall be procured with respective material test certificates.
- c) Explosion proof test at 50 psi as per NFPA code shall be done as type test. Leak tightness test shall be done on individual feeder casing. Endurance test for load cell shall be carried out. If the tests are already done for the similar design/size/capacity of 800 MW supercritical boilers then, reports will be shown and tests will not be repeated. Else, tests will be done.
- d) Test for weighing accuracy, calibration shall be carried out at various speeds by Coal flow on one feeder.
- e) Calibration check shall be carried out on all feeder cabinet/assemblies prior to dispatch

6.03.06

Dampers

- a) All guillotine gates & dampers of each size shall be subjected to shop tested.
- b) Leak tightness of test of Dampers / Guillotine Gates.
- c) All isolation dampers shall be checked for sealing dimensions to establish guaranteed tightness.

6.03.07

Boiler Structure, Ducts, Hoppers etc.

Steel Structure of Boiler, Mill Bunker building including Coal bunkers, Coal transfer points. Coal conveyor galleries and supporting trestles, Ducts, Hoppers, etc.

- a) Only material which has been identified against mill sheet or test certificates shall be used for construction. All plates above 40mm thickness shall be 100% ultrasonically tested.
- b) Visual inspection of all welds shall be performed in accordance with AWS D.1.1.
- c) NDT requirements of structural steel welds (other than Coal Bunkers) shall be as under:-
 - 100% RT/UT on butt-welds of plate thickness > 32 mm.
 - For plates of thickness > 25mm & < 32mm - 10% RT and 100% MPI
 - For plates of thickness < 25mm - 10% MPI/LPI.
 - All fillet welds of built up plate girders shall be inspected 100% by MPI.
- d) (Edge for field weld shall be examined by MPI for plate thickness > 32mm. Edge for field weld for ceiling girders shall be examined by UT for 100mm from the edge).
- e) Ceiling girders/columns, ducts hoppers & tunnels shall be trial assembled and match marked prior to dispatch/erection. At least two consecutive girders along with cross member shall be assembled at a time. Production test coupons for Butt and fillet welds of Main columns, ceiling grinders shall be carried out.
- f) Coal Bunkers / Bins
 - 10% DPT after back gouging.
 - 5 % spot radiography test on butt welds. Where access not available, UT shall be carried with prior approval of Client/Consultant.
 - Full penetration welds (other than butt welds) shall be subjected to 10% Ultrasonic testing.

6.03.08

Hangers & Supports:

- a) All major raw materials used shall have co-related mill test certificate meeting mandatory checks of material specification.
- b) Completed springs shall be tested for Scragging Test & Load vs Deflection Test and for dia. > 25mm MPI shall be carried out.
- c) Butt Welds shall be tested for UT and fillet welds shall be tested for MPI.
- d) Turn buckle/ pipe clamps/ Hangers of thickness > 25mm shall be checked by MPI/DPT on bent portion.

- e) Assembled Hangers shall be checked for Variation in deflection and Travel vs Load test and shall meet the requirements of specification.

6.03.09

Metallic Expansion Joint

- a) Hydraulic pressure test shall be carried out on each pipe and expansion bellow.
- b) Longitudinal butt weld on bellow shall be subjected to suitable NDT examination before forming, and after forming MPE / DP test shall be carried out.
- c) All welds shall be subjected to 100% magnetic particle/dye penetrant check and butt welds shall be subjected to 100% radiographic testing.
- d) All the bellows subjected to vacuum service shall be subjected to vacuum test.
- e) The bellows shall be subjected to movement test to establish suitability to perform satisfactorily in site conditions. During this test spring rate shall also be measured.
- f) Life cycle test, meridional yield rupture test and squirm test to be carried out on a prototype/expansion bellow as per Sec. D clause 3.2 of standards of Expansion joint Manufacturer Association (EJMA). In case these tests have already been accepted by Client/Consultant on a prototype expansion bellow, as defined in Sec. D Clause 3.2 of Expansion Joints Manufacturers Association (EJMA) test reports may be furnished by manufacturer for consideration and approval of Owner.

6.04.00

Thermal Insulation, Lagging & Cladding:

- a) Lightly resin bonded mineral wool:

LRB mattresses/sections of Rockwool/ Glass-wool shall confirm to & tested as per relevant clauses of Indian Standards. Type tests except Thermal Conductivity shall be regularly carried out once in three months, Thermal Conductivity Type Test shall be carried out minimum once in twelve months by the manufacturer. Requirements of various components like Binding wires, Lacing wires, Wire mesh, etc. shall be as per specification.

- b) Castable Refractory:

Fire Bricks / Castable Refractory confirming to & tested as per relevant clauses of Indian Standards and shall meet the requirements of specification. Castable Refractory shall have proper identification, supplier name, customer name, Batch No., Date, material name & Net weight in Kgs. with proper instructions for handling.

c) Lagging &Cladding:

All insulation shall be protected by means of an outer covering of Aluminium sheeting conforming to ASTM B-209-1060 temper H14 from reputed manufacturer meeting the requirements of specification.

6.05.00 **Field /Erection Checks for Steam Generator & Auxiliaries**

6.05.01 Raw Material, In-process and Non Destructive Testing indicated during manufacture shall be applicable for site fabrication/erection of the respective item.

- a) All rotary equipment shall be checked for its direction of rotation and free movement after placing it on the foundation.
- b) All Valves shall be checked for its direction of flow.
- c) Insulation shall be carried out only after satisfactory inspection of leak test.
- d) Erection checks, tolerance limits and Quantum of NDE are indicated in respective Drawing, Field Quality plan and Field Welding Schedule.

6.05.02 Hydraulic Tests of Pressure Parts

On completion of erection of Steam Generator, Piping and Auxiliaries, the unit with its fittings and mountings in position shall be subjected to hydraulic pressure test in accordance with requirements of Indian Boiler Regulations Water used for hydraulic test shall be made alkaline by addition of suitable chemicals. After the test, the steam generator shall be drained and suitably preserved.

7.00.00 **Pre-commissioning and Commissioning Activities**

7.01.00 Bidder's Scope shall include all pre-commissioning and commissioning activities, materials and services including the following for successful conductance of pre-commissioning and commissioning activities:

- i) Complete pre-commissioning work including tests of facilities such as line flushing, hydraulic testing of steam generator pressure parts, air and gas tightness tests of steam generator enclosure and duct work, chemical cleaning of pressure parts, steam blow off, safety valve floating etc. and all other tests as required.
- ii) Commissioning and initial operation of all facilities.
- iii) Supply of all consumables (except coal, Ammonia for SCR system and LDO/HSD for firing) like chemicals for chemical cleaning, passivation, inhibition etc., nitrogen for blanketing, consumables for air/ gas tightness tests and any other consumable as may be required for above pre commissioning / commissioning activities.

- iv) a) Supply of all temporary equipment such as tanks, piping, including supports, valves, pumps and all necessary instrumentation for successful conductance of pre-commissioning and commissioning activities.
- b) The temporary equipments specifically brought by the Bidder solely for the pre commissioning and commissioning work shall on completion of these activities, remain the property of the Bidder. However, the nitrogen blanketing equipment including nitrogen cylinders shall get included in the Bidder's permanent scope of supply and become property of the Employer.
- c) The selection of material of all the temporary equipments/ instruments shall be compatible with the service conditions expected during pre-commissioning/ commissioning activities.
- v) Supply of all labour, skilled/ semi skilled supervisors, engineers and any other manpower.

8.00.00 DRAWINGS, DATA AND INFORMATION REQUIRED

- 8.01.00 Documents to be furnished after award of contract.
- 8.01.01 Complete performance data sheets, efficiency figures of boilers at BMCR, 100%, 80%, 60% and 40% TG loads and HP-LP bypass at 60% BMCR. Performance data for sliding pressure operation for 40% to 100% TG load shall also be provided.
- 8.01.02 Engineering single line flow diagrams including instrumentation for boiler circulation, water/steam, gas and air circuit, bunker, feeder, milling plant, soot blowing plant, water lancing system, fuel oil systems, auxiliary steam system, SCR system, instrument air & distribution, service air & distribution, Fire water & quenching distribution system etc.
- 8.01.03 Outline and typical sectional drawing for all the systems of fans, RAPH, pulverisers, bunkers, Coal feeders, Electrostatic Precipitator, soot blowers, SCR & Ammonia handling system etc.
- 8.01.04 Layout, general arrangement and cross sectional drawings showing various views and sections of Steam Generator Unit.
- 8.01.05 List of auxiliary equipment & its GA, Datasheet, accessories and tools furnished including name of manufacturer, size, rating, range etc.
- 8.01.06 Characteristic curves and calculation sheets for all fans, pumps, exhausters, blowers, drives etc. being supplied, covering the entire range of performance from zero to maximum capacity.
- 8.01.07 Foundation plan and loading data.

- 8.01.08 Write-up and diagrams on burner lighting up, controls and interlocks. Write-up on soot blower, SCR control and interlock. Write up on feed water system, SH system, RH system, Evaporator & circulation system, Air system and Gas system.
- 8.01.09 Start-up curves for the Boiler
- 8.01.10 Structural, thermodynamic and pressure part calculations showing compliance with specifications and codes as and when required.
- 8.01.11 Detailed specification and data sheet of all the equipment.
- 8.01.12 O&M manual of boiler and its auxiliaries including write-up on system description, controls and interlocks of various system with P&IDs.
- 8.01.13 Write-up on Chemical Cleaning System and procedure, write up for all the SG commissioning activities.
- 8.01.14 Write-up on steam blowing with procedure.



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SL. NO.	ITEM	CRITERIA	
1.	Boiler Type	Pulverized Coal fired, Once through, Super-critical, single reheat (to suit the steam turbine parameters), Single Pass / Double Pass, Dry Bottom and Balanced draft.	
		BMCR	TMCR
2.	Rated Boiler Parameters		
a)	Estimated Steam flow at Super heater outlet	2475 TPH (min) (or) VWO flow (including 1% make-up) + 2%, whichever is higher.	Corresponding to TMCR flow.
b)	Pressure at Super heater outlet	Design requirement of SH outlet Pressure shall have additional margin of 2 kg/cm ² more than the designed piping pressure drop (rounded off to next higher integer) from SH O/L to Turbine stop valve. (corresponding to throttle steam pressure at HP Turbine inlet as 270 kg/cm ² (a))	Corresponding to throttle steam pressure at HP Turbine inlet as 270 kg/cm ² (a).
c)	Temperature at Super heater outlet	603°C	
d)	Estimated Steam flow at	Bidder shall specify	Bidder shall specify





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SL. NO.	ITEM	CRITERIA	
	Reheater outlet		
e)	Temperature at RH outlet	603°C	
f)	Estimated Pressure at HP turbine exhaust	Bidder shall specify	Bidder shall specify
g)	Permissible Pressure drop through Reheaters including CRH & HRH piping under all operating conditions	9% of HP turbine exhaust Pressure.	
h)	Estimated Temperature at HP turbine exhaust	Bidder shall specify	Bidder shall specify
i)	Estimated Feed water temperature at Economizer inlet	Minimum 290°C.	Minimum 290°C
j)	Operating capability (applicable for the entire	Steam generator shall be capable of sustained operation with all HP heaters out of operation so as to generate at least rated power output of the unit (i.e. 800 MW) considering all TDBFP in operation.	





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SL. NO.	ITEM	CRITERIA
	range of Coal specified)	
k)	S/H & R/H outlet Steam temperature control range	Within $\pm 5^{\circ}\text{C}$ at all load between 50% TMCR to 100% BMCR
3.	a) Fuel allocation for boiler (indicating principal fuel, start-up and stabilizing fuel)	i) Primary fuel – Coal. ii) Start-up and stabilizing Fuel- LDO/HSD. iii) Capacity for LDO/HSD burners for load carrying purpose shall be up to 30% BMCR (with oil firing only). The steam generator shall be capable of stable operation down to 40% BMCR with coal without oil support.
	b) Fuel analysis	i) Coal Analysis (Refer Volume-II A, Section-XV) ii) Fuel Oil analysis (Refer Volume-II A, Section-XV)
4.	Boiler Operation	Shall follow Coordinated Master Control (CMC) mode of operation. The steam generator and auxiliaries shall be capable of operation continuously for variation in power supply frequency between 47.5 Hz and 51.5 Hz. In case of full load rejection, Boiler shall be capable of coming down to house load operation without tripping by operating HP/LP bypass.



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SL. NO.	ITEM	CRITERIA	
5.	Component / System Sizing and Design Criteria		
5.1	Materials for Pressure parts	Design Metal Temperature	Material
		i) Upto & including 400°C	Carbon steel to ASME SA-106 Gr. B/C or SA 210 C or approved equivalent.
		ii) Upto& including 550 °C	Alloy steel to ASME SA-335 P-11/P-12/P-22; ASME SA213 T-11/T-12/T-22/T-23 or approved equivalent.
		iii) Upto & including 601 ⁰ C	Alloy steel ASME SA-335/213 P-91/T-91 or approved equivalent.
		iv) Upto & including 610°C (*)	Alloy steel ASME SA-335/213 P-92/ T-92 or approved equivalent.
		v) Above 610°C.	Austenitic stainless steel, SUPER 304H, TP347HFG or approved equivalent The maximum skin temperature of the tubes shall not exceed oxidation limit of the material.

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SL. NO.	ITEM	CRITERIA
	(*) Note i. The Bidder at his discretion can use ASME SA -335: P-92/T-92 or approved equivalent material for the components which are outside the Flue Gas path for Super heater, Reheater tubes, headers and inter-connecting piping. In case it is proposed by the Bidder to use ASTM A 335: P-92 or equivalent material, Bidder shall be required to furnish a certificate of provenness of the material certifying the usage and satisfactory performance of the proposed material in main steam / hot reheat piping / boiler internal piping / headers for a reference plant (or applicable unit of a reference plant) having rated main steam and / or hot reheat steam temperature at turbine inlet at least equal to or higher than the rated main steam and /or hot reheat steam temperature at turbine inlet offered by the Bidder. Such reference plant (or unit) should have been executed by the Bidder himself and should have been under operation for at least 50000 hours or six years from date of commissioning of the applicable unit (of the reference plant). ii. Maximum allowable stress values for ASME SA-335: P92 / T92 or approved equivalent material as per code shall be reduced by 10% for calculating the thickness of pressure parts. iii. Dissimilar metal joints shall be shop welded only.	
5.2	Furnace	
	a) Net Heat Input	4.75×10^6 kcal/hr/m ² (Maximum).



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SL. NO.	ITEM	CRITERIA
	(NHI) / Plan area of furnace	
	b) Heat Liberation rate	106920 kcal/hr/m ³ (Maximum).
	c) Burner Zone Heat Release Rate (BZHRR)	1.5 x 10 ⁶ kcal/hr/m ² (Maximum).
	d) Maximum FEGT (MHVT value)	60 Deg. C below Minimum IDT of ash.
	e) Heat Input per burner	650 x 10 ⁵ Kcal/hr (Maximum)
	f) Furnace Cooling Factor	1.9 x 10 ⁵ kcal/hr/m ² (Maximum).
	g) Furnace residence time	2.0 sec. (Minimum) (selected furnace residence time shall be for range of coals as per tender)
	h) Pressure withstanding capability	±660 mmWC (Minimum) at 67% yield strength or maximum conceivable head of fans, whichever is higher.
	i) Buckstay spacing	To ensure that its natural frequency is sufficiently away from the flame pulsation frequency.
	j) Buckstay support	Self-supported from furnace walls. No interconnection with boiler structure is allowed. To protect boiler





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SL. NO.	ITEM	CRITERIA
		pressure part from the seismic, the restraint link may be used with boiler structure. Restraint Link may not transfer furnace pressure and self-load.
	k) No. of burner elevation being fed from one mill	1 (maximum).
	l) Furnace Bottom hopper	Design of Boiler and its supporting structure shall be considering 50% volume of bottom ash hopper filled with ash/clinker loading and corresponding to ash density of 1350Kg/m ³ . Further load cells shall be installed in the furnace roof enclosure to give indication & alarm of ash build up in the furnace bottom slag hopper.
	m) Maximum design pressure	As per NFPA-85C but shall be not less than ± 660 mm WC at 67% yield strength or maximum conceivable head of fans, whichever is higher.
	n) Parameters to be considered	Excess air @ economizer outlet of 20% minimum (TMCR load), Minimum Flue gas temperature at RAPH outlet 125 Deg. C (corrected at TMCR design coal)
	o) Maximum gas velocity where gas flow changes direction	10 m/sec.





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SL. NO.	ITEM	CRITERIA
	p) NO _x emission at SCR Inlet	325 mg / Nm ³ (Guaranteed) at 6% O ₂ dry at inlet of SCR. The furnace and coal burner system shall be so designed and arranged such as to limit the NO _x emission up to this value without the use of SCR for the range of coal specified for minimum to maximum load.
5.3	Steam-Water Separator	
	a) Design pressure	1.05 times the maximum operating pressure or as per Indian Boiler Regulations latest edition, whichever is higher
	b) Design Temperature	As per Indian Boiler Regulations latest edition.
5.4	Water Wall	
	a) Type of tube	Seamless rifled / plain.
	b) Type of wall	Membrane with inclined wall /vertical rifled wall in furnace combustion zone as in qualified reference plant
	c) Height of the bottom of the lowest water wall header	Minimum 10.25 m. However, it shall be suitable to accommodate a bottom ash hopper to store bottom ash for eight (8) hours at BMCR with worst coal and ensuring installation of all bottom ash handling equipment above the ground.
5.5	Superheater & Reheater	



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SL. NO.	ITEM	CRITERIA
	a) Convection pass gas velocity (average) in section / tube banks	Maximum 10 m/sec (The maximum localized velocities across the cross- section shall not exceed 12 m/ sec) with 25% excess air at Economizer outlet for specified range of coals.
	b) Transverse tube pitch for banks / sections in the direction of gas flow path	i) Minimum 600 mm for gas temperature zones where gas temperatures equal to or more than specified FEGT (MHVT value). ii) Minimum 1000 mm (for Tower type boiler) or 762 mm (for Two pass boiler) where gas temperatures equal to or exceeds IDT of ash for range of coals specified.
	c) Reheater isolation device desirable (CRH & HRH lines)	Yes
	d) SH temperature control	Spray Water attemperation, (utilizing water tapped off from downstream side of top HP heaters or intermediate banks of economizer or Economizer outlet). Temperature shall be within $\pm 5^{\circ}\text{C}$ under steady state and in case of load change within $\pm 10^{\circ}\text{C}$. Spray control system shall consist of pneumatically operated control valves, upstream Motor Operated isolation valves and downstream manual isolation valve and fast acting pneumatically/ motor operated



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SL. NO.	ITEM	CRITERIA
		block valves meeting the requirement of ASME TDP – 1.
	e) RH temperature control	Burner tilting and Spray water attemperation (utilising water tapped off from inter-stage of BFP)/Gas biasing. Temperature shall be within $\pm 5^{\circ}\text{C}$ under steady state and in case of load change within $\pm 10^{\circ}\text{C}$. For RH attemperation, spray quantity against design coal firing shall be zero under TMCR condition. Flue gas recirculation for reheat temperature control is not accepted.
	f) Maximum allowable tube metal temperature	40°C below the oxidation limit of the tube material.
5.6	Economizer	
	a) Type	Non-steaming type with parallel, cross or counter flow arrangement. Approach temperature shall be minimum 17°C within control range during part load operation. (Bidder shall indicate the approach selected as per the proven design practice.)
	b) Maximum average flue gas velocity through the Economizer tube banks	10 m/sec (The maximum localized velocities across the cross-section shall not exceed 12 M/sec) with 25% excess air at Economizer outlet for specified range of coals.



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SL. NO.	ITEM	CRITERIA
	c) Minimum tube thickness of Economizer	Economizer tubes shall be seamless type, fabricated in modular construction. The tube thickness shall have minimum 1 mm erosion allowance over that calculated as per IBR. (Minimum tube thickness at the bends in no case shall be less than the minimum tube thickness for the tubes calculated above including after considering thinning & erosion allowance. For this purpose appropriate thinning allowance shall be considered while calculating the thickness of the bends. Finned tubes are not acceptable. Minimum 3.0 mm thick stainless steel erosion shields shall be provided for leading tubes of each tube bank of economizer. In addition minimum 5.0 mm thick sturdy cassettes baffles shall be provided for all front side and rear side bends of the economizer banks. The cassette baffles shall cover complete bends and additional 300 mm straight tube length).
	d) Maximum allowable tube metal steam temperature	Oxidation limit of the tube material.
5.7	Boiler start-up recirculation Pump	1x100% Boiler start-up recirculation pumps for initial start-up/low load operation shall be designed for maximum possible recirculation & drain flow under all possible normal, abnormal, upset and accidental conditions, with adequate margin as per proven design reference. Pump shall be glandless type and



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SL. NO.	ITEM	CRITERIA
		the motor shall be submerged type having wet stator with water coolers. Motor windings shall be non-hygroscopic material and shall withstand continuous water pressure and temperature. The pump motor shall be hermetically sealed and specially designed for the intended service. Provision for start-up and part load operation without BCP also to be provided for Emergency needs.
5.8	Air Pre-Heater (APH)	
	a) Type	Rotary Regenerative, Lungstorm or approved equivalent type with axis of rotation as vertical, Tri-sector type
	b) Heating Elements	Hot end shall be in two layers and its upper layer shall be of smaller height. Height of the cold end heating element shall be adequate enough to prevent ammonium bisulphate formation in the hot intermediate end heating element under all operating conditions for the range of coal specified. Heating element profile shall be selected to enable easy removal of ammonium bisulphate and ash. i) Cold End - Made of Corten steel of minimum 1.2 mm thickness. ii) Hot/ Intermediate end - Made of carbon steel minimum 0.8 mm thick. Hot end element height shall be selected to avoid any ammonium bisulphate (ABS) condensation.
	c) Numbers per boiler	Two (2) nos.





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SL. NO.	ITEM	CRITERIA
	d) Gas velocity	Maximum 13 m/sec.
	e) Sizing shall be based on following criteria, all conditions considered to be occurring together:	
	i) Ambient air temperature	27.5°C and 66% Relative humidity.
	ii) Load Range	- 60% BMCR with worst coal and maximum moisture with one RAPH in service. -100% BMCR with worst coal and maximum moisture with both RAPH in service
	iii) Air temperature rise across air preheater	Shall be adequate to achieve the required coal-air mixture temperature at burner inlet at all loads and for complete range of specified coals.
	iv) Minimum average cold end metal temperature at 100 % BMCR (with SCAPH out of service) shall be	76°C
	f) Minimum AH flue gas exit temperature (corrected)	125°C





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SL. NO.	ITEM	CRITERIA
	at 100% TMCR (800 MW unit load) with design coal	
	g) Minimum flue gas exit temperature (for complete range of specified fuels)	5°C above acid dew point of flue gas
	h) Air leakage to gas side	Less than 10% of the flue gas weight entering the air heater, at the maximum worn-out seal (end of the guaranteed life) condition at 100% TMCR for entire range of specified Coal.
	<u>Note:</u> For meeting the requirement of rated coal/ air mixture temperatures at burner inlet at part load operations of steam generator with coals of excessive moisture and under conditions of low ambient temperatures the Bidder may, if required, provide economizer bypass duct along with necessary dampers, expansion joints, structures etc. Even in case economizer bypass is provided by the Bidder, the sizing of air preheaters shall ensure that the rated mill outlet temperatures are achieved, for complete range of specified coals and complete operating range, at least for 100% of TMCR (800 MW) to 100% BMCR loads with economizer bypass fully closed.	
5.9	Steam Coil Air Pre Heater (SCAPH)	





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SL. NO.	ITEM	CRITERIA
	a) Type	Embedded Finned tube type or equivalent as per Bidder's standard proven practice.
	b) Numbers per boiler	One (1) no. in secondary air bypass duct after each FD fan and if required, for PA fan as per proven practice of Bidder for tri-sector type APH.
	c) Design ambient air temperature	6°C (minimum).
	d) Air temperature at the outlet of each SCAPH	i) At 100% BMCR : 27.5 °C (minimum). ii) At 30% BMCR : 100°C (minimum) (with oil firing). Air temperature at the outlet of each SCAPH shall take care of RAPH outlet flue gas temperature - To be minimum 5°C above the acid dew point for flue gas
	d) Air temperature at the inlet of each air preheater	To keep average metal temperature (cold end) at least 76°C with coal firing and 100°C with oil firing.
	e) Design loading	SCAPH and connected air ducts shall be designed to handle flows corresponding to 60% BMCR loads with one of the two streams working without any undue noise / vibration.
	f) Fuel	For range of coals, LDO and HSD (High Speed Diesel)
5.10	Pulverisers	





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SL. NO.	ITEM	CRITERIA								
	a) Type	Vertical Spindle type, Bowl Mills or Roller Mills or Ball & Race mills or approved equivalent. Direct drive (thru' Planetary Type gear-box).Mills shall have minimum three nos. of rollers and differential pressure across mill bowl shall not be more than 425 mm water column.								
	b) Number of pulverisers per boiler	Adequate to achieve 100% BMCR for all specified Coals and all operating conditions but not less than eight (8) mills.								
	c) Number of standby mills	<table><tr><td>At 100% BMCR Worst Coal firing</td><td>Nil</td></tr><tr><td>At 100% of BMCR, Design Coal firing</td><td>One</td></tr><tr><td>At 100% of TMCR, Worst Coal firing</td><td>One</td></tr><tr><td>At 100% of TMCR, Design Coal firing.</td><td>Two</td></tr></table>	At 100% BMCR Worst Coal firing	Nil	At 100% of BMCR, Design Coal firing	One	At 100% of TMCR, Worst Coal firing	One	At 100% of TMCR, Design Coal firing.	Two
At 100% BMCR Worst Coal firing	Nil									
At 100% of BMCR, Design Coal firing	One									
At 100% of TMCR, Worst Coal firing	One									
At 100% of TMCR, Design Coal firing.	Two									





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SL. NO.	ITEM	CRITERIA										
	d) Classifier	Dynamic Classifier with variable voltage variable frequency drive.										
	e) Coal quality	Refer Coal Analysis in Volume-II A, Section-XV.										
	f) Guaranteed life of the mill wearing components (with specified range of Coal)	The guaranteed life of different mill components in equivalent hours of continuous mill operation at its rated capacity, while firing the specified range of coals and without requiring any in between repair or replacement shall be as under: <table><tr><td>i) Seals</td><td>20000 hours</td></tr><tr><td>ii) Grinding elements</td><td>10000 hours</td></tr><tr><td>iii) Mill Discharge valves</td><td>15000 hours</td></tr><tr><td>iv) Classifier cone and other items lined with Ceramic material</td><td>25000 hours</td></tr><tr><td>v) Classifier vane</td><td>25000 hours</td></tr></table> The Bidder shall furnish a curve alongwith his offer indicating the variation in guaranteed wear life with variation in YGP index of coal fired. Separate curves for different wear elements of mill shall be furnished e.g. for grinding rolls, grinding rings, clearly indicating its relationship with YGP index of coal. The curve shall be subject to Owner's approval.	i) Seals	20000 hours	ii) Grinding elements	10000 hours	iii) Mill Discharge valves	15000 hours	iv) Classifier cone and other items lined with Ceramic material	25000 hours	v) Classifier vane	25000 hours
i) Seals	20000 hours											
ii) Grinding elements	10000 hours											
iii) Mill Discharge valves	15000 hours											
iv) Classifier cone and other items lined with Ceramic material	25000 hours											
v) Classifier vane	25000 hours											





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SL. NO.	ITEM	CRITERIA
	g) Maximum permissible mill loading for deciding mill capacities	90% or the mill loading achievable corresponding to the near worn out conditions of mill grinding elements, whichever is less. This condition shall be complied for the entire range of specified coals.
	h) Input Coal size to pulverizer	up to 50 mm.
	i) Expected output from pulverizer	75% thru 200 mesh (75 microns) and 99% thru 50 mesh (300 microns). Output shall be maintained even for total moisture content as high as upto 15% in coal or maximum range of moisture as per Contract, whichever is higher. Note: To be demonstrated at site for each mill by coal sampling as per ISO 9931 & with grinding elements within the guaranteed wear life of respective wear element.
	j) Noise level	Not exceeding the allowable limit as specified in Vol-IIA and Vol-I-B of this specification.
	k) Turn down ratio	3:1 (minimum).
	l) Unburnt carbon loss to be considered at various steam generator loads, for sizing/selection of coal	1% or actual expected value, whichever is higher.



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SL. NO.	ITEM	CRITERIA
	pulverizers	
5.11	Coal Pipe	
	a) Velocity of air mixture in coal pipe	Minimum 15 m/sec. Maximum 28 m/sec.
	b) Material of coal pipe	Straights and bends below 11 degree : Carbon steel conforming to International Standard Thickness 12.7 mm with minimum wear allowance of 4 mm. Bends 11 degree and above: will be ceramic lined. Ceramic thickness minimum 15 mm; casing/base material thickness: 8 mm. Ceramic lining of minimum 15 mm shall be provided at for following PF pipe portion, i) From mill outlet to first bend and two times pipe diameter straight length downstream of first bend. ii) All bends between 11° and 30° and one pipe diameter straight length downstream of the bend. iii) All 30° and higher bends and two pipe diameters straight length downstream of the bend. iv) The burner inlet elbow and the pipe piece after the elbow. PF pipe from mill to the classifier (in case of separate classifier).





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SL. NO.	ITEM	CRITERIA
	c) Special erosion protection at bend	Ceramic minimum 15 mm thick and minimum 90% alumina content.
	d) Guaranteed wear life of the coal pipe/ ceramic material	Minimum 25,000 hours.
	e) Design pressure	3.5 kg/sq.cm. (minimum) as per NFPA requirement.
	f) Continuous operating temperature for coal pipe design	110 Deg. C or actual whichever is higher.
5.12	Raw Coal Feeders	
	a) Type of feeder	Gravimetric belt feeder. Feeders will be having micro-processor based controls with variable voltage frequency drive. Minimum feeder inlet size for Gravimetric belt feeder shall be 914.4 mm (ID).
	b) Maximum moisture in coal	Refer Coal Analysis in Volume-II A, Section-XV.
	c) Feeder Capacity	Minimum 20% additional capacity over maximum capacity of coal pulverizer.



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SL. NO.	ITEM	CRITERIA
	d) Feeder Design Pressure & temperature	Feeder shall be designed for not less than PA fan shut-off pressure, and shall withstand an explosion pressure of minimum 3.5 kg/sq.cm (g) as per the NFPA norms. It shall be suitable for operating at ambient temperature of 70 Deg. C.
	e) 'No Coal' flow detection system	Paddle type coal alarm switch shall be provided at the following locations to detect no coal on the conveyor and pluggage at feeder outlet : i) Over the feeder conveyor belt. ii) Near the feeder discharge.
5.13	Coal Bunkers	
	a) Capacity	Coal Bunker Capacity shall be 10 Hrs. requirement of the unit under BMCR condition with worst coal firing or at BMCR condition with design coal firing or at TMCR condition with design coal firing, whichever is maximum For all above conditions, storage capacity of 10 hours shall be calculated based on number of operating mill/bunker as specified above in sl.no 5.10 c). Bulk density of coal shall be considered for capacity calculation as 0.8 T/cu.m and 1.1 T/cu.m for strength calculation.. Minimum vertical clearance above Crest of coal shall be maintained as 1.5 m.
	b) Number of bunkers	One no. of circular bunker for each mill.
	c) Minimum Angle	To ensure smooth flow of coal, the hopper surface shall be provided with minimum angle



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SL. NO.	ITEM	CRITERIA
		of 73 degree with the horizontal.
	d) Bunker material	Minimum thickness of structural steel bunker plates shall be 12 mm inclusive of 4 mm corrosion allowance. Minimum wall thickness of hopper shall be 8 mm.
	e) Bunker Liner material	SS-304 (minimum 4 mm thick) for complete conical portion and bottom 500mm for cylindrical straight portion above conical portion of the bunker.
5.14	Primary Air Fans	
	a) Type	Constant speed, two stage, Horizontal Axial type with blade pitch control.
	b) No. of fans	Two (2) fans per boiler. Fan sizing shall be such that it takes care of the transient condition when a stand by mill is changed to a working mill; each fan capacity shall however, meet the requirement of minimum 60% BMCR with worst coal. The best efficiency point shall correspond to the operating point at 100% TMCR. Minimum ambient temperature shall be considered as 6 Deg. C for BHP calculation of the Fan.
	c) Capability criteria-1	Each fan should be able to meet the requirement of 60% BMCR (one fan & one stream in operation) with design, best and worst grade of coal firing having maximum moisture content with following conditions occurring together.



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SL. NO.	ITEM	CRITERIA
		i) Worst coal firing with maximum moisture content. ii) Under frequency operation at 48.5 Hz. iii) Air heater air-in-leakage – 10% of flue gas flow entering tri-sector APH or actual guaranteed leakage, whichever is higher. iv) Ambient temperature - 48°C and RH - 66%.
	d) Capability criteria - 2	Each fan to be sized for 50% BMCR flow with margin of 25% on flow and 30% on pressure over the calculated values at 100% BMCR (with both fans under operation) with design, best and worst grade of coal firing having maximum moisture content with following conditions occurring together. i) Worst coal firing with maximum moisture content. ii) Under frequency operation at 50 Hz. iii) Air heater air-in-leakage – 10% of flue gas flow entering tri-sector APH or actual guaranteed leakage, whichever is higher. iv) Ambient temperature – 48°C and RH - 66%. v) All mills including standby mill shall be in service.

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SL. NO.	ITEM	CRITERIA
	e) Test block rating	Capability criteria-1 (or) Capability criteria-2, whichever is higher.
	f) Type of fan blade	Streamlined / aerofoil bladed type designed to withstand high bending and axial load.
	g) Silencer	At Fan suction.
	h) Fan rotational speed	1500 R.P.M (maximum).
	i) Stall margin	Minimum stall margin of 10% over the design duty points.
5.15	Seal Air Fan	2 x 100% per boiler.
	a) Type	Centrifugal.
	b) Margin	Flow - 25%, Head - 30% Above margins shall be based on an ambient temperature of 48°C, relative humidity of 66% and system leakages with all mills in operation at maximum duty.
	c) Fan rotational speed (test block condition)	1500 R.P.M (maximum).
5.16	Induced Draft Fans	
	a) Type	Constant speed, two stage, Horizontal Axial type with blade pitch control.
	b) No. of fans per boiler	Two (2) Numbers. Considering FGD, either combined ID fan or ID Fan with Booster fan system of



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SL. NO.	ITEM	CRITERIA
		proven practice shall be considered.
	c) Control	Variable Blade pitch control.
	d) Capability criteria-1	Each fan should be able to meet the requirement of 60% BMCR (one fan & one stream in operation) with design, best and worst grade of coal firing having maximum moisture content and gives maximum flue gas flow with the following conditions all occurring simultaneously, i) Gas temperature corresponding to ambient temperature of 48°C and RH - 66%. ii) Under frequency- 48.5 Hz. iii) Minimum excess air - 20% over the stoichiometric air requirement. iv) Air heater air in leakage as 12% of flue gas flow entering Tri-sector APH (Or) actual guaranteed value whichever is higher. v) Air in leakage - 1% of ESP inlet gas flow & 2% of gas flow at common APH outlet through ducts. vi) Pressure drop through SCR System - 150 mm WC or actual pressure drop of all the rows of SCR (including spare row installed with catalyst), whichever is higher.



ANNEXURE-I

SPECIFIC DESIGN CRITERIA FOR STEAM GENERATOR AND AUXILIARIES

SL. NO.	ITEM	CRITERIA
		vii) Pressure drop through ESP - 25 mm WC or actual whichever is higher. viii) Pressure drop through FGD System for combined ID fan - 200 mm WC or actual whichever is higher. ix) Pressure required at chimney inlet – Minimum +40 mm WC (In case separate booster fans for FGD system are provided, ID fans shall be sized for minimum +10 mm WC of pressure requirement at chimney inlet for any FGD bypass operation.) (Or) As per wet stack study requirement, whichever is higher.
	e) Capability criteria-2	Each fan to be sized for 50% BMCR flow with margin of 20% on flow and 44% on pressure over the calculated values at 100% BMCR (with both fans under operation) with design, best and worst grade of coal firing having maximum moisture content and gives maximum flue gas flow with the following conditions all occurring simultaneously i) Fan inlet gas temperature - 150°C or actual gas temperature corresponding to ambient temperature of 48°C and RH - 66%, whichever is higher. ii) Under frequency- 50 Hz. iii) Minimum excess air - 20% over the stoichiometric air requirement.



ANNEXURE-I

SPECIFIC DESIGN CRITERIA FOR STEAM GENERATOR AND AUXILIARIES

SL. NO.	ITEM	CRITERIA
		iv) Air heater air in leakage - 12% of flue gas flow entering Trisector APH (Or) actual guaranteed value whichever is higher. v) Air in leakage - 1% of ESP inlet gas flow & 2% of gas flow at common APH outlet through ducts. x) Pressure drop through SCR System - 150 mm WC or actual pressure drop of all the rows of SCR (including spare row installed with catalyst), whichever is higher. vi) Pressure drop through ESP - 25 mm WC or actual whichever is higher. vii) Pressure drop through FGD System for combined ID fan - 200 mm WC or actual whichever is higher. viii) Pressure required at chimney inlet – Minimum +40 mm WC (In case separate booster fans for FGD system are provided, ID fans shall be sized for minimum +10 mm WC of pressure requirement at chimney inlet for any FGD bypass operation.) (Or) As per wet stack study requirement, whichever is higher. ix) ID fan impeller staging shall be designed suitably to cater variable suction system resistance.



ANNEXURE-I

SPECIFIC DESIGN CRITERIA FOR STEAM GENERATOR AND AUXILIARIES

SL. NO.	ITEM	CRITERIA
	f) Test block rating	Capability criteria-1 (or) Capability criteria-2, whichever is higher.
	g) Fan rotational speed	750 RPM (maximum).
	h) Type of fan blades	Streamlined / aerofoil shaped section.
	i) Minimum wear life of ID fan components	25000 hours.
	j) Stall margin	Minimum stall margin of 10% over the design duty points.
5.17	Forced Draft Fans	
	a) Type	Constant speed, horizontal, axial type with blade pitch control.
	b) No. of fans per boiler	Two (2)
	c) Control	Variable Blade Pitch control
	d) Capability criteria-1	Each fan sized for 60% BMCR (one fan & one stream in operation) while design, best and worst grade of coal firing, whichever gives maximum FD fan air with the following conditions all occurring simultaneously.
		i) Ambient temperature -48°C and RH - 66%.
		ii) Under frequency- 48.5 Hz.





ANNEXURE-I

SPECIFIC DESIGN CRITERIA FOR STEAM GENERATOR AND AUXILIARIES

SL. NO.	ITEM	CRITERIA
		iii) Zero Air ingress in furnace and it's bottom.
		iv) Minimum excess air - 20%.
		v) Air heater air in leakage - Actual guaranteed value shall be considered.
	e) Capability criteria-2	Each fan to be sized for 50% BMCR flow with margin of 20% on flow and 44% on pressure over the calculated values at 100% BMCR (with both fans under operation) while firing design, best and worst grade of coal, whichever gives maximum FD fan air with the following conditions all occurring simultaneously.
		i) Ambient temperature -48°C and RH - 66%.
		ii) Under frequency- 50 Hz.
		iii) Air ingress - Zero Air ingress in furnace and its bottom.
		iv) Minimum excess air - 20% over the stoichiometric air requirement.
		v) Air heater air in leakage - Actual guaranteed value shall be considered.
	f) Test block rating	Capability criteria-1 (or) Capability criteria-2, whichever is higher.
	g) Silencer	At Fan Suction.
	h) Fan rotational speed	1500 RPM (maximum).





ANNEXURE-I

SPECIFIC DESIGN CRITERIA FOR STEAM GENERATOR AND AUXILIARIES

SL. NO.	ITEM	CRITERIA
	i) Type of fan blades	Streamlined / aerofoil shaped section.
	j) Stall margin	Minimum stall margin of 10% over the design duty points.
	Note: PA/FD/ID Fan components shall be designed for torsional stresses of three times the normal full load motor torque at all speed. (Bidder shall submit detailed calculations, for Employer's approval, to confirm compliance with above requirements for all fan components, specifically for fan shafts, impeller hubs and impeller as a whole. Areas of high stress concentration and residual stresses, like welded attachments shall be avoided on the fan rotor/shafts. Combined static, dynamic as well as residual stresses shall be demonstrated to be within allowable limits. These fan components shall last the life of the plant with such combined stresses present in them). The fan shall be suitable for parallel operation and sharing the load capacity over the entire range without hunting.	
5.18	Flue Ducts & Air Ducts	
	a) Flue gas velocity	Maximum 13 m/sec up to inlet of ESP. From outlet of ESP to chimney, the maximum velocity limit would be 16 m/sec. The velocities in the gas ducts shall not exceed the above limits under the following conditions, all occurring together: (1) Design/best/worst coal firing at 100% BMCR load whichever gives maximum gas flow. (2) 20% excess air over and above the stoichiometric air requirement at economizer inlet. (3) Air heater air-in-leakage - 12% of flue gas flow entering tri-sector APH or actual guaranteed



ANNEXURE-I

SPECIFIC DESIGN CRITERIA FOR STEAM GENERATOR AND AUXILIARIES

SL. NO.	ITEM	CRITERIA
		leakage, whichever is higher and duct leakage 3%. (4) Design ambient temperature of 48 degree Celsius and 66 % RH. The above velocities shall not be exceeded even in case of operation with one stream of ID, FD, PA fans and air heater operation at 60% of BMCR load.
	b) Air velocity	Maximum 16 m/sec The velocities in the ducts shall not exceed the above limits under the following conditions, all occurring together: (1) Design/best/Worst coal firing at 100% BMCR load whichever gives maximum flow. (2) 20% excess air over and above the stoichiometric air at economizer inlet. (3) Air heater air in leakage 10% of flue gas flow entering air heater for secondary air or actual guaranteed whichever is higher. Air heater air in leakage 10% of flue gas flow entering air heater for Primary air or actual guaranteed whichever is higher. (4) Design ambient temperature of 48 degree Celsius and 66 % RH.



ANNEXURE-I

SPECIFIC DESIGN CRITERIA FOR STEAM GENERATOR AND AUXILIARIES

SL. NO.	ITEM	CRITERIA
		The above velocities shall not be exceeded even in case of operation with one stream of fan and air heater operation at 60% of BMCR load.
	c) Design pressure	± 660 mm WC or maximum conceivable pressure of the relevant fans, whichever is higher, at 67% yield strength of material.
	d) Duct Plate	Minimum thickness 6 mm for flue gas duct Minimum thickness 5 mm for air duct. Corrosion allowance of minimum 1.5 mm shall be considered for both air and gas duct.
	e) Expansion Joint	i) Metallic Expansion joint with protection plate in cold & hot air duct. ii) Metallic bellow with protection plate shall be offered for gas ducts.
5.19	Burners	
	a) Coal Burners	
	i) Capacity	To cater 100% BMCR Low NO _x burners with matching furnace design & necessary over-fire air arrangement shall be employed to ensure that NO _x emission before SCR is less than 325 mg/Nm ³ at 6% O ₂ (Dry basis) from 40% BMCR to 100% TMCR load condition for the entire range of coals specified.





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ANNEXURE-I

SPECIFIC DESIGN CRITERIA FOR STEAM GENERATOR AND AUXILIARIES

SL. NO.	ITEM	CRITERIA
		Burners to ensure 40% BMCR output without oil support.
	ii) Turndown of each set from one mill	To be decided by Bidder as per stable operation criteria detailed elsewhere. However, Mill turndown ratio shall be 3:1 (minimum). Burners to ensure 40% BMCR output without oil support.
	iii) Control	Burner management system / FSSS, flame scanner with safety protection.
	b) Oil Burners	
	i) Type	Retractable oil gun with retractable electric ignitor (no gas ignitor is acceptable)
	ii) Atomisation	Air.
	iii) Capacity	Capacity of LDO/HSD burners for load carrying purpose shall be up to 30% BMCR (with oil firing only).
	iv) Turndown	4:1
	v) Control	Centralized automatic control with flame scanner and safety protection.
	vi) Measuring/Monitoring device	Integrating and on line oil flow monitoring device for individual burner.
5.20	Fly Ash Hoppers below Economisers, SCR inlet duct, Air Heaters, Electrostatic	





ANNEXURE-I

SPECIFIC DESIGN CRITERIA FOR STEAM GENERATOR AND AUXILIARIES

SL. NO.	ITEM	CRITERIA
	Precipitator	
	a) Capacity	Minimum eight (8) hours' storage when operating at BMCR, with worst coal.
	b) Elevation of lowest ash hopper outlet flange from ground / platform level	Minimum 3.5 meters
5.21	Soot Blower	
	a) Type b) Medium c) Location d) Type of control	Rotary and Retractable, Rack type soot blower or Sonic horn with ash sweepers for SCR Steam or Air (For sonic horns) WW/SH/RH/ECO/Air heater/SCR Controls will be realized in Unit DCS. Apart from soot blowing by steam, on load high pressure water jets shall be provided for APH to dislodge ABS deposition.
5.22	High pressure wash water pumps	
	Location / purpose	For APH wash / Dislodge ABS deposition



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SPECIFIC DESIGN CRITERIA FOR STEAM GENERATOR AND AUXILIARIES

SL. NO.	ITEM	CRITERIA
	Service	On load or Off load as per RAPH OEM's requirement
	Quantity	2 x 100% (1W + 1S) per boiler
	Medium	Service water
	Flow & pressure	As per RAPH vendor requirement

General Note: Above specific design criteria is applicable for steam generator and auxiliaries for each 800 MW unit.





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SUB-SECTION-III A

GENERAL SPECIFICATION FOR FUEL OIL HANDLING SYSTEM



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SUB-SECTION-III A

GENERAL SPECIFICATION FOR FUEL OIL HANDLING SYSTEM

1.00.00 GENERAL INFORMATION

- 1.01.00 The Fuel Oil System shall include fuel oil unloading, storage and pressurising system for LDO/HSD, supply of oil at required atomising pressure to the burners of the boiler from the fuel storage tanks. It also includes fuel oil drain system.
- 1.02.00 For the design of the fuel oil system, the properties of LDO/HSD shall be considered as indicated in Volume IIA, Section-XV of this specification.
- 1.03.00 Fuel oil shall be supplied in boiler for the following purpose(s):
- a) The LDO/HSD pressurising pumps shall be used for supply of fuel oil to the burners for lighting up of the boiler, warm-up, low load operation and also for load carrying purpose up to 30% BMCR load without coal firing.
- 1.04.00 The Fuel oil unloading and pressurising system shall be provided common for Steam Generators of 3x800 MW units. Fuel oil system shall be designed for Light diesel oil (LDO) as fuel and the complete Fuel oil system shall also be capable of firing High Speed Diesel Oil (HSD) as alternate fuel. The adequacy for firing HSD shall include compliance to NFPA 70 requirements of classification of locations for class I liquids.

2.00.00 SYSTEM DESCRIPTION

- 2.01.00 LDO/HSD shall be brought to plant site by road tankers. Capacity of each road tanker shall be considered minimum 20 m³.
- 2.02.00 Road tankers shall be positioned by the side of the unloading manifold and LDO/HSD unloading pumps shall be used for unloading of oil & storage of the same.
- 2.03.00 Unloaded LDO/HSD shall be stored in fixed roof type storage tanks inside a common dyke area.
- 2.04.00 One (1) NRV with an isolation valve shall be provided in each line connecting LDO/HSD unloading header and unloading pump suction header.

- 2.05.00 Oil (LDO/HSD) shall be pumped from the storage tanks to boiler by pressurizing pumps.
- 2.06.00 LDO/HSD return from pressurizing pumps shall be brought back to LDO/HSD storage tanks.
- 2.07.00 Suitable provision shall be provided for drainage of oil pumps, strainers, piping, etc. There shall be a drain oil tank to receive the miscellaneous drains and wastes from the system.
- 2.08.00 Oily waste water received through the drain trenches/pipes, from the pump house area, dyke area and unloading area shall be terminated to Fuel Oil area Oily waste water Separator Pit (API type) for further treatment onwards. Two (2) nos. dirty oil pumps of capacity 5 cu. m /hr (min) and two (2) nos. water pumps of capacity 10 cu. m /hr (min) shall be provided in the oil water separator pit for pumping out dirty oil and clear water respectively from the OWS pit to ETP.
- 2.09.00 The drainage scheme shall be generally as per the guidelines given flow diagram and as specified. All additions/modifications etc. as required to get the approval of the Explosive Authority and Pollution Control Board are the responsibility of the Bidder.
- 2.10.00 The scheme for Fuel Oil Handling is shown in Drawing No: 18A03-DWG-M-001N.

3.00.00 SCOPE OF SUPPLY

The Scope of Work under this section shall include fuel oil unloading, storage, Pressurizing System for three (3) Steam Generating units required for supply and circulation of the fuel oil from the storage tank to the boiler as detailed below and in the tender drawing.

The list is by no means exhaustive and the items though not specifically mentioned but needed for safe, efficient, trouble-free and coordinated operation of the system shall be provided by the Bidder under this section.

3.01.00 LDO/HSD Unloading & Storage System

- 3.01.01 One LDO/HSD unloading header shall be provided in the unloading area. Minimum sizes of this unloading header shall be designed, considering unloading of eight (8) numbers of road tankers (each of 20m³ minimum capacity) at a time.
- 3.01.02 Each tanker will be connected with the standpipes on LDO/HSD unloading header. Unloading of oil from each tanker will be done by flexible Neoprene rubber hoses of 80 NB size, each 8.0 M long. 8 nos. of hoses for LDO/HSD unloading shall be supplied. One end of the hose will have quick coupling to connect to the tanker and other end of the hose has flange connected to the unloading header.

- 3.01.03 Three (3) nos. of 60 m³/hr capacity, positive displacement, horizontal twin-screw type, LDO/HSD unloading pumps with drive and other accessories as required and as specified in Sub-Section-III B of this specification volume. Normally Two (2) pumps will run while other will remain as a standby. Unloading piping and header shall be designed considering eight (8) nos. of Road tankers (each of minimum 20 m³ capacity) to be unloaded at a time either by running one (1) unloading pump or by all three (3) unloading pumps at a time.
- 3.01.04 Duplex type heavy duty oil suction strainers & Discharge strainers (one for each pump) each of capacity not less than that of the LDO/HSD unloading pump capacity with isolating valves, drain valves, vent valves with goose neck piping and other accessories.
- 3.01.05 Two (2) nos. 2500 m³ effective capacity, fixed roof LDO/HSD storage tanks with other accessories (like flame arrestor, vent, foam nozzle connection etc.) as detailed in Sub-Section-III C of this specification volume, shall be provided.
- 3.01.06 One Coriolis mass flow meter with upstream and downstream isolation valves on LDO/HSD unloading pump common discharge header shall be provided.
- 3.01.07 One horizontal rectangular type drain oil tank of 10-m³ capacity for storage of clean oil spillage from pump house equipment. This drain oil tank will be located inside the unloading pump house.
- 3.01.08 Two (2) nos. (1W + 1S) drain oil pumps-set of 10 m³/hr capacity, positive displacement, vertical single screw complete with all the accessories of drive and mounting as required and as specified in Sub-Section-III B of this specification volume.
- 3.01.09 Two (2) nos. (1W + 1S) sump pumps-set of 5 m³/hr capacity, positive displacement, vertical single screw, complete with all the accessories of drive and mounting as required and as specified in Sub-Section-III B of this specification volume.
- 3.02.00 **LDO/HSD Pressurizing System**
- 3.02.01 Four (4) nos. positive displacement type triple screw pumps each having minimum 70 m³/hr capacity or as per max. flow requirement for 30% BMCR load requirement of Boiler with 10% margins over flow whichever is higher, along with drives, base plates, support plates, grounding pads, lifting lugs, eye-bolts, anchor bolts & nuts and accessories. Common recirculation control station with 2 x 100% pressure control valve with inlet/outlet manual isolation valves for each combined for all four pumps. Normally one pump shall be working per unit and a common standby pump has been envisaged for LDO/HSD pressurizing system of 3x800 MW units.

- 3.02.02 One (1) duplex heavy duty LDO/HSD strainer at each pump suction and in oil supply lines of each boiler with isolating valves, drain valve and vent valve with piping.
- 3.02.03 Entire LDO/HSD pressurizing system shall be from pressurizing pump discharge upto Boiler burner front. Adequately sized pressure accumulators, on fuel oil lines to each individual Steam Generator shall be provided for maintaining oil pressure at stable condition. Each accumulator shall be complete with a pressure gauge, stop cock and isolation valves to ensure maintainability of Nitrogen pressure.
- 3.03.00 LDO/HSD supply to auxiliary boiler burners shall be catered by dedicated 2 x 100% (1W + 1S) Aux boiler LDO/HSD pressurizing system by taking tap-off from main LDO/HSD tanks.
- 3.04.00 **Pipe, Fittings, Specialties and Valves**
- 3.04.01 Entire fuel oil piping, fuel oil drain pipe lines, drain pipe lines, all instrument air lines, complete with all supports, hangers, strainers, bends, flanges, counter flanges, gaskets, valves, fittings, steam traps etc. All piping required to complete the system shall be in Bidder's scope as specified. For details of this fuel oil piping, please refer Volume-II-D/2 of this specification.
- 3.05.00 Other Service related to the system and forming part of Bidder's Scope of Work are :
- 3.05.01 Approval is required from statutory authorities for the entire Fuel Oil storage and pumping installation. The Bidder shall prepare all necessary drawings / data / documents as per the requirements of the statutory authority and assist the owner in obtaining the necessary approval from the authorities.
- 3.05.02 For piping system coming under the purview of Indian Boiler Regulations, detailed calculation of pipe thickness shall be submitted and approval as required from the Chief Inspector of Boilers shall be obtained.
- 3.05.03 Obtaining of approval/certificates as necessary for design, manufacture, installation and tests from the Statutory Authorities.
- 4.00.00 EQUIPMENT/ SYSTEM DESIGN CRITERIA**
- 4.01.01 Fuel oil system and its facilities shall be designed as per Pollution Control/Petroleum/Explosive/Fire rules of Govt. of India.
- 4.01.02 LDO/HSD unloading system shall be designed considering 8 nos. of Road tankers (Each of minimum 20 m³ capacity) to be unloaded at a time.
- 4.01.03 LDO/HSD storage tank shall be designed in accordance with the latest Code IS 803/800/API 650 and as specified in other sections of this specification (refer Sub-Section-III C of this volume).

4.01.04 LDO/HSD storage tanks shall be installed in a common dyke area as per the guideline stated in OISD-118 standard and others as applicable. Fire wall as required shall be provided inside the dyke. The dyke volume shall be such that it can store maximum capacity of the tank in the dyke. Volume of pipe and accessories, spray water for fire, water required for foam and Hydrant hose stream as required shall also be considered during dyke volume calculation. Height of dyke wall shall be such that pump suction and gravity drain pipes can pass over it. No dyke wall puncture is recommended.

4.01.05 LDO/HSD forwarding/pressurizing pump recirculation line and control valve shall be designed considering

- a) Maximum flow capacity : Full pump discharge flow
- b) Minimum flow capacity : 10% of pump discharge Flow

4.01.06 Pipe, Fittings & Specialties

The diameters of various pipes in the Fuel oil Handling system shall be selected based on the velocity indicated in the below table and the flow rates established by the Bidder.

MAXIMUM VELOCITIES IN PIPES

Service or Type of Fluid		Pipe sizes (NB upto and including)		
		50 mm	65-200 mm	250 mm & above
1.	Fuel Oil (LDO/HSD)			
	Pump suction	0.4 m/sec	0.5-0.6 m/sec	0.7-0.9 m/sec
	Pump discharge	1.0 m/sec	1.3-1.5 m/sec	1.7-2.0 m/sec

- Compressed air pipe (For all sizes) : 20 m/sec

While calculating pressure drop, the effect of deposition of sediment in piping shall be taken into consideration. A margin of minimum 10% over friction loss shall also be taken into account. All piping system and valves shall be sized to meet the fuel oil requirements of three (3) number Steam Generator(s) operating simultaneously at 30% BMCR load.

4.01.07 Thickness calculation of the pipes shall be done based on the allowable stress of the pipe material at design temperature and the design pressure considered by the Bidder.

The minimum thickness of the pipe as detailed in other section (refer Vol-II-D2) shall be adhered to.

5.00.00

INSTRUMENTATION AND CONTROL

In addition to the requirement spelt out above, all instruments & controls as shown in Tender drawing no. 18A03-DWG-M-001N and as found necessary for safe and trouble free operation of the system shall be provided. Relay based local control panel shall be envisaged for the Fuel Oil Unloading System. Bidder shall refer C&I Specification Volume: II-E - Control & Instrumentation of this specification.



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ROTARY POSITIVE DISPLACEMENT PUMP



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SUB-SECTION-III B

ROTARY POSITIVE DISPLACEMENT PUMP

1.00.0 GENERAL SPECIFICATION

1.01.00 The specification is intended to cover the requirements regarding design, performance, manufacturing, construction, testing, painting and delivery to site of rotary positive displacement pumps.

2.00.00 CODES & STANDARDS

2.01.00 The design, manufacture and performance of the rotary positive displacement pumps as specified herein, shall comply with the requirement of the latest edition of VDMA/API 676. Other equivalent Indian/International standards are also acceptable, subject to approval by the Owner/Consultant.

2.02.00 In case of any contradiction with the aforesaid standards and the stipulations of the technical specification as specified hereinafter, the stipulations of the technical specification shall prevail. In case of any contradiction between the technical specification and "Data Specification Sheet" enclosed, stipulations of the later will prevail.

3.00.00 PERFORMANCE REQUIREMENT

3.01.00 The pumps shall be suitable to handle liquid of characteristic as indicated elsewhere in this specification.

3.02.00 The pumps may have to handle liquids having wide range of viscosity and as such the pump capacity shall be selected based on lowest possible viscosity and drive motor power rating shall be selected based on highest possible viscosity.

3.03.00 The pump shall have minimum vibration, noise or capacity reduction even when the viscosity of oil increases.

3.04.00 The Bidder shall assume full responsibility in the operation of the pump and the motor as a unit.

3.05.00 The performance curve (Q-H curve) representing the relationship of flow and head shall vary smoothly, and the head rises from the rated flow point to zero flow point shall not be more than 20% head at the pump rated point.

3.06.00 In the design condition the performance of the oil flow, head and efficiency shall all be guaranteed, and minus deviation shall not be allowed, and the head deviation shall be within +3% when the flow is rated.

3.07.00 The noise of the oil pumps shall comply with the related regulation. Noise level measured at a distance of 1.0 m horizontally from the nearest surface of equipment/ machine and at a height of 1.5 m above the floor level in elevation shall not be more than 85 dB(A).

4.00.00 DESIGN & CONSTRUCTION

4.01.00 Pump Type

Pumps shall be of positive displacement, screw type as per Data Specification Sheet in Annexures-I & II of this sub-section.

4.02.00 Bearing

Bearing shall be antifriction ball or roller type. Bearings shall be adequately sized to absorb radial as well as axial thrust loads, if any. Bearings shall be of external type as specified in data sheet. Provision of lubrication of the bearings by oil or grease shall be made. Pumps specified to be furnished with external bearings shall have bearings which are completely sealed from the pumped liquid and provided with separate lubricant supply. Pumps shall be provided with external bearing. If bearing cooling is required, provisions for air cooling shall be provided.

4.03.00 Mechanical Seal

Mechanical seal shall be provided instead of stuffing box. The seal material shall have low co-efficient of friction and shall be suitable for the fluid handled.

4.04.00 Relief Valve

4.04.01 Each pump shall have relief valve either built-in with the body or end plate, or attachable as specified in pump data sheet for protection against damage due to accidental closure of discharge valve & pressure build up.

4.04.02 The capacity of the relief valve shall be at least that of the pump to ensure the full discharge of liquid through the bypass line to the suction side of the pump during accidental pressure build up.

4.04.03 A thermal relief valve shall be provided to protect the system against pressure build up due to thermal expansion of entrapped oil.

4.05.00 Timing Gear

Timing gear shall be provided when asked for in the Pump Data Specification Sheet to transmit torque from one rotor shaft to another and to maintain the

proper angular relationship of the rotors. Proper lubricating arrangement for this shall be provided.

4.06.00 Coupling

4.06.01 Pump shall be connected to its drive either directly, or through gear reducer, by means of flexible coupling.

4.06.02 Coupling guard shall be provided.

4.07.00 Base Plate

Common base plate for the pump and motor shall be provided. The base plate shall be suitably drilled for the anchor bolts. The base plate shall have drip pan & suitable draining arrangement.

4.08.00 Material of Construction

For material of construction for the vital parts of the pump, pump data specification sheet shall be referred.

4.09.00 Drive Motor

4.09.01 The design and construction of the drive motor shall be as specified in Volume-II F/1 & F/2 of this specification.

4.09.02 Enclosure shall be sufficiently strong so as to withstand internal explosion that may occur within the motor. The enclosure shall also be provided with such devices as may be necessary to protect the motor from damage if an electrical defect such as sparking, occurs accidentally due to internal fault in the apparatus like failure of insulation/fracture of conductor/loose connection.

4.09.03 The surface temperature of the enclosure shall be kept within such value so as not to ignite the oil vapor, in which motor is working, under any condition of operation.

4.09.04 The enclosure shall be constructed complying various requirement of IS-2148.

4.09.05 Drive motor kW shall have margin of minimum 10% over the maximum shaft power requirement in the entire range operation. All motors used for fuel oil unloading and pressurizing area shall be flame proof type motors.

5.00.00 INSPECTION AND TESTING

5.01.00 All pumps shall be performance tested as per relevant / applicable code.

5.02.00 Inspection and testing shall be carried out as per relevant code and approved Quality Assurance Plans and as detailed below.

5.03.00 Fuel Oil Pumps:

- (a) Material Tests (Chemical Analysis, Mechanical Tests & other tests) as per applicable material standard of all components (plates, forgings etc)
- (b) All forged / rolled bars (for pump rotors / screws) shall be subjected to Ultrasonic Test (for diameter $\geq 50\text{mm}$) at proof machine condition and DPT / MPI after finish machining.
- (c) Rotating parts i.e. Screws / Rotors, Impellers shall be statically and dynamically balanced as per requirements of code ISO: 1940 Gr. 6.3 or better.
- (d) The machined surfaces of castings shall be subjected to DP Test.
- (e) Pump casing shall be hydraulically tested at a pressure 150% of specified shut off head or 2 times working pressure (whichever is higher) for leak tightness..
- (f) All pumps including spare cartridges shall be subjected to performance test at the manufacture's works under as near site conditions as possible and strip down examination after the test.

6.00.00 CLEANING, PROTECTION AND PAINTING

- 6.01.00 The equipment shall be surface cleaned and painted as per Volume-IIA, of this specification.
- 6.02.00 All openings shall be covered to guard against damage and entry of foreign objects. All parts shall be properly boxed, crated or otherwise protected for transportation to suit the mode of transportation. Exposed finished surfaces shall be thoroughly greased before transportation.

7.00.00 DRAWINGS, CURVES AND INFORMATION REQUIRED

- 7.01.01 Outline/GA drawings indicating the principal dimensions and weight of the equipment and location of pump suction and discharge connections.
- 7.01.02 Cross-sectional drawings indicating the assembly of pumps.
- 7.01.03 Diagram showing the type of lubrication system etc.
- 7.01.04 Complete descriptive and illustrated literature on the equipment being offered.
- 7.01.05 A comprehensive write-up or brochure on the details of manufacturing and test facilities in the shop of the manufacturer.

ANNEXURE-I

**DATA SPECIFICATION SHEET
FOR
ROTARY POSITIVE DISPLACEMENT PUMP
(LDO/HSD UNLOADING PUMPS)**

GENERAL INFORMATION		LIQUID DATA	
Service designation	Fuel oil unloading	Liquid Handled	Fuel Oil
Duty	Intermittent	Type of Oil	LDO/HSD
Location	Indoor		
Parallel operation	Required	Characteristic of various Oil to be handled	Refer analysis enclosed with Vol-IIA, Section- XV
Number of pumps:			
1. LDO/HSD tanker unloading pump	Three (3), 2W + 1S	Handling Temperature of Oil	
2. Drain Oil pumps at pump house	Two (2), 1W + 1S	LDO/HSD	Ambient
PUMP PARAMETERS			
Item description	LDO/HSD tanker unloading	Drain Oil Pump	Sump Pump
Type	Rotary positive displacement screw type		
Number of screw elements	Twin	Single	Single
Liquid handled	LDO/HSD	Drain oil	Oily water
Design capacity at lowest viscosity, m³/hr	60	10	5
Differential pressure at design capacity, MLC	To be decided by the Bidder		
Design viscosity, Cst, max/min.	2.5 to 15.7	2.5 to 15.7	2.5 to 15.7

ANNEXURE-I

Installation	Horizontal	Vertical	Vertical
Pump speed (rpm)	Bidder to decide	Bidder to decide	Bidder to decide
Suction condition	Flooded	Flooded	Flooded
Relief valve	In- built	In- built	In- built
Lubrication	External	External	NA
Shaft sealing	Mechanical	Mechanical	
Type of suction strainer	Duplex vertical	As applicable	As applicable
Steam jacket	No	NA	NA
Material of Construction			
Casing	Cast iron as per IS:210 Gr FG 260		
Bearing	Antifriction, located outside the pump body		
Rotor	AISI 431 or equivalent		
Base plate	Carbon steel fabricated		
Shaft	Stainless steel, AISI 431		
Relief valve body	Carbon steel, ASTM A 105		
Relief valve internals	Stainless steel, ASTM A182, Grade F 316/316L		
Mechanical seal	30% Cr steel or C/Si		
DRIVE MOTOR DATA			
Motor specification	Refer Volume II-F/1, Section-II		

ANNEXURE-II

**DATA SPECIFICATION SHEET
FOR
ROTARY POSITIVE DISPLACEMENT PUMP
(LDO/HSD PRESSURIZING PUMPS)**

No.	Description	LDO/HSD pressurizing pump	Drain Oil Pump (Boiler Area)
1	Type	Rotary positive displacement screw type	
2	Number of screw elements	Triple	Single or Twin
3	Medium temperature (deg. C)	Normal temperature	Normal temperature
4	Flow (m³/h)	Minimum 70 or as per maximum flow requirement by a Main Boiler with 10% margins over flow, whichever is higher.	6
5	Discharge Head (mwc)	Bidder to decide as per pressure requirement at burner end.	Bidder to decide.
6	Pump design Suction pressure (kg/cm²)	Considering minimum possible LDO/HSD storage tank level	Bidder to decide.
7	Design Viscosity	2.5-15.7 Cst	2.5-15.7 Cst
8	Installation	Horizontal	Horizontal
9	Rotating speed (rpm)	Bidder to decide	Bidder to decide
10	Quantity	4 (1W per unit + 1 common standby)	6 [(1W+1S) per unit]]
11	Material of construction		
a	Pump Casing	ASTM A 216 Gr. WCB	
b	Screw (for screw pump)	Alloy steel (16MnCrS5-Nitrided steel or Equiv)/SS 431	
c	Rotor/Shaft	Alloy steel 35crMo or Equivalent) / SS 431	
d	Relief valve body	Carbon steel, ASTM A 105	
e	Relief valve internals	Stainless steel, ASTM A182, Grade F 316/316L	
f	Mechanical seal	30% Cr steel or C/Si	
DRIVE MOTOR DATA: Refer Volume II-F/1, Section-II			



EPC Bidding Document

**NLC India Limited
NLC Talabira Thermal
Power Project- 3x800 MW
Jharsuguda, Odisha**

VOLUME: II-B
SECTION-III
SUB-SECTION-III C
ATMOSPHERIC STEEL STORAGE TANKS



Development Consultants Pvt. Ltd.

**Vol. II-B/Section-III
Fuel Oil Handling System**

SECTION-B

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SECTION-III

SUB-SECTION-III C

ATMOSPHERIC STEEL STORAGE TANK

1.00.00 GENERAL SPECIFICATION

1.01.00 The specification is intended to cover the requirement of design, fabrication, installation, supply of accessories, testing and commissioning of atmospheric steel storage tanks for fuel oil system.

2.00.00 CODES AND STANDARDS

The design, manufacture and testing of the tanks shall comply with the requirements of the latest revisions of one or more of the following standards as applicable

2.01.00 IS-803: Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded oil storage tank.

2.02.00 IS-816 : Code of practice for use of metal arc welding for general construction in mild steel.

2.03.00 IS-817: Code of practice for training & testing of metal arc welders.

2.04.00 IS-823: Code of procedure for manual metal arc welding of mild steel.

2.05.00 API-620: Recommended rules for design and construction of large welded, low pressure storage tanks.

2.06.00 API-650: Welded steel tank for oil storage.

2.07.00 API-2000: Venting Atmospheric and Low-Pressure Storage Tanks.

2.08.00 The materials of the various components shall conform to those specified in Data Specification Sheet.

2.09.00 In case of any contradiction with the aforesaid standards and the stipulations of the Technical Specification and Data Specification Sheets the stipulations of Technical Specification and Data Specification Sheets shall prevail.

2.10.00 In case of any contradiction between the technical specification and the data specification sheet, stipulations of the later shall prevail.

2.11.00 Tank capacity should be certified by the Department of Weights and Measures.

3.00.00 SUPPLY OF STEEL MATERIALS

3.01.00 The scope of supply and applicable standard for all the material required for fabrication and erection of tank shall be as indicated in the Data Specification Sheet.

3.02.00 The plates as required for the fabrication of the steel tanks along with all structural supports, staircases, ladder, platforms, etc. will be supplied by the Bidder.

4.00.00 DESIGN & CONSTRUCTION

4.01.00 Tanks shall be suitably constructed for safe, proper and continuous storage of liquid described in Data Specification Sheet. The design code, material standard, size and other details shall be as per the Data Specification Sheet. The tank foundation shall be high enough to reduce idle storage volume of tanks.

4.02.00 Tanks for storage of inflammable liquids shall be in accordance with the requirement specified in Indian Petroleum and Explosive rules. Before commencing the erection/construction, the relevant drawings/documents shall be got approved by Directorate of Explosive, Govt. of India.

4.03.00 For cylindrical tanks, the plates shall be cold rolled through plate bending machine by several number of passes to true curvature.

4.04.00 Vessel seams shall be so positioned that they do not pass through vessel connections. For cylindrical vessels consisting of more than two sections, longitudinal seams shall be offset.

4.05.00 Where possible, the inside seam weld shall be ground smooth, suitable for application of corrosion resistant primer.

4.06.00 Proper means shall be provided against the chance of over-turning effect of wind on an empty vertical cylindrical tank having a shell height greater than the diameter. Anchorage of tanks shall be done when "C", a dimensionless figure exceeds 0.66 where :

$C = 2M/dw$, for vertical cylindrical tanks

Where, M = Overturning moment due to wind, kg-m.

d = Diameter of shell, m

w = Weight of shell and portion of roof supported by shell, kg.

4.07.00 Due consideration for wind load and/or earthquake effect shall be given by the Bidder in the design of tanks as specified in API 650. Data for wind load and earthquake shall be taken as indicated in the Data Specification Sheet/lead

specification. Maximum allowable stresses for design loadings combined with wind or earthquake shall not exceed 133% of stress permitted for the design loading condition but in no case shall exceed 80% of minimum specified yield strength of the material.

- 4.08.00 For tanks of diameter 4.75 m and thickness less than 6 mm or of diameter larger than 4.75 m added structural supports in the form of rafters shall be provided.
- 4.09.00 Reinforcement pads in tank connections shall be provided as per applicable code & the reinforced connection shall be completely pre-assembled into a shell plate. The completed assembly including the connection shall be thermally stress-relieved as per API Standard 620 if so specified in the Data Specification Sheet.
- 4.10.00 The joint efficiency factor to be adopted for design calculation shall be in accordance with the Data Specification Sheet. In absence of any such data this figure shall be taken as per applicable standard.
- 4.11.00 All welding shall be done as per IS:816, latest revision. All welds are to be continuous welds. Bidder shall clearly state in his offer the make and type of welding rods proposed by him for fabrication.
- 4.12.00 Sufficient air space is to be provided in the tank. Temperature expansion of oil shall be taken into account.
- 4.13.00 The supply and return pipes shall be extended well inside (upto bottom) of the tank and wear plates shall be provided.
- 4.14.00 Tank Connections
- 4.14.01 Bidder shall furnish all piping material required for the tank connections.
- 4.14.02 Unless otherwise specified, for all flanged connections Bidder shall furnish suitable counter flanges and the necessary nuts, bolts, gasket. Blank flanges shall be provided on spare connections.
- 4.14.03 Flange faces of all nozzles shall be machined square with the nozzle centerlines.
- 4.14.04 Unless otherwise stated, bolts and nuts shall be of hexagonal head conforming to ASTM A 193 Gr.2H & ASTM A 194 Gr.B7.
- 4.14.05 The material and thickness of gaskets shall be suitable for the specified service. On completion of hydraulic test, Bidder shall replace the gaskets used during testing at his own cost.
- 4.14.06 Pad plate as required to be welded on tank shell for support of fire water spray pipes/foam pipes shall be provided by the Bidder.

5.00.00 TANK ACCESSORIES

5.01.00 The tanks shall be provided with accessories as indicated in the Data Specification Sheet. All the accessories shall conform to relevant Indian Standard and as specified. The following broad guideline are given for some of the accessories.

Each LDO/HSD tank shall be provided with float type level indicators, level transmitters, level switches, steel spiral staircases complete with grated stair treads, hand railing, etc. Dip stick arrangement & inside cat ladder, outside spiral staircase with rails shall be provided.

5.02.00 Flame Arrestor

Each vent connection on tanks shall be provided with a flame arrestor. The flame arrestor design shall meet the approval of the Inspector of Explosives. The Bidder shall furnish the materials of construction and detail cross-sectional drawing along with his proposal. The sizing of vent shall be as per API 2000.

5.03.00 Conservation Vent Valve

Where continuous venting to atmosphere directly is not permitted for the stored liquid, a conservation vent valve or a breather of approved make and design shall be provided on each of the vent/ overflow connections of the tanks as specified. The conservation vent valves where provided, shall be designed to relieve the pressure or vacuum corresponding to plus or minus 65mm water gauge in the space above liquid in the tank. Detail cross-sectional drawing indicating materials of construction shall be submitted.

5.04.00 Instrumentations

For instrumentations refer tender P&I diagrams 18A03-DWG-M-001N attached.

All other accessories, fittings and tank connections including level transmitters and level switches etc. shall generally be as per the drawings and required for sound engineering practice. Level Transmitter (radar type) shall be mounted on top of the tank.

6.00.00 INSTALLATION

6.01.00 When installation of tank is specified, the recommendation regarding installation in IS:803 shall be followed in general. In addition to those recommendations, the following shall also be taken care of.

- 6.02.00 All fabricated parts, before assembly, shall be transported by the Bidder to the tank installation site. All preliminary work and fabrication in part or full shall be done at the Bidder's fabrication yard or shop as much as possible to suit his transportation arrangement subject to Owner's approval.
- 6.03.00 All material before final installation over the foundation at the respective locality shall be inspected and repaired as necessary to ensure that any damage received during transportation is corrected before erection to the satisfaction of the Engineer. Particular attention shall be given towards removal of buckles and other form of distortion in shell and bottom plates. Irregularities and dirt which would prevent metal-to-metal contact at the jointing faces shall be removed.
- 6.04.00 The finished tank head for cylindrical tank shall be crowned from the outer periphery to the center with a slope of around 1: 16.
- Sufficient number of plugged holes shall be provided in the bottom plate of the vertical tanks for bottom testing as specified in IS:803.
- 6.05.00 Welding sequence shall be adopted in such a way so as to minimize the distortion due to weld shrinkage. Bidder shall indicate in his drawing the sequence of welding proposed by him which should meet prior approval of Owner.
- 6.06.00 During construction period, the tanks and the sections shall be suitably anchored and tied by guy-wires ropes etc. to avoid blowing/ toppling/Sliding due to gusty wind.
- 7.00.00 INSPECTION & TESTING**
- 7.01.00 Inspection and testing shall be carried out as per relevant code and approved Quality Assurance Plans.
- 7.02.00 For tank and Vessels:
- 7.02.01 Material Tests (Chemical Analysis, Mechanical Tests & other tests) as per applicable material standard of all components (plates, forgings etc.)
- 7.02.02 Only Qualified welders as per approved WPS and PQR shall be deployed for fabrication of tanks.
- 7.02.03 Dimensional checks, during in-process and final inspection, shall be carried out for alignments, circularity, verticality, orientation of connections, slope of bottom plate etc.
- 7.02.04 NDT on weld joints shall be done as per relevant / applicable standard. However, minimum requirement of NDT, as given below, shall be complied:
- a) 100% DPT on root run (butt welds / back-gouged welds).

- b) 100% DPT on all finished welds.
- c) RT on butt welded seams (which shall cover all 'T' / Cross joints) as per design code / Standard.

7.02.05 All tanks shall be subjected to hydraulic test. Other tests, (as per relevant design standard), given below shall be applicable:

- a) Vacuum test for bottom plate seam testing and annular plate.
- b) Air / vacuum test for roof testing.

8.00.00 CLEANING, PROTECTION AND PAINTING

The equipment shall be surface cleaned and painted as per data specification sheet.

9.00.00 DRAWINGS, DATA AND INFORMATION REQUIRED

9.01.00 The Bidder shall submit with his offer the following besides the different information required elsewhere in this specification.

9.01.01 GA/Outline and fabrication drawings of the tanks indicating plate thickness, details of structural support, stiffeners and details of connection.

9.01.02 Illustrative literature and drawings for the tank accessories.

9.01.03 Experience list of similar works.

9.02.00 The successful Bidder shall submit the following:

9.02.01 Detailed fabrication drawing showing the sizes, materials, weld preparations etc. furnishing all necessary information for fabrication, erection and painting of steel work in accordance with the provision of this specification.

9.02.02 Design calculation for plate thickness etc. considering all applicable loads, seismic effect, wind load etc., also calculations for selection of tank heating coils, suction heaters etc. as specified.

9.02.03 Test procedures for tanks, QAP & FQP.

9.02.04 Test certificates.

9.02.05 Instruction Manuals for the accessories supplied specially covering maintenance, repair and replacement.

ANNEXURE-I

**DATA SPECIFICATION SHEET
FOR
ATMOSPHERIC STEEL STORAGE TANK AND ACCESSORIES**

Technical particulars	Tanks Data	
	LDO/HSD Storage tank	Drain Oil tank (FOPH & Boiler area)
Type	Vertical cylindrical	Rectangular / Cylindrical
Roof shape	Fixed cone roof, supported type	Flat / dished end
Installation	Outdoor	Indoor (FOPH) Outdoor (Boiler area)
Construction	Welded shell, bottom plate butt welded	Welded
Design code	IS: 803 / API-650	IS: 800
Effective capacity, m ³	2500	10 & 6
Quantity required	2	1 & 2
Tank dimension	Bidder to decide.	
Min. Plate thickness	Roof-6 mm, Shell-6 mm, Bottom-8 mm	6 mm
Corrosion allowance	1.8 mm	
Design pressure	Atmospheric pressure over max liquid column	
Design temperature, °C	Ambient	Ambient
Material of construction	Carbon steel as per IS 2062 Gr. B	
Insulation	No	No
VARIOUS TANK ACCESSORIES AND MOUNTINGS		
• Flame arrestor	Yes	Yes
• Spiral staircase & platform	Yes	No. Ladder for roof access
• All nozzles with counter flanges	Yes	Yes

ANNEXURE-I

Technical particulars	Tanks Data	
	LDO/HSD Storage tank	Drain Oil tank (FOPH & Boiler area)
Temperature controlled steam valve for floor coil and suction heater	No	No
SURFACE PREPARATION & PAINTING:		
Surface preparation	Sand blasted to SA 2 ¹ / ₂ by abrasive metal grit	Sand blasted to SA 2 ¹ / ₂ by abrasive metal grit
Exterior surface		
Primer	Two coats of zinc phosphate primer (DFT 30 μ per coat)	Two coats of zinc phosphate primer (DFT 30 μ per coat)
Finish Paint	Two coats synthetic enamel (DFT 35μ per coat)	Two coats synthetic enamel (DFT 35μ per coat)
Internal surface	Two coats double boiled Linseed Oil	Two coats double boiled Linseed Oil
Underneath	One coat Bituminastic paint (DFT 75 μ min.)	One coat Bituminastic paint (DFT 75 μ min.)
All instrumentation including pressure gauge, temperature gauge, temperature and level instruments, level indicator, standpipes etc. as specified and as required	Yes	Yes
Dip hatch	Yes	Yes
Earthing pad	Yes	No
Lightning Arrestor	Yes	No
Insulation cleats	No	Yes
Cleat for fixing fire water spray & foam pipe with support	Yes	As per bidder standard practice

ANNEXURE-I

Technical particulars	Tanks Data	
	LDO/HSD Storage tank	Drain Oil tank (FOPH & Boiler area)
• Foam chamber	Yes	As per Bidder's standard practice
• Nozzle for fire detector	Yes	As per Bidder's standard practice



EPC Bidding Document

**NLC India Limited
NLC Talabira Thermal
Power Project- 3x800 MW
Jharsuguda, Odisha**

VOLUME: II-B
SECTION-VI
AUXILIARY BOILER



Development Consultants Pvt. Ltd.

**Vol. II-B/Section-VI
Auxiliary Boiler**

SECTION-B



EPC Bidding Document

NLC India Limited
NLC Talabira Thermal
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Jharsuguda, Odisha

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Development Consultants Pvt. Ltd.

Vol. II-B/Section-VI
Auxiliary Boiler

VOLUME: II-B

SECTION-VI

AUXILIARY BOILER

1.00.00 DESIGN BASIS

1.01.00 Type and Rating

One number outdoor installation type, natural circulation, pressurized furnace, water tube boiler suitable for firing LDO and having minimum steaming capacity of 70 T/hr or of higher capacity if the requirement of auxiliary steam for pre-commissioning, commissioning and start-up activities is greater than 70 T/hr as envisaged by Bidder (Excluding steam requirement of Auxiliary boiler) with steam parameters at superheater outlet as optimized by the Bidder maintaining minimum 19 kg/cm²(g) and temperature range of 250 to 315°C. The auxiliary boiler shall supply auxiliary steam to 3x800 MW units. However, it will cater the auxiliary steam requirement of one unit at a time.

Auxiliary Boiler shall be capable of achieving full load from cold conditions within maximum (2) hours time from cutting in of first burner. The capacity of auxiliary boiler shall be crosschecked considering main boiler plant start up without boiler recirculation pump.

The design of Auxiliary Boiler shall meet all requirements of IBR. The Bidder shall be responsible to obtain necessary approval of Inspection Authority / Director of Boilers on behalf of Owner as may be required for design & design calculation, manufacturing & erection procedures, testing etc. as called for under IBR.

The auxiliary Boiler, including its interlock & protection system shall conform to NFPA – 85.

The Bidder shall also be responsible for obtaining approval from the statutory authorities applicable in India, as may be required for any other plant and system supplied by him such as fuel oil system installation etc.

1.02.00 Boiler Steam & Water Circuit

Feed water shall be supplied to the water tube Boiler and feed control station. Feed control station shall comprise of 2x100% feed control valves. Saturated steam from drum shall pass to convective super-heater. Super-heated steam shall be sent to steam export pipe through a NRV and a motor operated isolating valve.

1.02.01 Furnace

Furnace shall be of membrane type welded water wall construction with buck stays etc. The pressure withstand capability at the furnace shall not be less than the maximum conceivable head of the FD fans.

1.02.02 Drum

Drum shall have fusion welded construction and shall be designed as per IBR requirements. The drum shall be complete with internals, safety valves, level indicators and transmitters, chemical feed, pressure gauges, vents and drains, sampling connections, acid washing connection and thermocouples etc.

1.02.03 Super Heater

Convective type super heater will be suitable to take care of hot end corrosion due to LDO firing.

1.02.04 Feed System

The feed system shall comprise of a feed water pressure type deaerator complete with necessary mountings and fittings and 2 x 100% electric motor driven Boiler feed pump sets (One running & other standby) with auto changeover facility on failure of duty pump, together with all pipe work, valves fittings, controls etc. as necessary. Two feed pumps shall be identical multistage centrifugal pumps (ring section type) complete with drive. Each pump shall be rated for continuous operation at 100% Boiler's MCR with an additional margin of 15% on flow. The pumps shall have stainless steel impellers. The shaft seals shall be hard faced water wear resistant material with automatic wear adjustment take up and alignment. Each pump discharge shall be fitted with isolation valve & NRV. Auto recirculation line and balance leak off line to deaerator for each boiler feed pump to be provided. For boiler feed pump recirculation system to deaerator, automatic recirculation valve against each boiler feed pump discharge shall be provided.

The deaerator feed water storage tank having a capacity adequate for continuous operation of Auxiliary Boiler for minimum 30 minutes without feed water make-up. The make-up for the auxiliary boiler deaerator shall be provided by means of dedicated 2x100% (One running & other standby) horizontal centrifugal pumps (**Auxiliary Boiler deaerator make-up pumps**) taking suction from condensate storage tank(CST). For technical details of the pumps, the Bidder shall refer Volume-II-IA, Section-II of this specification.

1.03.00 Fuel System

The main burners are to be designed for firing LDO. The characteristics of LDO are given in Lead specification under Vol-IIA, Sec-XV. The ignition system shall use spark ignition system with HEA ignitor assembly. LDO supply to auxiliary boiler burners shall be catered by dedicated 2 x 100% (1W

+ 1S) Aux boiler LDO pressurising system by taking tap off from main LDO tanks.

Service air for LDO atomisation shall be taken from main boiler area. LDO firing system shall be complete with trip valve, flow control valve and flow measurement system, having necessary interface with auxiliary boiler BMS.

1.04.00 Chemical Feed System

The following chemical feed system shall be taken into consideration as minimum requirement.

- i) Hydrazine dosing system to deaerator storage tank outlet.
- ii) Ammonia/Morpholine dosing system for deaerator make-up water system.
- iii) HP dosing system to boiler drum.

Each chemical feed system skid shall be complete with chemical preparation tank, input DM water source, agitators & 2 x 100% dosing pump assembly.

1.05.00 Nitrogen Inerting System

Nitrogen inerting system, complete with nitrogen cylinder, pressure regulator, flexible hose connection with isolation valves for boiler drum & deaerator shall be provided.

1.06.00 Ducting

The Boiler shall be provided with flue gas ducting connected to chimney inlet. The duct shall be rectangular in shape & constructed from carbon steel plate. The ducting section shall have flanged & bolted joints self-supported against all wind seismic and gravitational loads.

1.07.00 Structural Steel Work

All Boiler structures & support shall be provided. All steel work & structures shall be capable of accepting seismic loading in addition to other loadings including dead weight, wind forces etc.

1.07.01 Ladders, Platforms

Auxiliary Boiler shall be complete with platforms, ladders, walkways, handling provisions. Suitable platform & approach shall be provided for operation of auxiliary Boiler and for attending all maintenance requirements of the Boiler & its auxiliaries.

1.07.02 Auxiliary Boiler Canopy

To offer protection to the Boiler against rainfall, a rain canopy shall be provided. This shall be made from steel frames, supports and steel sheathing and shall be complete with guttering & down pipe, etc. as necessary.

The rain canopy shall not prevent reasonable access to Boiler mountings and shall be arranged as necessary to allow the use of lifting tackles supported off the rain canopy steel work. The colour coding scheme of the Auxiliary Boiler canopy shall be same as Main Boiler.

1.08.00 Chimney

1 No. 35 M minimum height designed as per Indian chimney code IS-6533. The chimney shall be manufactured from CORTEN steel plate with insulation and cladding and shall be provided with access door with cover and a drain connection. The chimney shall be insulated with mineral wool. Boiler outlet gas temperature to chimney shall be limited to 180 deg. C or the sulphur dew point temperature whichever is less.

1.09.00 Safety Valves

At least three (3) safety valves, two (2) at drum of 75% MCR combined capacity and one (1) at SH outlet of 30% MCR capacity shall be provided and as per IBR regulation.

1.10.00 Draft Plant

Complete draft system comprising of 2 x 60% FD fans complete with drives, silencers, grease/oil lubrication system and associated ducting system etc. shall be provided.

1.11.00 Blow down system

One (1) no. of blow down tank complete with blown down quenching system shall also be provided. The drain lines of Auxiliary boiler will be connected to the nearest local drain pumping station.

1.12.00 Equipment Handling Arrangement

Where it is necessary to handle any item in excess of 50 kg weight on the Boiler for purpose of erection or maintenance, a suitable lifting beam arrangement is to be provided. Electric / manual hoist for equipment handling shall be provided as specified in Volume-II-K, Section-III of this EPC specification.

1.13.00 Valves

For Valves of fuel oil system for auxiliary boiler, shall be as per Vol-II-B, Section-III, same as stipulated for main boiler. Gate and globe valves for isolation and regulation purpose respectively shall also be acceptable.

1.14.00 Electrical

For electrical pertaining to auxiliary boiler, the Bidder shall refer to Volume-II-F/1 & F/2 of this specification.

1.15.00 Instrumentation & Control

All necessary sensors, transmitters, switches & local instruments including flame scanners, Oxygen Analyzer, Local Burner panel etc. shall be provided by the Bidder for safe, efficient operation of the plant. The control, interlock & protection shall be implemented in Plant DDCMIS. For details, refer to specification Volume-II-E of this specification.

2.00.00 PAINTING

For painting of boiler components and auxiliary, Bidder shall comply the requirement indicated in Volume-IIA-Lead Specification, Section-XII.