SUB-SECTION–A-02

STEAM GENERATOR AND AUXILIARIES INCLUDING ESP

STEAM GENERATOR AND AUXILIARIES

1.00.00 **EQUIPMENTS AND SYSTEMS SPECIFICATIONS**

Specified hereafter are the minimum acceptable functional requirements of the Employer, and all components, equipment and systems for the Steam Generator(s) shall be designed to cater to these requirements. Compliance to various stipulations of the Technical Specifications, functional requirements of the Employer and utilization of various parameters and their values in the specification by the Contractor shall in no way relieve the Contractor of his responsibilities to meet all guarantee requirements or of providing completely safe and reliable operating equipment/systems.

The specified requirements shall be complied for the most stringent conditions resulting either from the range of coals (design/worst/best/adequacy) specified or from the range of operating conditions specified (like 100% BMCR or HP Heaters out of operation etc.), or from both occurring simultaneously, unless specifically mentioned otherwise by the Employer.

1.01.00 **FUELS**

1.01.01 **Coal**

(a) The primary fuel for the main Steam Generator(s) shall be coal. The quality parameters are given in, Annexure IV-2, Sub-Section-I-B of Part A of the project.

(b) The Steam Generator shall be designed to give the maximum efficiency when firing the coal having the characteristics for Design coal as given in Annexure IV-2 of Sub-Section-I-B of Part-A of the project.

(c) The Steam Generator and its auxiliaries shall also be capable of obtaining the boiler maximum continuous rating (BMCR) when firing the coal having the characteristics for worst coal as given in Annexure IV-2**,** Sub-Section-I-B of Part-A of the project.

(d) NOT USED

(e) Steam Generator and its auxiliaries shall also be capable of obtaining maximum continuous rating as specified in clause no 1.02.00 of Subsection -A-01 above, safely and on sustained basis, when firing upto 30% imported coal (typical data specified in Annexure IV-4, Sub section-I-B ,Part-A of Section-VI) by weight blended with Indian coal(s) as specified in Annexure-IV-2, sub section-I-B ,Part-A of Section-VI of the project. System redundancies/ margins on equipment/ auxiliary sizing need not be available under such fuel firing condition unless specifically mentioned otherwise. However, equipments/ systems shall not exceed their safety limits under such firing, and shall not transgress into factors of safety as per specification/ codes. Further during this firing, there shall not be slagging / clinkering phenomena and any hot spot in the pulverized coal system / pulverizers etc.

(f) Due to open cast method of mining involved, the shale and sand stone content of coal may be as high as 20% with alpha quartz contamination upto 5.0 mm size. Contractor shall consider the effect of these shale, sand stone and alpha quartz content while designing the equipment and systems and also for wear life guarantees of mill wear parts. The Bidders are advised to collect coal samples for independent analysis of coal combustion, slagging/ fouling characteristics etc., to satisfy themselves so as to meet all specified requirements.

1.01.02 **Fuel Oil**

(a) **Description of Fuel Oil Unloading & Storage System**

The fuel oil requirements for steam generator shall be drawn from the LDO tanks to be provided by the contractor. The fuel oil pressurizing and firing system shall be in the scope of contractor. Bidder shall include all required piping, valves, fittings, instrumentation etc. upto the terminal point.

(b) **Fuel Oil Firing System**

(1) The fuel oils having characteristics as given at Table-1, Annexure –IV-1, of Part-A, Sub-section-I-B shall be used for start-up, coal flame stabilization and low load operation of the main Steam Generator(s)

(2) The design and construction of the Steam Generator shall be suitable for firing the fuel oils mentioned above for continuous operation of the Steam Generator.

1.02.00 **Codes & Standards**

(1) All equipment, systems and work covered under this specification shall comply with all latest statutes, regulations and safety codes, as applicable in the locality where the equipment will be installed. This shall however be subject to change in Laws & Regulations as specified in Section-IV GCC.

(2) The design of Steam Generator shall meet or exceed all the requirements of latest editions of Indian Boiler Regulations (IBR). This is subject to provision in Section-IV, GCC.

(3) Any other standard acceptable to IBR can also be considered, provided that the requirements of that standard are equivalent or more stringent than the IBR requirements.

(4) Wherever the specification stipulates requirements in addition to those specified in IBR, the same shall also be complied with, by the Contractor.

(5) In all above cases specific approval of concerned Chief Inspector of Boilers shall be obtained by the Contractor before manufacture of the equipment.

(6) In cases where IBR does not govern, other International Standards, established to be equivalent or superior to the Codes and Standards specified are also acceptable. However, in the event of any conflict between the requirements of the equivalent codes and standards, and the requirements of the Indian Standards/ Regulations, the latter shall govern, unless, specified otherwise in the specification.

(7) NFPA requirements including that for load changes & stabilization.

1.03.00 **Statutory Approval**

It shall be responsibility of the Contractor to obtain the necessary approvals of Inspection Authority/Chief Inspector of Boilers Registration Authority etc. on behalf of the Employer, as may be required for designing and design calculations, manufacturing and erection procedure, testing etc. as called for under the IBR. All such documentation submitted to statutory authorities shall also be submitted to the Employer for his review.

1.04.00 **Minimum Load Without Oil Support for Flame Stabilization**

The design of Steam Generator shall be such that it does not call for any oil support for flame stabilization beyond 40 % TMCR load when firing any coal from the range

specified, with any combination of adjacent mills (to Employer's choice) in service. This shall be demonstrated by the Contractor.

1.05.00 **Loading/Unloading Pattern and Adaptability for Sudden Load Changes/Load Throw off**

(i) To match the desired plant operating capabilities, the Steam Generator shall also be designed for cyclic/two shift operation. Expected numbers of Steam Generator start-ups during 25 years of design life are as follows:

	Type of Starts	Number of Starts
a.	Hot start (after 8 hours of unit shut down)	4000
b.	Warm start (after 36 hours of unit shut down)	1000
c.	Cold start (after 72 hours of unit shut down)	150

To make unit capable of continuous two shifting operation, the number of hot start ups shall be increased from 4000 numbers to 6700 numbers without changing cold and warm start up as well as daily N1 (minimum 13400 cycles in total design life) and N2 (minimum 6700 cycles in total design life) requirements as defined Sub section -G-01 operating capability of Plant , Part-B ,Section VI.

(iv) In case of sudden load throw-off, in worst case from 100% BMCR, 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.

(v) In line with automatic run back capability of the unit load on loss of critical auxiliary equipments, the Steam Generator equipment and systems shall also ensure smooth and stable runback operation.

Steam generator shall be capable of operation with HP heaters out of operation. The steam generator heat output under HP heaters out condition shall not be less than heat duty required for generating rated power output or design BMCR heat duty, whichever is lower. For turbine trip & HP/LP bypass mode operation condition the economizer shall be suitably designed to take a thermal shock of sudden change of feed water temperature from rated value(s) to 140°C. The superheater and reheater outlet temperature shall be maintained during HP/LP bypass operation at above mentioned superheater outlet flow.

1.06.00 **Steam Generator Control Range**

The automatic control range of Steam Generator shall be from 50% TMCR to 100% BMCR. Under the above control range, the steam temperatures at SH & RH outlets shall be maintained at their rated values.

1.07.00 Following anticipated parameters shall be considered in boiler design.

(i)	Air infiltration in ESP	:	1% of ESP inlet gas flow
(ii)	Pressure drop in ESP	:	25 mmWC
(iii)	Temperature drop in ESP	:	2°C

1.08.00 NOT USED

1.09.00 **Limits of NOx Emission**

1.09.01 Combustion system along with wind box, air ducting and other associated parts shall be

	designed for guaranteed maximum NOx emission of 300 mg/Nm3 at 6% O_2 on dry gas basis at Steam Generator Outlet. Minimum two levels of separated overfire air (SOFA) shall be provided. The value of NOx shall include both fuel and thermal NOx and shall not be exceeded during 40% to 100% TMCR load condition from the range of specified coals.
1.09.02	NOT USED
1.09.03	Bidder to submit details of NOx emissions achieved by him at other stations using similar fuels burner/furnace designs, to substantiate his claims.
1.10.00	**Capital Overhaul of Steam Generator**
	Employer envisages to carry out the capital overhaul of units once in three (3) years. The design and materials for various equipments/auxiliaries etc. shall be selected by the Contractor keeping in view the above requirement of the Employer, such that no major repairs/replacements, requiring shutdown of the unit, are needed in between the capital overhauls.
1.11.00	**Maintenance**
1.11.01	The Contractor shall provide adequate handling facilities & approach as for carrying out on-line and off-line maintenance of the Steam Generator and its auxiliaries. In order to carry out on-line maintenance, it shall be possible to readily disassemble, repair and reassemble the equipment supplied in the shortest period.
1.11.02	A minimum of two accesses and clean out doors shall be provided to permit access to the furnace, superheater, reheater, the area between tube bank, Separator, economizer and any other area requiring maintenance.
1.11.03	Material handling equipment consisting of monorails, cranes, motorized hoists and motorized trolleys and any other lifting device, as may be required, alongwith all supporting structure etc. shall be provided for maintenance of all auxiliaries like ID, FD & PA fans, air preheaters, pulverizers, Steam Coil Air Preheaters, fuel oil pumps etc.
1.11.04	A vertical & straight garbage chute of minimum 500 mm diameter 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 and suitable access to the doors at all platform levels. Garbage collection trolleys shall also be provided at the ground level.
1.11.05	Header to be provided with hand hole at end cover for ease of inspection and removal of foreign material. Enclosures for headers outside the gas path shall have provisions to avoid dust accumulations & facilitate dust removal & cooling in order to aid access for maintenance & inspection activities.
1.12.00	NOT USED
2.00.00	**STEAM GENERATOR ENCLOSURE**
2.01.01	Steam Generator enclosure shall form air/gas tight envelope from secondary air and primary air inlet points to chimney inlet.
2.01.02	The enclosure integral with boiler (except air heaters) shall be formed by water/steam cooled tubes on all the four sides, roof and bottom. The furnace waterwalls shall be formed using either spiral (helical) wound tubes or vertical plain/rifled tubes. The roof of single pass/tower type boilers could be formed by gas tight metal sheeting of appropriate

material.

2.01.03 The enclosure shall be formed using welded wall construction only. Where use of refractory is unavoidable, 4mm thick steel plate behind refractory shall be provided to form enclosure.

2.01.04 NOT USED

2.02.00 The Steam Generator enclosure shall be provided with:

(a) Observation ports for each oil/coal burner and at various platform levels on all the walls. Cooling of the observation ports shall be as per bidder's proven standard practice.

(b) Openings with hinged doors (air/gas tight) in all areas needing access for internal observation/maintenance. Provide minimum two openings for each area.

(c) Approach platform for each observation port/opening along with ladders from nearest platform level.

(d) Seal plates of stainless steel (type 430) or better corrosion and erosion resistant steel material of minimum 6.00 mm thickness, all round the furnace bottom, to prevent ingress of air.

2.03.00 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.

2.04.00 In the Steam Generator enclosure, minimum 1.5 m cavity height shall be provided in between the horizontal banks/sections of economizer, superheater and reheaters for maintenance purpose.

3.00.00 **FURNACE/EVAPORATORS AND WATER WALLS**

3.01.00 Furnace/evaporator/waterwalls shall comply with following requirements at 100% BMCR and HP Heaters out conditions for the range of specified coals, under most stringent combination of conditions

3.01.01	No. of burner elevation being fed from one mill*	1 (Maximum)
301.02	Buckstay spacing	To ensure that its natural frequency is sufficiently away from the flame pulsation frequency.
3.01.03	Buckstay support	Self support from furnace walls. No interconnection with boiler structure is allowed.
3.01.04	Furnace Bottom hopper	Design of Boiler and its supporting structure shall be considering 50% ash/clinker loading in furnace bottom hopper and corresponding to ash density of 1600 Kg/m^3. Further minimum sixteen (16) Nos. of load cells shall be installed by Contractor in the furnace roof enclosure to give indication of ash build up in the furnace bottom hopper. The contractor shall provide the design basis for the

	selection for number of load cells, their distribution and fixing up of alarm set points.
	(*) Refer Sub-Section-A-01, Part-B, Clause No. 1.05.08.02(i).
3.02.00	Furnace / Evaporator shall be designed for variable pressure operation over 30% to 100% BMCR load range.
3.02.01	Water/steam walls shall be of membrane wall construction and shall be made of seamless cold drawn tubes. Furnace / evaporator shall be formed using spiral wound / inclined tubing or vertical plain / rifled tubing as per the proven practice of the manufacturer for boilers of similar capacity. Irrespective of the type of water wall tubing offered for the evaporator, the design offered shall ensure that no readjustment of tube mass flow is required during entire operating regime of the Steam Generator for complete range of specified coals. In case such readjustment becomes necessary over a period of five years from the date of successful completion of initial operation of respective Steam Generator, the cost of carrying out such flow readjustment/modifications including cost towards rectifying any damages to the Steam Generator tubing resulting from the inappropriate mass flow in the tubes shall be borne by the Contractor. Contractor in its proposal shall indicate the approximate time required for such readjustment of tube mass flow and the period of unit shut down. The thermo-hydraulic design of the offered evaporator shall be stable under varying heat flux and mass flux conditions as well as other system disturbance that the evaporator may encounter during operation. The stability of the thermo-hydraulic design of the evaporator shall be demonstrated by the contractor by conducting stability analysis (both static and dynamic) of the finalized evaporator design. As a part of the static stability, interalia, the outlet temperature profile for each tube at the intermediate header inlet (if applicable) and vertical wall outlet header be calculated. The variance of tube outlet temperature shall be validated by carrying out site demonstration for the first boiler during commissioning by affixing metal temperature thermocouples at each evaporator outlet tube (at intermediate header inlet, if applicable, and vertical wall outlet). These thermocouples shall be over and above the requirements for metal temperature thermocouples specified elsewhere. In case the temperature variance in the evaporator tubing temperature during such demonstration is found to exceed the design considerations necessary modifications to the evaporator flow circuits shall be done by the contractor to control the tube temperatures. The mechanical design of the evaporator shall be carried out considering its primary stresses due to internal pressure as well as secondary stresses due to loads like weight membrane panel, buckstays, ash, and other elements loaded on evaporator, differential stresses restrained thermal expansion between evaporator tubes and the evaporator support elements etc. The calculations in support of the same shall be submitted by the contractor.
3.02.03	A minimum allowance of 0.6 mm over and above the calculated thickness as per IBR shall be provided for entire water wall. An additional tube thickness of 1.0 mm over and above the tube thickness of water wall tubes calculated as per above shall be provided on all water wall tubes coming within a radius of one meter around each wall blower to guard against premature tube failure due to soot blowing steam erosion.
3.02.04	Flame impingement on steam/water walls is not permitted. Suitable provisions, including the extent of combustion staging, shall be made to minimize the water wall corrosion. The bidder shall demonstrate that the average thinning of tubes in the burner zone due to corrosion, erosion etc. shall not be more than 0.1 mm/per year.
3.02.05	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.

3.02.06 For, vertical tubing arrangement, Minimum 10 mm dia. Wear bars of suitable wear resistant material shall be welded along the full length of first 40 tubes of inclined water wall tubes of S-panel of bottom hopper from each corner up to hopper opening.

In case of spiral tube arrangement, wear bars shall be welded on each of the inclined water wall tubes of S-panel up to a length of 3.3 m from each corner. Alternatively, instead of welding wear bars to the inclined wall tubes as indicated above, in order to take care of tube erosion due to sliding ash, contractor can also provide 1.0mm additional tube thickness on entire inclined tubes of the 'S' panel over and above the tube thickness calculated as per IBR and other specified requirements**.**
Extra thickness of corner tubes shall be provided and suitable erosion prevention measures to be considered during erection stage itself.

3.02.07 Minimum tube thickness at the bends in no case shall be less than the minimum tube thickness for the straight tubes calculated in the manner described at 3.02.03 & 3.02.06 above. For this purpose appropriate thinning allowance shall be considered by the contractor while calculating the thickness of the bends.

3.02.08 Provide adequate nos. of furnace observation and tapping points for local instruments, gauges, switches, test pockets etc.

3.02.09 NOT USED

3.03.00 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
(i)	Soot Blowing Frequency	Soot Blowing Frequency as per bidder's recommendation to ensure adequate cleaning of heating surfaces for specified range of coals
(ii)	Preferred mill combination	Any combination of mills (to Employer's choice without any restriction).
(iii)	Max. coal flow unbalances in coal pipes from same mill, from the average	5.0%
(iv)	Slagging:	
	a) Inter burner	Nil
	b) In furnace/ash hopper/water wall areas	Nil
(v)	Control range of boiler	50% TMCR to 100% BMCR
(vi)	Maximum permissible Reheat Spray Water Flow with rated steam temperature at Reheater outlet	3% of steam flow at reheater outlet
(vii)	Min. load without oil support	Refer Clause 1.04.00
(viii)	Maximum gas temperature variation across furnace width and depth.	45°C (Max.)
(ix)	Maximum steam side temp. imbalance in the LHS & RHS at boiler outlet (with the average)	10 deg C (max.)
(x)	Min. load with separator running dry	30-40 % TMCR (As per Manufacturer's proven practice)
(xi)	Header unbalance (steam side)	6 % (Maximum)
(xii)	Air ingress from furnace bottom	As per manufacturer's Predictions

	hopper **Note: -**(a) No ingress of air from any opening like bottom hopper, soot blower, any manhole or peep hole, ducts etc. shall be considered for sizing of secondary and primary air fans while the same shall be considered for performance predictions. (b) Temperature upset due to maximum gas temperature variation across furnace shall be considered while selecting pressure part materials.
3.04.00	Provide following: (a) Water cooled hinged doors at furnace hopper, for introduction of power operated maintenance cradle into furnace. (b) Inspection opening with welded forged caps for each header.
3.05.00	Provide the following: (a) Provision for future installation of additional Soot Blowers shall be made in the furnace. Necessary space provision in layout for providing approach and platform for future soot blowers shall be kept in the original design itself so that 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, the Contractor shall install these soot blowers and associated access and platforms without any cost implication to the Employer. (b) Erosion resistant shields for tubes/header affected by gas impingement/laning effects (e.g. in a between SH/RH, Economizer and furnace walls openings for economizer bypass etc.) (c) Tapping points at five levels for furnace vacuum monitoring (in addition to routine monitoring) (d) All round seal plates of stainless steel type 430 or better (6-mm thick minimum) welded to furnace hopper for sealing against air ingress. (e) Corrosion resistant shields/coating for tubes/header affected by splashing of water from bottom ash hopper, due to fall of ash clinkers.
3.06.00	Panel to panel welding in burner zone to be avoided to maximum possible extent. Profile shields/ erosion prevention measure to be provided on top and bottom burner panel bends.
3.07.00	Provide stainless steel expansion markers/indicator on all the four furnace walls to monitor thermal expansion. Predicted thermal expansion at different levels to be indicated. In addition to local indicators, measurement system (4-20mA Output) for remote indication shall also be provided on all the four furnace walls.
3.08.00	For continuous monitoring of water wall tube metal temperatures provide 100 numbers of thermocouples outside the gas path as per specification specified elsewhere in the Technical Specification. **Note:** (a) The exact location and number of thermocouples shall be finalized during contract stage. However, Bidder shall furnish unit rates for addition/deletion of the thermocouples with respect to the numbers mentioned above. (b) Alarm set point for tube metal temperature shall not exceed the design temperature of respective tube

3.09.00	Suitable temperature monitoring system consisting of 80 nos. of thermocouples should be provided for Bottom hopper, Penthouse, Economizer, APH hopper etc. The exact location and number of thermocouples shall be finalized during contract stage. However, Bidder shall furnish unit rates for addition/deletion of the thermocouples with respect to the numbers mentioned above.
3.10.00	Insulation skin temperature measuring system consisting of 40 nos. of thermocouples to be provided in critical areas like Burner panel and critical piping areas. The exact location and number of thermocouples shall be finalized during contract stage. However, Bidder shall furnish unit rates for addition/deletion of the thermocouples with respect to the numbers mentioned above.
4.00.00	**STEAM GENERATOR CASING AND FRAMING**
4.01.00	Steam Generator casing/penthouse (as applicable) shall be provided. The casing/penthouse design shall ensure: (a) Complete enclosure of Steam Generator including superheater, reheater& economizer headers. (b) The casing/penthouse and its supporting system shall be capable of taking additional loads due to accumulations of ash upto 300 mm height or actual expected (in between two overhauls of the units), whichever is higher. This additional load is over and above other loads considered for casing design. The ash density for the purpose of ash loading shall be at least 1300 kg/m^3. (c) Temperature upset due to maximum gas temperature variation across furnace shall be considered while selecting pressure parts materials.
4.02.01	**Steam Generator casing/penthouse shall**: (a) Form rigid self containing structure, with adequate stiffening. (b) Be welded wall construction, sectionalized to allow easy removal/replacement of casing/penthouse wall sections. (c) Be weatherproof and water tight construction for protection from monsoon rains/winds. (d) Have all drainage arrangement like gutters, drain pipes etc., connected to plant drainage system at ground level. (e) Be provided with boiler roof arrangement of proven design & architecture. 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.
4.02.02	Provide at least two penthouse ventilation/cooling/pressurizing fans with their air inlet openings at opposite ends.
4.02.03	**The casing/penthouse shall be provided with**: (a) Accesses and access platforms for easy and quick installation of scaffolding for furnace inspection/maintenance.

(b) All necessary access, observation and cleaning doors with frame for building brickwork's and securing the casing shall be provided. The doors shall be insulated and perfectly air tight. It is considered highly important to ensure proper closure of doors to maintain minimum air-in-leakage.

4.03.00 A common drain pipe shall be provided in the boiler from boiler penthouse roof to the nearest identified drain separation trench. Various open water drains and vents for shall be connected with this drain pipe.

5.00.00 **STEAM SEPERATOR(S)**

In addition to the sizing design criteria requirement elaborated at Sub-section- A-01, following design requirements shall also be adhered:

5.01.00 Steam Separator construction shall have:

(a) Materials as specified at clause no 1.05.02 of Sub-section- A-01 to suit maximum design pressure/temperature.

(b) Fusion welded/ forged construction with welded hemispherical dished ends.

(c) Nozzles for Steam/Water connections and tappings for instrumentation, sampling and other mountings/fitting etc.

(d) Nozzles/tapping to comply with heat treatment, weld and other requirements as per ASME Section I/BS 5500.

(e) Handhole with forged steel cap.

6.00.00 **BOILER STARTUP RECIRCULATION AND DRAIN WATER SYSTEM**

Boiler start-up recirculation & drain system shall be provided with start-up drain re-circulation pump and alternate drains to Atmospheric flash tank. 2x50% condensate pumps shall be provided for pumping the flash tank condensate to turbine condenser. Necessary control valves shall be provided in the condensate line for maintaining the level in the flash tank / drain receiving vessel.

6.01.00 The start-up recirculation & drain system shall comply with following design requirements:

(i) Designed for fast start-up and cyclic load operation of Steam Generator.

- Start-up with and without the recirculation pumps (Condenser vacuum shall be available at such times)

- Black Start-up with recirculation pumps in service. Under black startup of steam generator, the condenser vacuum may not be available due to non-availability of auxiliary steam for turbine gland sealing and therefore it may not be possible to dump boiler drains into the condenser of turbine. Bidder shall, therefore, make necessary arrangement of draining of boiler startup drain (required to maintain the necessary feed water quality) to facilitate the black start of the unit.

(ii) Designed for maximum possible recirculation & drain flow under all possible normal, abnormal, upset and accidental conditions.

(iii) The drain piping, valves, flash tank, drain receiving vessel and condensate pumps shall also be sized to cater to the maximum drain requirement as per clause 6.01.00 (ii) above. Design of the flash tank shall conform to the

specification as stipulated elsewhere in the specification.

(iv) Pressure transmitter to be installed downstream on control valves in the line connecting individual level control valves with flash tank for both units (4 Nos.)

6.02.00 Start up recirculation & drain piping and its supports shall be designed to take care of excessive vibration, which may result from two phase flow conditions, if it occurs.

6.03.00 The start-up drain re-circulation pumps shall be of proven design. Boiler start-up drain recirculation pumps and their motors shall meet the following requirements:

(i)	Number of pump	1x100% (sized for maximum flow as specified at Clause 6.01.00 (ii) above)
(ii)	Type of pump	Gland less zero leakage type with overhung impeller.
(iii)	Motor specification	Submerged type with wet stator with water coolers. Motor for Steam Generator start up recirculation pumps shall be a wet motor, specifically designed by the pump manufacturer for the application and shall be as per the standard adopted by the pump manufacturer subject to Employer's approval. Motor windings shall be of non-hygroscopic material and shall be designed to withstand continuous water pressure & temperature variation.
v)	Cooling system	One number external high-pressure cooler for each motor rated for 100% duty shall be provided to remove the heat generated by the motor and bearings during operation. The temperature of high-pressure cooling water leaving the motor cavity to the cooler shall not exceed 60 deg. C. The cooler shall be adequately sized to reduce this temperature to 50 deg. C. A high temperature motor cavity alarm / trip shall be provided to operate the alarm at 63 deg. C and to trip the motor at 66 deg C while the pump is in operation. The design shall be such that during hot standby service of the pumping unit, sufficient cooling effect is provided by natural circulation of the coolant so as to prevent over heating of the motor.

6.04.00 Provide suitable features in pumps and motors to reduce the radial and axial thrust.

Provide suitable design feature and material of construction to reduce electrolytic action, corrosion, erosion and cavitation.

The recirculation pumps/motors shall be provided with necessary handling arrangement including runway beams, trolleys etc.

Pumps & motors shall be hermitically sealed. Heavy duty design & construction suitable for operating pressure & temperature. Pumps to be mounted & supported directly from the Steam Generator recirculation piping system and motor to be mounted beneath the pump.

The pump shall be suitable for cyclic operation as specified in part-A-01 of part-B of the technical specifications. The specific features adopted in this regard shall be brought out by the contractor like casing shape & design including its curvature/corner radius, stress concentration areas, no. of pieces/joints for a pump casing, materials adopted, performance monitoring etc. with proper justification. A CFD and FEM analysis to conform to specified cyclic requirements shall be carried out and furnished by the contractor alongwith the pump data sheet.

Online monitoring requirements on the pump casing/heat barrier shall be recommended by the OEM like an array of thermocouples to give adequate indication of temperatures.

The pump OEM shall share the test/inspection/feedback data of high load cycling power plant cases where the offered pump design has been successfully run.

7.00.00 **SUPER HEATERS & REHEATERS**

In addition to the sizing design criteria requirement elaborated Sub-section- A-01, following design requirements shall also be adhered:

7.01.00 **Construction of Superheaters(s) &Reheater(s) shall have following features:**

7.01.01 1 **Heating surfaces arrangements**

(a) Completely drainable tubes/banks/ sections for SH/RH tube banks in case of tower type gas path arrangement. For the two pass boilers, the arrangement of SH/RH banks shall have a drainable layout to the maximum possible extent.

(b) Banks/sections/tubes should be made from seamless tubes.

(c) Ensure even temperature distribution at gas and steam side by criss-crossing the steam paths between LHS and RHS. In case the contractor is able to limit the steam temperature imbalance between LHS and RHS to withing 10^{o}C by employing suitable furnace/ burner configuration like twin furnace, the contractor may not provide criss-crossing arrangement. Bidder shall, however, submit the information relating to the performance of reference steam generators to the Employer so substantiate such decision.

The contractor shall demonstrate steam temperature imbalance across two paths (LHS and RHS) to be within 10^{o}C during commissioning. Incase the temperature difference between the two paths of more than 10^{o}C is observed beyond reasonable extent, the contractor shall provide criss-cross arrangement along with other suitable measures (as required) without any extra cost implication to CSPGCL.

All necessary provisioning for installation of criss-crossing or any other measures (as required) including space/hanger provision/header tapping points etc. shall be made by the contractor so that the same can be installed if the operational experience warrants the same.

(d) Use of girdling loops not permitted.

(e) Uniformly spaced elements to avoid gas bypassing.

(f) Use of radiant wall super heater is not allowed.

Note: If Contractor intends to utilize design with Radiant wall reheater, the use of such radiant wall reheater shall be restricted to only on one of the furnace walls (i.e. either on the front wall or on one of the side walls). Further, the

lowest portion of wall RH shall not be below the furnace nose tip level.

2 **Minimum transverse tube pitching in the direction of gas flow path**

(a) 600 mm for banks/sections placed in areas where gas temperature exceeds the FEGT (MHVT) value.

(b) For bank/sections placed in areas where gas temperature exceeds IDT of ash for the range of coals specified, the minimum transverse pitching shall be under :

i) For tower type boiler - 960 mm

ii) For two pass boiler- 762 mm

3 Maximum depth of tube banks/sections in the direction of gas flow: 2 Meters or maximum soot blowing radius, whichever is lower. Bidder can also provide the higher depth limited to 2.5 m also, only if it's a bidder's proven practice. References shall be provided in support of the same. However, it will be limited to maximum soot blower radius.

4 **Supporting arrangement**

All horizontal heat transfer surfaces shall be supported by steam or water cooled hanger tubes designed for a minimum of 2 times the calculated load so as not to cause any dislocation/damage to the tube banks/sections. Necessary calculations in support of this shall be furnished by the bidder. The stress in the hanger tubes under such condition also shall not exceed the maximum permissible limits as per IBR. One (1) mm erosion allowance shall be provided over and above the calculated thickness of hanger tubes.

5 **Arrangement of headers**

Located outside the gas path, fully drainable. Wherever locating the headers in the gas path becomes unavoidable these shall be suitably protected with erosion shields. Further, the nipples and studs of the header shall also be provided with wear resistance stainless steel shields of minimum 2.5 mm or higher thickness. The arrangement of headers shall be such that it does not cause the high localised flue gas velocity on tubes downstream side of the header.

6 **Attemperators**

(a) Location — At inlet or between the two SH/RH stages.

(b) Construction — i) Made from Corrosion/Erosion Resistant steel. ii) Fitted with removable liners.

7 **Minimum tube thickness**

(a) LEADING TUBES OF THE BANK: Provide 1.0 mm (min.) over and above the calculated thickness as per IBR (Ref. as specified at clause no 1.05.02 of Sub-Section A-01 of this document for erosion allowance.

(b) BALANCE OF TUBES IN THE BANK: Provide 0.6 mm (min.) over and above the calculated thickness as per IBR (Ref. as specified at clause no 1.05.02 of Sub- Section A-01 of this document for erosion allowance.

(c) Minimum tube thickness at the bends in no case shall be less than the minimum tube thickness for the straight tubes calculated in the manner described at (a) and (b) above. For this purpose, appropriate thinning allowance shall be considered by the contractor while calculating the thickness of the bends

8 **Tube/Header Material**

(a) Appropriate for most adverse operating conditions and as per conditions specified in this Sub-Section (Alloys containing Molybdenum only, without any suitable stabilization with Vanadium and Chromium shall not be used. Total

content of Molybdenum, Tungsten, Silicon, Vanadium, Titanium, Tantalum etc., individually or all together, if not otherwise specified, shall not exceed the limit specified in relevant material codes).

(b) Contractor to minimize/limit use of different grades of tube materials in one SH/RH bank to three. One SH/RH bank is defined as tubes/elements connected between two headers.

(c) Dissimilar Metal Welds (DMW) in gas path shall be avoided. Also refer cl. no 2.03.00 of this Sub- Section in this regard

9	Max no. of material grades in flue gas path inside the boiler can be used in one bank	Three (3)

10 **Space Provision**

Keep provision of space for atleast 20% addition of additional economizer and 10% for the reheater surfaces in future. The surface provisioning shall be flue gas upstream section of the economizer. Structure/hanger design shall be suitable for loads due to these additional surfaces (filled with water) also.

7.02.00 Superheater(s)/Reheater(s) design shall cater to following operational requirements throughout the control range of Steam Generator, with whole range of specified fuels and under all operating conditions like, H.P. Heaters out of service, HP/LP bypass operation, top mills in service etc:

(i)	Preferred mill combination	Any mills (To Employer's choice)
(ii)	Maximum permissible spray attemperation flow (as percentage of main steam flow at super heater/Reheater outlet)	
	(a) Superheater attemperation	8% of main steam flow at superheater outlet.
	(b) Reheater attemperation	3% of Reheat flow at reheater outlet.

Above permissible limits shall be applicable to all boiler loads with any combination of Mills in service and shall be guaranteed by the Contractor.

The SH/RH attemperation system shall, however, be sized for 12% of the rated main steam flow requirement for superheater and 8% of rated reheat flow for reheater, both at 100% BMCR load

The steam temperature downstream of desuperheater shall have at least $10^{o}C$ superheat to ensure proper evaporation.

(iii)	Spray water carryover	Nil
(iv)	Maximum steam side header unbalance	6 %
(v)	Ash bridging between the tubes	Nil

Note: The Steam Generator design shall ensure that no damage is caused to the Reheaters with sudden closure of turbine interceptor valve.

7.02.01 For continuous monitoring of tube metal temperatures of SH and RH elements, minimum number of thermocouples as per the following shall be provided:

(i) 450 numbers of Chromel-Alumel thermocouples located outside the gas path for measurement of tube metal temperature covering all stages of Superheaters and Reheaters.

(ii) 80 numbers of Acromat/ Drilled Pad type metal temperature thermocouples located inside the gas path for measurement of gas side metal temperature covering all stages of Superheaters and Reheaters.

Note:

(a) The exact location and number of thermocouples shall be finalized during contract stage. However, Bidder shall furnish unit rates for addition/deletion of the thermocouples with respect to the numbers mentioned above.

(b) Alarm set point for tube metal temperature shall not exceed the design temperature for respective tube.

7.02.02 For continuous monitoring of temperature variation across the length of the headers, six (06) thermocouples shall be provided on each Superheater header and reheater header except the final superheater header. The number of thermocouples for each final superheater header shall be 30. This requirement is over and above the requirements specified in clause no. 7.02.01 above.

7.03.00 For maintenance/inspection of SH/RH, provide:

(i) 1.5 m clear cavity height between two sections/banks of horizontal heat transfer surfaces for personnel access. For vertical surfaces, minimum clearance between the two banks shall be 600 mm.

(ii) Access openings along with air/gas tight hinged doors for approach to above maintenance spaces without any hindrance from hanger tubes.

(a) All access doors shall be of 500x500 mm size (minimum).

(b) Access doors 800 mm above the nominal floor level shall have access platform.

(c) Hanger tubes of horizontal banks shall have access opening for crossing over.

(iii) Stainless Steel Erosion shields for all bends of outer most tube/coil of all SH/RH sections and hanger tubes in areas where flue gas temperature is below FEGT. For the pendant tube sections, the erosion shield on the leading tubes and wherever else considered necessary by the Contractor as per the proven product is acceptable.

(iv) Arrangement for internal inspection of attemperators / headers.

8.00.00 **ECONOMISERS**

8.01.01 In addition to the sizing design criteria requirement elaborated at Sub-section- A-01, Economizer design shall conform to the following criteria/requirements under all conditions of operation and for the complete range of specified fuels.

8.02.00 Economizer shall be:

(a) Bare tube and inline type, arranged for counter flow of feed water and flue gases in case of two pass boiler and parallel cross flow of feed water and flue gases in case of tower type boiler configuration with modular construction.

(b) Not Used

(c) Provide minimum 3.0 mm thick stainless steel erosion shields 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) Supported by steam or water cooled hanger tubes forming part of Steam circuit with hanger tubes designed for a minimum of 2 times the calculated load so as not to cause any dislocation/damage to the tube banks/setting. Necessary calculations in support of this shall be furnished by the bidder.

Structural type hanger support will not be acceptable.

(e) With minimum 63.5 mm clear side spacing (gas lane), with proper barriers installed, to avoid gas laning.

(f) Without any valve in the pipeline from the economizer outlet to evaporator section of Steam Generator.

(g) If the Steam Generator has the flue gas down-flow section with horizontal tube banks, the top most row shall be shielded to reduce erosion.

(h) Headers shall be located external to gas path and shall be completely drainable. If locating headers in gas path becomes unavoidable, than suitable erosion shields must be provided.

(i) Provided with ash hoppers alongwith high ash level switches/alarms, if economizer is placed in the second pass of Steam Generator.

8.03.00 Economizers shall be provided with:-

(a) Minimum 1.5 m clear cavity height between two sections/banks of the economizer for maintenance access.

(b) Access /Opening for each tube banks alongwith air/gas tight hinged doors.

(c) Arrangement for off load water washing with necessary drainage connected to nearest drain shall be provided for economizer if two pass boilers are offered.

(d) The header shall be provided with drains and suitable opening with forged weld on caps for internal inspection and chemical cleaning. Inspection openings with forged weld on caps for headers.

8.04.00 On gas inlet side of the Economizer, provision of space shall be kept for future addition of minimum 20% economizer surfaces. Structure/hangers design to be suitable for loads due to this additional water filled surfaces also.

9.00.00 **REGENERATIVE AIR PRE-HEATERS AND STEAM COIL AIR PREHEATERS**

9.01.00 Regenerative Air Preheaters can be either (a) Bisector type or (b) Trisector type.

9.01.01 In addition to the sizing design criteria requirement elaborated at Sub-section- A-01, Air preheaters shall be sized / designed to cater to following requirements also:

9.01.02 APH inlet/outlet flue gas/air ducts shall have aerodynamic design for even distribution of air/flue gas at all loads.

9.01.03 Air preheater Construction shall conform to following:

	Design	Requirements	
(1)	**Type**	Rotary, regenerative, (Ljungstrom or approved equivalent), counter flow with vertical axis of rotation, enclosed with air/gas tight casing.	
(2)	**Heating Elements**	a) Cold end	Made of Corten steel of minimum 1.2 mm thickness
		b) Hot end/ Intermediate end	Made of carbon steel minimum 0.8 mm thick.

(3) **Bearings (forced lubricated and oil cooled)**

a) Cold end — Spherical roller thrust (Kingsbury thrust bearings are not acceptable)

b) Hot end — Radial guide bearing.

Note: Only metallic hoses shall be used for bearing cooling/lubrication. Rubber hoses are not acceptable. The bearings shall have a minimum L10 life of 100,000 hrs.

(4) **Air heater seals.**

(i) Externally adjustable and easily replaceable seals.

(ii) The maximum air-in-leakage to flue gas of the Steam Generator with coal shall be guaranteed and demonstrated along with the Boiler PG test. 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 there will be no need for any shut down for seal replacements or any internal adjustments. The seal design/construction shall be such that the above requirements are satisfied.

(iii) Seals shall have life not less than 2 years (with leakages not exceeding guaranteed limits)

(iv) The seal should be of flexible soft thin material and hardness should be less than that of sector plate / seal plate.

(v) Alternatively, the bidder can also select the seal material based on its standard practice and proven design only for similar applications so as to ensure that these offered seals meet the above guaranteed life. The bidder will provide the basis for the selected material & seals type along with proven references.

(5) **Air Heater drive system**

(i) 1 No. peripheral / centrally mounted AC VFD drive, with gear box and automatic clutching/declutching facility. Alternatively, centrally mounted APH AC VFD Drive system having sufficient space for mounting emergency drive and having handling facility with proven experience may also be acceptable.

(ii) 1 No. independent air motor drive, with its gear box and automatic clutching, declutching facility for rotation during non availability of A.C. drive system.

(iii) An air receiver tank of storage capacity adequate to operate air pre-heater using air motors for 10 minutes (minimum) with no air make-up during this period. Air motor valve for air supply from air receiver tank to APH shall have lock open arrangement.

(iv) One of the drive of each of the air preheater shall be provided with VFD

for speed regulation from full design rotational speed or 1 rpm, whichever is higher, to about 0.3 rpm.

The Contractor shall carry out a test after commissioning to detect the optimum speed of the air preheater to maximize gas temperature reduction at its gas side outlet. Optimum rotation speed for 100% TMCR, 80 % TMCR and 60% TMCR unit loads shall be recommended by the contractor based on such tests. The test shall be made by incrementally reducing the speed in steps of 0.1 rpm from its present maximum operating speed onto the minimum specified speed. Suitable soaking time at each speed step shall be given during the test before recording the temperatures and other performance parameters. Test procedure shall be furnished during detail engineering.

Specifications of the electric motor to be operated through VFD shall be selected to operate at lower speeds for long durations. The insulation and cooling for the motor shall be selected/designed suitably for the operation duty.

(v) The APH motor sizing should be designed for maximum torque required in the condition of radial, axial, circumferential seals are touching with corresponding sealing plates both at hot end and cold end and motor should be capable of running the APH.

(6) APH Guarantee Condition

1. Air Leakage (at 100% TMCR i.e. 660 MW unit load for design coal) – 10% (Max.)
2. Design Ambient Temperature & Relative Humidity: 25 deg.C & 60% RH
3. Excess Air – 20%
4. The maximum air-in-leakage to flue gas with coal shall be guaranteed and the same shall be demonstrated along with the boiler PG test.
5. Contractor shall demonstrate that the air-heater air-in-leakage do not exceed the guaranteed or specified value (whichever is lower) as per description at Sub section-A-01 & A-02, Part-B (Mechanical), of Technical specifications.

9.01.04 Provide hoppers in air heaters for ash collection alongwith high ash level switches/alarms.

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

9.01.06 Alarms for failure of drive, lubrication system etc. shall be provided.

9.01.07 Air preheater rotor stand-still sensing device with alarm shall be provided.

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

9.01.09 Provide:

(a) Sufficient space provision 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, casings, drives for APHs etc. as well as APHs supporting structures and foundation loads are designed to take care of all the requirements due to the above addition of heating surface. APH design shall enable easy modular installation of heating surfaces including 15% additional surface.

(b) Soot Blowers in the Flue gas hot end and cold end. A pressure transmitter shall be provided at the downstream of each Soot blower valve for APH.

(c) NOT USED

(d) Air heaters elements arranged in baskets and easily removable in groups/baskets for maintenance.

(e) Basket removing facility alongwith/without removal gear, if applicable as per vendor's standard design.

(f) Handling facility (covering structural steel/runway beams, trolley/hoists, along with platform along runway beams) for conveying, lowering and placement of elements/baskets to ground level.

(g) Hinged / bolted access doors in air heater housing for internal inspection / cleaning / maintenance and for replacements of elements without dismantling airheaters or alternate arrangement for replacements of elements without dismantling airheaters as applicable based on standard design.

(h) Observation ports with vapour proof light at air inlet duct for rotor inspection.

(i) Facility for positioning of rotor while element replacement (manual or otherwise),

(j) Galleries and platform around air heater and access to observation ports/access doors etc. Platforms to be capable of taking load and storing elements for at least one sector.

(k) Special T&P kit for removal of bearings and for replacement of shaft.

(l) Leakage control system - sector plate (s) system with drive unit & accessories shall be provided at hot end to reduce the hot end leakage and energy loss. This shall also online maintain the seal gap/radial seal clearance based on pre-set temperature and thereby ensure leakage control at various loads. The bidder at its discretion can also optimize the above clearances, over & above the methodology as given above, by also measuring the actual gap between seals and sealing surface. However, in such case suitable calibration and checks to be ensured during commissioning for synchronism in above two approaches. In any case, all the guarantees as specified are to be ensured by the bidder.

9.01.10 Provide thermocouple type fire sensing device and redundant temperature element for each bearing and oil sumps. 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 side as well as air side of air preheaters. Deluge system water quantities for hot end firefighting facilities shall comply with NFPA 850 requirements. Necessary water draining system, connected to station drains shall also be provided.

9.01.11 The complete installation of air heaters shall be under the supervision of the air heater manufacturer.

9.02.00 **Steam Coil Air Preheaters (SCAPH)**

9.02.01 In addition to the sizing design criteria requirement elaborated at Sub-section- A-01, SCAPH suitable for Bisector type RAPH/Trisector type APH, as applicable, shall be designed / sized to increase the air heaters inlet air temperature based on following criteria also:

Sl. No.	DESCRIPTION	Primary SCAPH*	Secondary SCAPH
(i)	Number of SCAPHs	One (1) no. for each PA fan at the outlet of each fan in bypass duct	One (1) no. for each FD fan at the outlet of each fan in bypass duct

* In case Bidder offers Tri-sector RAPH, Bidder at his option may or may not provide the SCAPH in primary air side if bidder can meet the specification requirement of preventing cold end corrosion with sizing of SCAPH in secondary air side. Bidder will furnish the

	relevant details, calculations, curves etc. along with his offer establishing the same.
9.02.02	Condensate from SCAPH, through SCAPH tank, shall lead to atmospheric flash tank in the boiler area.
9.02.03	NOT USED
9.02.04	Provide facilities for complete SCAPH isolation from the airflow path.
9.02.05	SCAPH shall be suitable to operate during start-up, low load operation of unit and at abnormal conditions when an increased air inlet temperature is considered desirable.
9.02.06	The boiler design shall ensure that the SCAPH is not required to operate under normal operation for the complete specified range of fuel.
9.02.07	Provide: (a) Side entry for removal of SCAPH modules by sliding out of modular frame or alternatively, top entry for removal of SCAPH module along with proper lifting arrangement is also acceptable (b) Approach to the side entry if applicable. (c) Handling facility (runway beam/hoist, platforms/approach etc.) for removal and placement of SCAPH modules on ground.
10.00.00	**COAL PREPARATION AND FIRING SYSTEM**
10.01.00	**GENERAL**
10.01.01	The coal preparation and firing system shall commence with the shut-off valve at Raw Coal Bunker outlet and shall include raw coal feeders, coal pulverizers, primary air & seal air fans, pulverized fuel pipes, coal burners, coal valves and associated auxiliaries.
10.01.02	The coal preparation and firing system design shall ensure: (a) Complete safety of the plant, equipment and the personnel. (b) Complete compliance with the latest NFPA, (USA), requirements and other requirements specified.
10.02.00	**Bunker Shut Off Gates & RC Feeder inlet & outlet gates**
10.02.01	Bunker shut off gate(s) & RC feeder inlet gate having following features shall be provided: (a) Size of gates/valves shall be suitable for 914.4 mm (36") round bunker opening. (b) Bunker Shut Off Gates shall be motor operated & RC Feeder outlet gates shall be motor/ pneumatic operated and RC Feeder inlet gates shall be manually operated with double rack and pinion drive arrangement and shall be designed for non-jamming. (c) Manual isolating SS rod type needle gate before Bunker Shut off gate shall be provided.
10.02.02	The Bunker shut off gates and feeder inlet & outlet gates shall have: Stainless steel material for following: (i) All components coming in contact with coal. (ii) Gate and shaft roller bearing.

10.02.03 Shut off and inlet gates shall be designed to operate with "bunker full of coal" condition without its motor getting overloaded. Further, normal motorized as well as inching operation of these shut off gates should be possible from the feeder floor.

10.02.04 The bunker shut off gate shall insure 100% closure of bunker outlet even "bunker full of coal" & "static column of coal in the chute between bunker & feeder" conditions.

10.02.05 Local push buttons for open/close command & chain wheel & chain for manual operation from floor level shall be provided for each gate/valve.

10.03.00 **Coal Chutes**

The requirements specified herein apply to the following coal chutes:

(a) Chutes between outlet of raw coal bunker shut off valves and inlet to the coal feeders.

(b) Chutes between outlet of coal feeder and inlet to the pulverizers.

(c) Permanent chutes and temporary chutes

10.03.01 The internal diameter of coal chutes selected shall not be less than following:

Coal Chute		**Minimum I.D**
(i)	Between bunker outlet gate & feeder inlet *	914.4 mm
(ii)	Between feeder outlet & pulveriser inlet	600 mm.

*Note : Chute length and gate size shall be to 'Employer's' approval.

10.03.02 Chutes at (a) & (b) above shall be made of minimum 12 mm thick stainless steel SS-410 material and shall be of full welded construction. Chutes at (c) above shall be of minimum 6 mm thick and provided with suitable liner at bends and suitable reinforcements.

10.03.03 Provision shall be made for the insertion of poke rods in two directions at right angles to each other at following locations on the chute.

(a) Outlet of the bunker.

(b) Inlet to the feeders.

10.03.04 The chute between feeder outlet and pulverizer inlet shall have a stainless steel lined hopper with suitable reinforcement.

10.03.05 Slip-on coupling for chute connections (at inlets of the R.C. feeder and the coal pulverisers) with SS 410 inner ring shall be provided.

10.03.06 Permanent Chutes shall be provided at the feeder floor near each feeder for unloading of coal from bunkers on trucks at ground level. Each bunker outlet chute shall have arrangement for fixing a temporary chute for diversion of coal flow to the permanent emptying chute near each feeder. Two (2 nos.) of temporary chutes shall be provided for each steam generator for the above purpose. Necessary handling/lifting arrangement & suitable platform & approach shall be provided for quick installations and removal of temporary chutes.

10.03.07 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

R.C. feeder and trip the R.C. feeder if the level of coal tends to be below this seal height.

10.04.00 **Raw Coal Feeders**

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

10.04.02 In addition to the sizing design criteria requirement elaborated at Sub-section- A-01, following minimum features in the RC feeder(s), in addition to complying with all the stipulations of NFPA (latest edition) shall be provided:

(i) "NO COAL" flow detection to 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 at the following location:

(a) Over the feeder conveyor chain/belt	For indication of loss of coal flow to feeder.
(b) Near the feeder discharge	to stop the feeder in the event of coal pluggage at the feeder outlet.

10.04.03 The feeder belt shall be of multiply reinforced rubber of single piece construction with arrangement for tracking and to prevent spillage.

10.04.04 Width of the belt shall have sufficient margin while operating in conjunction with the feeder inlet opening provided.

10.04.05 All R.C. feeder components coming in contact with coal (except belt), shall be made of stainless steel.

10.04.06 Provide suitable arrangement to adjust belt tension.

10.04.07 Provide following facilities for the feeders:-

(a) Spraying water inside the casing.

(b) Providing purge air to the feeder.

10.04.08 The feeder control system shall be microprocessor based. Coal weighing shall be automatic and shall include local & remote indication of rate of flow & totaliser counter.

10.04.09 Provide adequate nos. of manholes on the feeder for quick and easy release of the feeder jamming.

10.04.10 Easy access to any part of the feeder internals shall be possible without dismantling the complete casing.

10.04.11 The feeder cabinet shall be located in control equipment room (CER).

10.05.00 **Coal Pulverizers**

10.05.01 In addition to the sizing design criteria requirement elaborated at Sub-section- A-01, following design requirements shall also be adhered:

A) **Classifier design**

(a) Provide dynamic classifier with Variable Frequency Drive (VFD) capable of maintaining rated conditions of fineness [as per clause 1.05.08.02 (iii) (c) of Sub-Section-A-01, Part-B, Section VI of Technical Specification under all conditions of

operation, load changes and specified fuels. Further the classifier vanes (if applicable) shall be lined with approved wear resistant material to ensure the guaranteed wear life.

(b) Dynamic classifier height shall be selected for minimal pressure drop & as per the proven practice and its design shall be based on optimized guide vane assembly and rotor design. Aerodynamic shapes shall be utilized especially for the outlet to prevent eddies. The classifier shall be provided with replaceable, statically and dynamically balanced vanes.

(b) Fineness adjustment shall be possible while the mills are in service

(c) The classifier shall ensure reduction in particle of 50 mesh without increasing 200 mesh percentage to ensure uniform sizing and distribution of particles.

(d) Aerodynamic shape for the outlet to prevent eddies. The classifier vanes and cones shall be lined with approved wear resistant material to ensure the guaranteed wear life.

(e) Proper adequate space shall be identified for placing the classifier & its parts while maintenance.

A1) Following specific key features for the Dynamic Classifier shall be ensured/provided:

(a) Slope on R-R scale shall be as per fineness requirements.

(b) The operation/classifying capability of dynamic classifier shall be optimized for a particular speed and the same should be automatically controlled during load variations/fluctuations. Speed monitoring shall be provided.

(c) Bearing temperature measurements shall be provided.

(d) Blades to be made of wear resistant material.

A2) NOT USED

B) Ensure adequate vibration isolation of pulverizers so that no adverse effects are transmitted to the nearby structure/installations.

C) **Pulverizer Sound Level**

Shall not exceed specified values. While selecting lagging, background noise from adjacent mills, drive system and other secondary & stray noises shall be taken into account.

D) **Seal Air System**

(a) 2x100% centrifugal seal air fans with electrically operated Inlet Guide Vanes (Alternatively Electrically operated 'Inlet dampers' shall also be acceptable based on bidder's proven practice) common for all the pulverizers of one Steam Generator unit shall be provided. The seal air fans shall preferably be located at ground floor away from Economiser hopper evacuation systems, milling systems & ESP hoppers without disturbing the maintenance space of around equipment.

(b) The sealing system shall prevent ingress of any dust into the bearings and leakage of coal-air mixture to atmosphere.

(c) Seal air connections shall be provided at all locations including bearing, journals, feeders etc.

10.05.07 The design shall ensure that each pulverizer shall supply coal to only one burner elevation.

10.05.08 Separate mill lubricating oil tank and associated pumps shall be provided. Complete system shall be dust proof and placed above ground. The design of lubrication system shall ensure continuous operation of pulverizer bearings. Mill lubricating oil system breather should be of adequate capacity. For taking care of any additional torque and high vibration, mill coupling should be of failsafe type.

10.05.09 Pulverizer Gear Box: Planetary type gearbox shall be provided. The gearbox design shall ensure that there is no ingress of coal dust into gearbox under all conditions of operation. The gearbox shall be guaranteed for trouble free operation of not less than 100,000 hrs. of operation of pulverizer.

10.05.10 Pulverize Motor Capability: Ensure minimum pulverizer motor capability to restart the pulverizer after a trip with pulverizer full of coal. Such restart shall not call for any emptying of pulverizers.

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

10.05.12 Each pulverizer shall be fed with coal by an independent coal feeder.

10.05.13 **Material of Construction**

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 as specified at clause no. 1.01.00 of this sub-section.

PULVERIZER COMPONENT			SPECIFICATION
(i)	Classifier		
	(a) Cone	-	Lined with minimum 15 mm thick ceramic tiles on both inside and outside surfaces of the cone
	(b) Vanes	-	Lined with suitable material to provide mini-mum specified wear life.
(ii)	Grinding Rings/Race	-	Material with hardness 550 BHN (min.) at surface (with adequate chilled depth)
(iii)	Grinding balls/rolls	-	Material with hardness 350 BHN (min.)

10.05.13A Mill body thickness at grinding zone shall be suitable to take care of coal abrasion. Suitable thickness material or/along-with liners shall be provided to accommodate the high wear at such areas.

10.05.14 Ensure that flap / knife in the power (electric / pneumatic) operated pulverizer discharge valve is totally out of coal path during operation of the pulverizer.

10.05.15 All pulverizer wear parts shall be arranged so as to facilitate easy replacements without total dismantling of pulverizer(s).

10.05.16 Ensure minimum mill turn-down ratio(s) of 3:1.

10.05.17 Provide suitable arrangement for readily determining the oil level in the gear box(es) and all other lubricated parts.

10.05.18 For pulverized coal sampling for fineness and distribution:

(a) Provide tapping points on each PF pipe at pulverizer outlet suitable for coal sampling as per IS 16617: 2018.

(b) Ensure that the coal sampling provisions are complete with screwed plugs, compressed air purging connections at tapping points, heating arrangement and other requirements as required for IS 16617: 2018 sampling.

(c) Provide

(1) Rota Probe for coal sampling as per IS 16617: 2018 and ASME respectively.

(2) Dirty Pitot tubes per Steam Generator, suitable for measurement of coal-air velocity in coal pipes.

(d) Provide convenient approach/access for above coal sampling/measurement points, from nearest platform floor.

10.05.19 Provide suitable arrangement for readily determining the oil level in the gearboxes and all other lubricated parts.

10.05.20 Provide mill outlet temperature control capable of achieving and maintaining rated values for adequately drying the specified coal range for all unit loads.

10.05.21 **Primary Air Flow Measurement**

(a) Each PA flow measuring device shall be provided with three sets of tappings.

(b) The location, type and design of flow measuring devices shall be to Employer's approval.

(c) Necessary tapping points for temperature compensation shall be provided.

10.05.22 **Mill Rejects System:**

(a) Mill reject system shall automatically discharge the tramp iron and other non grindable material through an outlet connection at a suitable height (to be approved by Employer). The conveying system shall be as defined elsewhere in the specifications.

Pyrite hopper outlet spout should be having adequate ground clearance. Adequate maintenance space (as approved by employer) should be provided for various C&I instruments, valves and other equipment of mill reject system.

(b) Mill rejects collection & discharge system shall be designed (as detailed in Mill Reject sub-section in Part-B of Technical Specification) to ensure sequential automatic operation of the coal mill discharge gates for flow of rejects into the reject spout.

(c) The necessary mill isolation dampers/valves, to facilitate automatic continuous or automatic intermittent discharge of rejects to the conveyor.

10.05.24 Fire Detection and Extinguishing System shall be provided for the complete coal

preparation firing system including coal feeding system.

10.05.25 Lubrication of bearings & other parts shall be automatic and continuous.

10.05.26 **Handling of Pulverizer Parts**

(a) The pulverizer shall be designed to facilitate ease of handling of heavy parts for maintenance purpose.

(b) Motorized hoists shall be provided for lifting of heavy parts including mill discharge valves. In case the weight of such part is below 500 kg, manual hoist shall also be acceptable.

(c) All pulverizer wear parts shall be arranged so as to facilitate easy replacements without total dismantling of pulverizer(s)

10.05.27 Accessible gear case suitable for removing gearing without removing upper structure for vertical mills.

10.05.28 **Access Doors/Windows**

(a) Adequate numbers of hinged access doors/windows with access ladders shall be provided to facilitate access to various parts of pulverizer. The access doors shall be suitable for on load inspection and maintenance of pulverizer.

(b) Oil pumps & filters shall be readily accessible.

10.05.29 **Approach platforms**

Access & platform shall be provided to carryout maintenance of pulverizer for replacement & removal/installation of pulverizer wear parts.

Continuous platform of adequate width/area (more than the mill diameter plus sufficient margin at both side) connecting all adjacent mills (at each side) at around roller level (grinding part) shall be provided to facilitate ease of removal of grinding parts & their maintenance. While platform shall suit the specific offered design of mill, it should facilitate the O&M requirements of other parts/components of the milling system. This continuous platform (at each side) shall be approachable from ground floor at both sides through suitable stairs. Suitable ladder & platform shall be provided to approach & inspect mill discharge valve and also dynamic classifier including its vane inspection/setting requirements.

Necessary ladders and approach platforms for mill bay hoist shall be provided to carry out any maintenance activity on hoists.

10.05.30 The mill and its motor, gear box foundation bolts shall have adequate maintenance space and accessibility for tightening both from top and bottom side of foundation bolts. Alternatively, additional minimum four (04) numbers of extra foundation bolt shall be provided at extreme corners of base plate which can be used in case of failure of existing foundation bolts.

10.06.00 PULVERISED COAL PIPES

In addition to the sizing design criteria requirement elaborated at Sub- Section A-01, following design requirements shall also be adhered:

10.06.01 The design and arrangement of fuel pipe shall ensure uniform distribution of primary air and pulverized coal between all burners served by one pulverizer under all conditions of loading.

10.06.02	Calculated static loading of each support of the PF 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.
10.06.03	The guide plates, wherever provided in the coal pipe, shall be removable, and access to them shall be obtained through detachable cover.
10.06.04	The guide plates shall be made up of suitable abrasion resistant material.
10.06.05	Coupling and toggle section arrangement for fuel piping shall be provided to take up the furnace expansion.
10.06.06	Following PF pipe portions shall be ceramic lined with ceramic thickness not less than 15 mm. (a) From mill outlet to first bend and two times pipe diameter straight length down stream of first bend. (b) All bends between 11 degree & 30 degree angle and straight length downstream of the bends equivalent to one pipe diameter. (c) All bends 30 degree and higher and two times diameter straight length downstream of the bend. (d) The burner inlet elbow and the pipe piece after the elbow. PF pipe from mill to the classifier (in case of separate classifier).
10.06.07	The pipe/bend base material thickness, wherever ceramic liners are provided, shall not be less than 8 mm.
10.06.08	The straight unlined PF pipe length shall be of mild steel having a thickness not less than 12.7 mm with a minimum wear allowance of 4 mm.
10.06.09	Mill discharge valve on pulverized fuel line shall also have provision of manual operation mechanism locally and provision of its external local position indication.
10.06.10	Suitable devices shall be provided in each pulverized coal pipes to enable on load adjustment for equalizing flow.
10.06.11	Purge air connections shall be provided after the mill outlet valve to clean pulverized coal pipes of any deposits etc.
10.06.12	Fuel pipes shall be arranged and supplied so that they are easily replaceable.
10.07.00	**COAL BURNERS** In addition to the sizing design criteria requirement elaborated at Sub- Section A-01, following design requirements shall also be adhered:
10.07.01	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 (electric / pneumatic) and hooked up to Burner Management System.
10.07.02	Compartmented wind box shall be provided for supply of secondary air for combustion.
10.07.03	The material and construction of burner shall withstand radiation from the furnace, when not in use and shall not get damaged.

10.07.04 Parts subjected to high temperature, which cannot be protected by other means, shall be made of alloy steel.

10.07.05 Burner design shall ensure freedom from distortion under all operating condition in the furnace.

10.07.06 Burner design shall ensure freedom from deposits.

10.07.07 Burner shall not require adjustment to maintain flame shape.

10.07.08 Air register (If applicable) construction shall be such that:

(i) The tangential air vanes are always free to move.

(ii) The support bearings shall be preferably located outside. In case the support bearings are located inside minimum period of operation shall be 16000 hrs without calling for any type of maintenance during this period.

10.07.09 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.

10.07.10 Burner parts subject to abrasion that may require replacement at frequent intervals shall be easily removable.

10.07.11 Minimum operating life of burner parts without requiring any maintenance and replacement shall be 16000 hrs. Further, burner design shall ensure that no cooling of burner is envisaged by primary air from PA Fan during oil firing and in part load operation.

10.07.12 Burner shall be removable or replaceable from outside the Steam Generator without entry to the furnace.

10.07.13 **Scanner Air System**
2 x 100% Scanner Air Fans for all the scanners of one Steam generator unit shall be provided preferably at firing floor and away from Economiser Hopper ash evacuation system to avoid any ash ingress in scanner air fan system.

10.08.00 **PRIMARY AIR FANS**

In addition to the sizing design criteria requirement elaborated at Sub- Section A-01, following design requirements shall also be adhered:

10.08.01 **Fan Characteristics**

(a) Shall be compatible with Pulverized Fuel system resistance and boiler operation at rated loads, during boiler start up & low load operation with minimum number of mills.

(b) The system resistance curves shall always be sufficiently below the fan stall line.

(c) Best efficiency point shall be close to TMCR (660MW load) operating point of fan.

10.08.02 **Fan control System:**

(a) Fan flow control

(i) By blade pitch control.

(ii) The final control element shall be electrically operated.

(iii) The actuators shall be compatible with selected automatic control system.

(b) The system shall be designed to achieve:

(1) Stable and satisfactory operation.

(2) Primary air flow control
(3) Primary air pressure control.

(i) The system shall be capable of working on automatic mode for all regime of operation in a steady and stable manner.

(ii) The final control element shall not have a backlash or play etc.

10.08.03 **Primary air flow measurement**

(a) Provision for measurement of PA flow required for total airflow measurement & control.

(b) PA flow measuring devices shall be provided at air inlet to each pulverizer as well as at the suction of each fan. PA Fan inlet flow measurement shall be provided using fan inlet elbow. However, if such an arrangement is not possible flow element (venturi/ aerofoil / orifice system) shall be provided with three pair of tapping points at suction of each PA Fan.

(c) Location, type and design of flow measuring devices shall be subject to Employer's approval.

(d) Necessary tapping points for temperature compensation in the flow measurement shall also be provided.

(e) Independent tapping points with necessary isolating valves shall be provided for control, measurement & test.

10.08.04 Fan casing shall be properly stiffened to minimum vibration and distortions during operation.

10.08.05 **Material of Construction**

(a) Fan blades - high strength Aluminium alloy with minimum hardness of BHN-75.

(1) Base plate - cast iron or welded steel.

(2) Casing - sheet steel of suitable thickness.

(b) Fan inlet boxes, diffuser and intermediate pieces fabricated with sheet steel of thickness not less than 6.00 mm.

10.08.06 **Special construction Feature**

(a) Fan components shall be designed for torsional stresses of three times the normal full load motor torque at all speed.

b) The fans shall be suitable for parallel operation and sharing the load capacity over the entire range without hunting.

(c) The fan suction shall be provided with rigid bird and trash screen assembly and shall have suitable arrangement to prevent rainwater from directly entering the fan.

(d) The fan suction shall be so located that it does not suck-in dirty air and shall be subject to Employer's approval.

10.08.07 **Fan bearing lubrication system**

(a) The rotor assembly shall be supported over a oil lubricated bearing assembly consisting of antifriction/sleeve bearing adequately sized to take care of radial thrust loads.

(b) For mounting of vibration pads/pickups, flat surfaces shall be provided both in X and Y directions, by the Contractor on the bearing housing.

In case of oil lubricated bearing the design shall be such that bearing are lubricated by external oil lubricating system in which oil is cooled by external cooler. Bearing shall contain sufficient oil to take care of fan coasting down period.

(d) Three nos. Duplex Pt-RTD (100 ohm at 0 deg.) with dual input temperature transmitters shall be provided for local and remote monitoring of each bearing metal temperature of fans.

10.08.08 NOT USED

10.08.09 **Fan Vibration Monitoring**

All accessories/ arrangements like flat surfaces, vibration pads/ pick ups etc. shall be provided for fan vibration monitoring as per OEM recommendations.

10.08.10 Silencers shall be provided to limit the noise level to specified values.

10.08.11 Fan housing shall be designed for ease of maintenance and access to the fan wheel or impeller. The casing shall be split type to provide easy removal of the fan wheel or impeller for replacement and repairs. The casing section shall have gasket joints to ensure air-tight sealing.

10.08.12 Access doors shall be provided in each suction chambers, casing and diffuser.

10.08.13 Drain connections shall be provided at the bottom most point of the fan housing.

10.08.14 Layout of PA fans shall ensure inter-changeability of impellers. Similar fans shall have same direction of rotation.

10.08.15 Acoustic insulation for suction duct, discharge duct and casing of PA fans shall be provided for the purpose of noise reduction. Thermal insulation for this purpose shall not be permissible.

10.08.16 PA fans shall operate with highest possible efficiency, which shall be nearly equal at 100%TMCR (660 MW) and test block points.

10.08.17 NOT USED

10.08.18 Stall detection probes shall be installed on the PA fans. The probes shall be integrate with the stall duration measurement and integrator to enable assessing to total stall duration of the fans during the life time of operation.

11.00.00 **FUEL OIL SYSTEM**

11.01.00 **GENERAL**

Light Diesel Oil (LDO) firing requirements of Steam Generators, as per characteristics specified at Sub-Section-I-B of Part A.

The fuel oil system shall comprise of:

(a) Fuel oil preparation and firing system.

(b) Fuel oil drain system

11.02.00 **Fuel Oil Preparation and Firing System**

Fuel oil preparation and firing system shall comprise of LDO firing system.

(a) **NOT USED.**

(b) **LDO Firing System**

LDO shall be used for initial start-up, low load operation and as secondary fuels for pulverized coal flame stabilization at the startups/low load operation. The scheme as envisaged for firing these oils shall cater to requirements of all the Units.

(c) **Fuel Oil Drain System**

The fuel oil drains from different equipments and piping etc. of a Steam Generator shall be brought by gravity to a common drain oil tank provided for each Steam Generator and pumping provision back to Fuel Oil storage tanks.

11.03.00 **Fuel Oil Preparation and Firing System**

In addition to the sizing design criteria requirement elaborated at Sub- Section A-01, following design requirements shall also be adhered:

11.03.01 The Fuel Oil preparation and firing system shall be designed to function in total association with the Burner Management System;

11.03.02 The adequacy for firing HSD shall include compliance to NFPA 70 requirements of classification of locations for class I liquids.

11.03.04 **Design/Sizing of various pump shall be based on following Criteria**

	Design Criteria	**Requirements**		
		LDO Pumps	Drain Oil Pumps	Sump pump
	1	2	3	4
(i)	Type of fuel to be handled	LDO	LDO	Oil & Water
(ii)	Pump Suction Temperature	Ambient	Ambient	Ambient
(iii)	Temperature	Atmospheric	Atmospheric	Atmospheric

		of fuel oil to be handled			
	(iv)	Pump design/ construction code	HI Standards, ASTM, ASME or equivalent (subject to Employer's approval)		
	(v)	No. of pumps	3 (2 working +1 standby)	3	2 (1 working + 1 standby)
	(vi)	Capacity of each pump	To cater to 30% BMCR requirements of one Steam Generator without coal firing plus 10%	$4M^3$/hr	$10M^3$/hr
	(vii)	Pump suction head	Considering zero tank level	considering zero tank level	---
	(viii)	Pump discharge head	To suit the requirements of burners.	25 MLC (minimum) or as required to pump oil from drain to main oil storage tank @ $4m^3$/hr, whichever is higher	50 MLC (minimum) or suiting site requirements whichever is higher

(ix) Materials

(a) Casing : Close grained Cast Iron/ Carbon Steel, as per the manufacturer's standard practice.

(b) Shaft : Carbon steel

(x) Material of filtering mesh shall be stainless steel.

11.03.08 **Trip and Nozzle Valves**

Light oil trip valves & individual burner nozzle valve solenoid shall be:

(i) Of single coil heavy duty construction having class 'H' insulation.

(ii) Having closing time less than one (1) second

(iii) De-energized/air fail to close type.

(iv) Designed for operating voltages as under:

(a) Trip valve solenoid 24 Volts DC

(b) Nozzle valves solenoid 24 Volts DC

Light oil Trip valves and nozzle valves shall be suitable to handle oils at temperature/pressure required at the burners. Further, these valves shall confirm to ANSI leakage Class-VI under shut off pressure conditions of respective pumps.

11.03.09 **Oil Burners/Burner Components**

Type –The oil burners should be air atomized be able to operate together with pumping system offered. The oil gun design shall not be of pre-mix type.

11.03.10 Following maintenance facilities shall be provided in the fuel oil system for the Steam Generator:

(a) Burner maintenance trolley alongwith accessories.

(b) Fixed drip trays with easy means of emptying for each oil burner to contain any oil leakage. The drain from each drip tray shall be connected to the drain oil tank.

(c) Handling facility (with runway beam, hoists, equivalent structure etc.) for all pumps

(d) Oil gun cleaning station and the facility for blow off of the oil guns using compressed air at each firing floor. For this purpose compressed air tapping with necessary isolation valves and necessary hose connection shall be provided.

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

(a) Facilities for Auto start of standby LDO pressuring pumps in event of tripping of any running pump or low fuel oil pressure.

(b) Facility for Auto start and shutdown of drain oil pumps in conjunction with level in the drain oil tanks.

(c) Facility for automatic as well as manual start/ignition of oil burners (in association with BMS)

(d) Maximum turn down ratio, for the oil burners (without needing burner tip changes)

(e) Automatic purge interlock to facilitate restarting of oil firing system after prior trips/shut down of oil firing.

(f) Separate flame viewing opening/facility for boiler operation and for flame monitoring at each burner from out side of the boiler viewing heads to have provision:

(i) To keep it cool below 75°C

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

(g) Means of determining oil flow to each burner like calibration curves and pressure measurements at the burner as a minimum requirement.

11.03.12 Following features shall be provided for interfacing with other systems/equipment's

(a) Adequate local instrumentation such as temperature, pressure, differential pressure, flow switches for independent high and low signaling contacts required for Burner management system and other interlock/alarm.

(b) Adequate potential free contacts for status of individual pumps.

11.04.00 **Fuel oil drain system**

11.04.01 Drain oil tank(s) design/construction shall comply with following requirements.

S.No		Drain Oil Tank
(i)	Medium to be Stored	LDO
(ii)	No. of tanks	One (1) for each Steam generator in SG area and one (1) in FO pressurizing pump house area
(iii)	Tank capacity	6m^3 (each) (min. effective volume) in SG area and 10m^3 (min. effective volume) in FO pressurizing pump house area
(iv)	Dimensions	3M x 2M x 1M, 2.5M X 2M X 2M
(v)	Design and construction code	IS:800
(vi)	Design température	50 deg.C (min)
(vii)	Tank design pressure	-
(viii)	Type of construction	Rectangular
(ix)	Material of Construction	As per IS:2062 plates
(x)	Corrosion allowance in tank thickness	1.8 mm
(xi)	Insulation	Not Required
(xii)	Nominal Venting capacity	-----
(xiii)	Tank design, fabrication, erection, commissioning and testing	-----

11.05.00 **Piping fitting and valves in fuel oil firing system:-**

11.05.01 The Piping in fuel oil (LDO) firing shall confirm to following codes

	Piping	Code
i)	Fuel Oil Piping	a) IS1978 or ASTM-A-106 Gr. B or approved equivalent
ii)	Piping/Valve sizing	**LDO:** All piping system shall be sized to meet the fuel oil requirements of 02 (two) number Steam Generator(s) operating simultaneously at 30% BMCR load.

11.05.02 Piping fittings shall be of carbon steel butt welded connection (where possible) conforming to ASTM-A 234 (or approved equivalent standard). All the flange connections shall conform to IS: 6392 (or approved equivalent standard) and shall be suitable to withstand design conditions of system, to which they are connected.

11.05.03 Valves shall conform to following requirements:

S.No.	Parameter	Requirement
i)	Type of valves (for oil services)	Plug type (metallic seated), leak proof, fire safe as per the requirement of API 6FA
ii)	Material of valves on oil lines	

S.No.	Parameter	Requirement
	a) On pump suction side	Cast Iron/ cast steel
	b) On pump discharge side	Cast Steel
iii)	Material of valves on steam/ condensate lines	Cast Steel

11.05.04 Instrument root valves on LDO lines shall be of 15 NB size, flanged OS & Y type, with body rating in ASA as per process condition.

12.00.00 **DRAFT PLANT**

12.01.00 In addition to the sizing design criteria requirement elaborated of Sub section A-01, following requirements shall also be adhered.

12.02.00 Both FD fans and both ID fans shall operate with highest possible efficiency which shall be nearly equal (not lesser than the best values given for the reference fans by the OEM of the fan) at the 100% TMCR (660 MW) and test block points.

12.03.00 Fan components alongwith servo/blade pitch control mechanism shall be designed to withstand and continuously operate with the maximum air or flue gas temperature that these fans will be required to handle. ID fan component shall also be designed to withstand the excursions in flue gas temperature up to 300 degree Celsius, which may persist for about 30 minute duration. Such temperature excursion will not inhibit the safe and smooth operation of fans or cause any damage or increased maintenance.

12.04.00 The construction of FD & ID fans shall also comply with following requirements

DESCRIPTION	FD Fans	ID Fans
Type of fan blades	Stream lined, aerofoil shaped section	stream lined, aerofoil shaped section
Blade material	high strength aluminum alloy, BHN-75 (min.)	Nodular Cast Iron or High Wear Resistant Steel with or without Hard coating as per the proven practice of the fan manufacturer
Fan rotational speed	1500 rpm (max.)	745 rpm (max.)
Air/Flue gas flow	blade pitch control	blade pitch control
Fan critical speed	not less than 125% of fan maximum operating speed	not less than 125% of fan maximum operating speed
Fan component design*	to withstand torsional stresses three (3) times the normal/full load motor torque at all speeds	to withstand torsional stresses three (3) times the normal full load motor torque at all speeds
Fan casing material thickness	6.00 mm (min.)	Abrasion and wear resistant, high BHN steel having minimum 8.0 mm thickness or 12 mm mild steel with liner of thickness 10 mm (min.) Alternatively, 22 mm thickness casing of mild steel is also acceptable.

DESCRIPTION	FD Fans	ID Fans
Fan Housing design	for shut off head of fan	for shut off head of fan

*Note:

(a) 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.

(b) Although employer envisages installation of a highly efficient electrostatic precipitator to control particulate emission, however, bidder shall select the ID fan components such as blades, hubs, casing etc. to encounter the high dust burden of the order of 250 mg/Nm^3. The minimum wear life of ID fan components shall not be less than 25000 hours of operation from the date of commissioning.

12.05.00 **Fan Bearings**

(a) Bearing shall be provided with oil bath to prevent damage in case of complete loss of plant auxiliary power when the fans must coast down without power.

(b) Size oil reservoir in bearings housing for maintaining lubrication for extended periods in case of oil circulation system is out of service.

(c) Three nos. Duplex Pt-RTD (100 ohm at 0 deg.) with dual input temperature transmitters shall be provided for local and remote monitoring of each bearing metal temperature of fans.

12.06.00 **Fan balancing**

(a) The fans shall be statically and dynamically balanced before shipment.

(b) Balancing of each fan shall be checked and adjusted at site, if necessary.

(c) Natural frequency of all fan components shall be established by vibration testing to ensure that no part of the wheel is adversely excited by any force generated at operating speeds.

(d) The fan blade shall be subjected to natural frequency test. The other components of ID & FD fan wheels need not be subjected to natural frequency test if supplier can prove that these components are very rigid and have very high natural frequency compared to the operating frequency of respective fans giving justification.

12.07.00 FD and ID fans shall meet following operational requirements.

	Description	FD Fans	ID Fans
(a)	Mode of operation	i) two fans in parallel	i) two fans in parallel.
		ii) one fan (one stream in operation)	ii) one fan (one stream in operation)
(b)	Fan control system	i) capable of operating in automatic mode for all regimes of operation in a steady and stable manner	i) capable of operating in automatic mode for all regimes of operation in a steady and stable manner
		ii) The final control element shall not have	ii) The final control element shall not have

		any backlash, plays etc., and shall operate in the range of 20% to80% depending upon generating loads upto Boiler MCR.	any backlash, plays etc., and shall operate in the range of 20% to 80% depending upon generating loads upto Boiler MCR
	(c) Bearing metal temperature monitoring	shall be possible from remote as well as locally, using atleast three (03) nos. of duplex platinum RTD's per bearing (100 ohms at 0 deg.C)	Shall be possible from remote as well as locally, using three (03) nos. of duplex platinum RTD's (100 ohms at0 deg. C) per bearing

12.08.00 The fans shall be suitable for parallel operation and sharing the load capacity over the entire range of operation without hunting. Pulsation shall be avoided by suitable design of fans and connected ductwork.

12.09.00 **Flow Measuring Devices**

(a) The draft plant shall include flow measuring devices in the air system for total air flow measurements and control with adequate number of tapping points.

(b) The location, type and design of the flow measuring devices shall be subject to Employer's approval.

(c) Three independent pairs of tapping points with the necessary isolating valves shall be provided for control, measurement and test.

(d) Two nos. duplex temperature element with thermowells for temperature compensation shall be provided.

(e) Fan inlet flow measurement shall be provided using fan inlet elbow. However, if such an arrangement is not possible, flow element (venture/aerofoil) shall be provided with three pairs of tapping points at suction of each FD fan.

12.10.00 **Fan Casing :**

(a) The fan casing shall be split to provide easy removal of the fan hub/impeller for replacement and repairs.

(b) The sections shall have gasket joints to ensure airtight sealing.

(c) Access doors shall be provided in each suction chamber casing and diffuser.

12.11.00 **Drain Connection:**

Drain connections shall be provided at bottom most point of the fan housing to the nearest trench.

12.12.00 **Fan Suction:**

(a) Silencers shall be provided at the suction of FD fans to limit the noise level as specified.

(b) FD fan suction shall be provided with rigid bird and trash screen assembly and shall have suitable arrangement to avoid rainwater from directly entering the fan.

(c) Location of FD fan suction hood shall prevent entry of dusty air into fan and shall

be subject to Employer's approval.

12.13.00 The layout of FD and ID fans shall ensure interchangeability of the impellers. Similar fans shall have same direction of rotation.

12.14.00 Acoustic insulation for suction duct, discharge duct and casing of FD and ID fans shall be provided for the purpose of noise reduction. Thermal insulation for this purpose shall not be permissible.

12.15.00 The complete installation of FD and ID fans shall be under the supervision of the FD and ID fan manufacturer respectively.

12.16.00 Stall detection probes shall be installed on the ID and FD fans. The probes shall be integrate with the stall duration measurement and integrator to enable assessing to total stall duration of the fans during the life time of operation.

13.00.00 **DUCT WORK AND DAMPERS:**

13.01.00 In addition to the sizing design criteria requirement elaborated at Sub section A-01, following requirements shall also be adhered:

13.01.01 CFD Modeling

1. Contractor shall develop Computational Fluid Dynamics (CFD) model for design of the duct layout, assessment of flue gas/ash flow distribution in the flue gas duct work and ESPs and intervention to improve the flow pattern in the duct/ESPs

2. CFD modeling shall be developed using established commercial Computational Fluid Dynamics software like Ansys, Star CCM+ etc., though Ansys shall be a preferred option.

3. The result of the CFD model shall be validated by the physical model test which is specified in the technical specification. The validated CFD model shall be used for duct/ESP layout and internal design.

4. The aim of the CFD aided design/layout/internals of flue gas duct and ESP is to achieve the following in the ducts:
   a. Minimize the adverse flow phenomenon of:
      i. Pressure drop in the duct/duct section/ESP
      ii. Recirculation/stagnation zones
      iii. Localized high velocities
      iv. Ash accumulation
   b. Achieve the following flow criteria of:
      i. Equal distribution of flow in ESP inlet ducts as per the limit given elsewhere in the specifications
      ii. Equal distribution of flue gas flow in different ducts wherever duct diverges and uniform flow in the common duct wherever two or more duct section converges.

5. The CFD modelling shall be carried out in two steps.

   a. First Step: Single phase flow model to establish the optimized duct layout among different options and the location of flow guides to achieve the criteria mentioned in point 4 above.

   b. Second Step: In the second step of CFD modeling, 2-phase flow model shall be developed for analyzing the sensitivity of ash settlement in different segments while considering different ash particle sizes and velocities. The results of the 2-

phase CFD model shall be used to locate fly ash hopper location in different duct segments.

c. The reports for the first step and second step CFD model along with the CFD Modelling file shall be submitted before the finalization of flue gas duct layout.

13.01.02 **Loads for Duct and Structure Design**

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

(a) Wind loads as specified.

(b) Dead weight including weight of insulation, lining, wash water and the vertical live load.

(c) Horizontal ducts to be designed for minimum 245 kg/m² additional fly ash loading on the surface or for one fourth of duct full of ash or for maximum possible accumulation of ash in the ductwork, under all normal, upset or abnormal operating conditions, whichever is higher. For flue gas ducts downstream of ESP, additional fly ash loading on the surface or for one tenth of duct full of ash or for maximum possible accumulation of ash in the ductwork, under all normal, upset or abnormal operating conditions, whichever is higher. The ash accumulation considered for economizer bypass duct (if provided) upto Guillotine gate shall be 100% filled with ash. The ash density for the purpose of loading shall be at least 1300 kg/m^3.

(d) Expansion joint reaction.

(e) The following minimum load factors shall be applied to the design loads:

Temperature (Deg C)	27	37	93	149	205	260	316	321
Loading factor	1.00	1.02	1.12	1.19	1.25	1.29	1.34	1.42

13.01.03 **Duct design pressure:**

All flue gas duct, air ducts and the wind boxes shall also be designed for +/- 660mmWC or maximum conceivable pressure of the relevant fans, whichever is higher, at 67% of yield strength of material.

13.01.04 **Duct Slope**

All interconnecting gas ducts between the boiler and the ESP shall have a minimum slope of 45 degree with respect to horizontal so that any chance of accumulation of ash particles in the duct can be avoided under all normal/abnormal operating conditions.

13.01.05 **Type of duct construction:**

The ducts shall be of rectangular cross-section and shall be of all welded construction. Circular ducts are not acceptable. The following requirements shall be complied with:

(a) Minimum 8 mm thick steel plates for gas ducts upstream of ESP and minimum 7 mm thick steel plates for gas ducts downstream of ESP

(b) Min. 5 mm thick steel plates for air ducts.

(c) A corrosion allowance of 1.5 mm shall be considered for stress calculation for the flue gas ducting.

(d) NOT USED

(e) The thickness of the duct plate shall be suitably increased, if required, in the transition zone at Steam Generator outlet where the flue gases change direction, to increase the wear life of the duct plates.

13.01.06 **Material of Construction:**

(i)	Duct plates, turning vanes perforated plates	IS 2062: 2011 (For ducts operating above 400°C gas temperature, suitable Alloy Steel material shall be provided to Employer's approval. Ducts associated with FGD and its bypass system shall be as per material specified elsewhere in the specification.)
(ii)	Structural shapes	IS 2062: 2011
(iii)	Pipe struts, trusses, bracing	ASTM A 53 or equivalent seamless steel pipe. Material conforming to equivalent Indian standard shall also be acceptable.
(iv)	Erection tools for ducts	ASTM A 307 or equivalent
(v)	Bolts for connection to structural steel	ASTM A 325, AISIA 325 (friction type) or equivalent
(vi)	Stainless Steel	ASTM A 316 L
(vii)	Gaskets	"Relrosil" by Hitco or equivalent
(viii)	Access & inspection doors	Reinforced Steel Plates.

13.01.07 **Insulation & Lagging**

Thermal insulation shall be applied to all air/gas ducts to comply with the requirements as specified in separate 'Thermal Insulation' chapter.

13.01.08 **Specific Requirements**

(a) The stiffeners provided on the duct walls shall be of such a design and layout that no rainwater can accumulate on the duct surfaces.

All necessary wall boxes and floor collars shall be provided where the ductwork passes through walls, floor and roof. The same shall also be ensured for duct entry into chimney.

(b) Air and gas ducts shall not counter internal bracings, which cause excessive pressure drop.

(c) Guardrails inside the flue gas ducts at the bends shall be provided, as a safety measure, to prevent fall while maintenance work is in progress.

13.01.09 **Duct Work Structure**

(a) Ductwork sections between expansion joints shall be investigated with regard to their ability to transmit loads to supports. Care shall be exercised to identify uplift condition.

(b) Internal stiffeners:

(1) Duct shape shall be maintained by providing internal stiffening elements at or near supports. However, these internal stiffeners shall be used, if and only if, it is not possible to provide external stiffeners.

(2) Internal stiffening elements shall consist of trusses, preferably comprised of extra-strong steel pipes (min. dia. 76.2 mm) acting in conjunction with external stiffeners. Such internal stiffeners for the flue gas duty between boiler and ESP shall be provided with erosion protection shields.

(c) Field welding and all connections of bracing (stiffening elements) to stiffeners shall be well designed in order to develop full strength of the members. The gusset plates shall be of 10 mm minimum thickness.

(d) Fabrication shall be as per IS specification for Design, fabrication and erection of 'Structural Steel for Building.

(e) Welding shall be in accordance with Section IX of ASME code.

13.01.10 NOT USED

13.01.11 **Expansion Joints**

i) Metallic type expansion joints suitable for the service conditions shall be provided. The expansion joint design shall conform to the requirements of the EJMA Standards.

ii) Expansion joints shall not support the ductwork.

iii) The expansion joints shall be of heavy duty construction. The expansion joint material shall be compatible with the flowing medium, the external environment and the operating temperature. Suitable corrosion and erosion allowances shall also be taken.

iv) All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition. No movement of the expansion joint due to duct misalignment, if any, shall be imposed which has not been anticipated and designed into the movement capability of the expansion joint.

v) For the flue gas ducts or for air ducts where ingress of ash/dust particles from atmosphere or air preheaters etc. is expected, the expansion joints shall be designed with suitable internal cover/canopy fixed at one end and freely supported (sliding type) at the other end in the direction of flow to avoid dust accumulation. The cover/canopy should be suitably designed so as not to interfere with any internal duct support and material should be selected taking into account expansion at the operating temperature.

vi) If expansion joints are procured as bought out items then complete installation of expansion joint shall be under supervision of the expansion joint manufacturer.

The expansion joints shall be tested as per requirements specified elsewhere in the Technical Specification. Each identical type (corresponding to various size, operating/design parameters, material, design etc.) from the given populace shall be selected for representing the identical sets. The number of EJs to be selected for performing tests shall be discussed and finalized. A minimum of 5 expansion joints, however, shall undergo performance testing.

The type test of expansion joints shall also be governed by EJMA requirements.

vii) The minimum trouble free operational life of expansion joint shall be not be less than 20000 hrs of operation from the date of commissioning.

viii) Expansion joints in the flue gas side after air- preheater shall also be designed to withstand the excursions in flue gas temperature up to 300 degree Celsius, which may persist for about 30 minute duration. Such temperature excursion shall not inhibit the safe and smooth operation or cause any damage or increased maintenance.

13.01.12 **Blanking Plates**

Bolted plates or other positive closure shall be supplied in order to permit pressure testing of the Steam Generator enclosure.

13.01.13 Access and inspection door shall be of minimum 450 mm x 450 mm size.

13.02.00 **DAMPERS**

13.02.01 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 pulverizers, electrostatic precipitators and induced draft fans when the Steam Generator is on load. As a minimum following locations shall be provided with power operated gas tight dampers:

(a) In each hot air and cold air duct to each of the mills (pneumatically operated only).

(b) On each inlet and outlet to each ESP stream (there being Six (6) ESP streams, with twelve inlets and twelve outlets)

(c) Before and after each I.D. fan.

(d) At inlet to each of the Regenerative Air Pre-Heaters on flue gas side in case of Bisector APH

(e) After each of the Regenerative Air Pre-Heater, SCAPH bypass duct & after each SCAPH on airside.

(f) At discharge of each of PA fans.

(g) At discharge of each of FD fans.

(h) NOT USED

(i) At each economizer by pass duct (2 x 100%) (if provided).

13.02.02 Heavy Duty multi louver dampers shall be provided at locations not requiring tight shut off duty. As a minimum following locations shall be provided with Heavy Duty multi louver dampers:

(i) Before each SCAPH on airside.

(ii) On common duct from Primary and Secondary regenerative Air-Pre heater to ESP on flue gas side in case of Bisector APH OR on duct from each RAPH outlet to ESP on flue gas side in case of Tri-sector RAPH.

(iii) In addition to gas tight isolation damper at discharge of each of PA fans as per 13.02.01(f), 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.

(iv) Flue gas biasing damper in boiler second pass (if applicable).

13.02.03 Pneumatically operated control dampers shall be provided at the following locations as a minimum:

(i) Hot and cold air inlet to each mill.

(ii) At each air preheater outlet on flue gas path (only incase of Bi-sector APH).

13.02.04 Type of power operated gas tight dampers at various locations shall be as follows:

(i)	Guillotine Damper Type	at locations Cl. no. 13.02.01 (a), (b), (c), (d), (f), (g) & (i).
(ii)	Double multilouver (Biplane) type	at location Cl. no. 13.02.01(e), 13.02.02(ii) & 13.02.02(iii)
(iii)	Multilouver Type	at location Cl. no. 13.02.02 (i)

13.02.05 **Damper Gas Tightness**

The dampers mentioned at Clause No. 13.02.04 (i) & (ii) above shall have a guaranteed gas tightness efficiency (on flow), along the duct as well as from the duct to atmosphere or from atmosphere to the duct, depending on the pressure in both the damper open and damper closed condition without the use of seal air fans of the damper, as follow:

Damper at locations	**Min. Guaranteed Gas tightness Efficiency**	
As per Clause No.	**Without Seal Air**	**With Seal Air****
13.02.01 (e), 13.02.02(ii) & 13.02.02 (iii)	99.50%	100%
13.02.01 (a) & (f)	99.60%	100%
13.02.01 (b), (g) & (i)	99.80%	100%
13.02.01 (c), (d) & (h)	99.95%	100%

****** Applicable for Dampers which are provided with pressurization fans/ Seal Air line from cold air duct/ Atmosphere

13.02.06 **Pressurization Fans:**

(a) All dampers at ID Fan discharge, primary and secondary APH outlets on air side, primary and secondary 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.
As an alternate offer, the above dampers can be provided with a sealing air from cold air bus duct suitably meeting the specification requirement of 100% sealing. The Bidder shall furnish the applicable rebate for such alternate offer in the relevant Bid Proposal Sheets for Employer's review and acceptance.

(b) The location and scheme for pressurization system shall be subject to Employer's approval.

13.02.07 All dampers shall be designed to withstand the operating air and flue gas temperature

without distortion.

13.02.08 Components of regulating dampers coming in the flue gas path, including gas biasing dampers (if applicable), shall be made of erosion resistant material, having minimum life of 16,000 hrs. Material of the shaft for all types of dampers shall be stainless steel. Dampers associated with FGD and its bypass system shall be as per material specified elsewhere in the specification.

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

13.02.10 All pneumatically operated interlocked dampers actuators shall be provided with solenoid valves. For open and close feed back of hot air dampers, Proximity (i.e non–contact) type limit switches (2NO+2NC) shall be provided. These shall be suitable for working in hot & dust environment.

13.02.11 **Dampers:**

(a) **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. The damper sealing efficiency shall be as per cl. no.13.02.05 on flow without seal air and with seal air.

(b) **Multilouver dampers & Double multilover (Bi-plane) dampers**

(1) The double multilouver type damper sealing efficiency shall be as per clause 13.02.05 on flow without seal air and with seal air.

(c) All dampers shall be arranged to facilitate local manual operation also from a gallery or floor level.

(d) The force required to operate the damper shall be limited to 35 kg (maximum) at the rim of the hand wheel.

(e) The operating gear shall be fitted with a graduated indicator and shall be designed such that the damper may be retained in any position.

(f) The isolating dampers shall in addition be fitted with locking devices to permit locking in the fully open and shut positions.

(g) All powered dampers shall also have provision for manual operation during emergency/maintenance along with graduated local position indicator.

(h) Suitable all round approach and platform for manual operation of dampers and for carrying out maintenance on damper shall be provided. The same shall be provided including that for actuator and in a safe manner. Necessary handling arrangement should also be ensured.

(i) The layout of the isolating guillotine gates should be such that, it opens and closes only in vertical direction. Further, in case of flue gas duct, layout should take care for minimum straight duct length, in order to avoid any ash accumulation during closed condition of gates.

14.00.00 **STEAM GENERATOR INTEGRAL PIPING, VALVES, FITTINGS AND MOUNTINGS**

14.01.00 **General**

In addition to certain specific requirements indicated in the subsequent paragraphs below, the Steam Generator integral piping, valves, fittings and mounting shall also comply with all specifications requirements indicated in other subsections of Part-B.

14.01.01 Safety valves and relief valves shall have minimum discharge capacities as under:

	Valve		Minimum Discharging Capacities
(i)	Spring loaded safety valves		
	a)	Separator &Superheater	Combined capacity 105% BMCR.
	b)	Reheater System	Combined capacity 105% of reheater flow at BMCR
(ii)	Electromatic Relief Valve)/ Electromatic ball valve(EBV) at:		
	a)	Super heater outlet	15 %BMCR
	b)	Reheater outlet	20% of Reheat flow at BMCR

Note: Number of safety valves shown on the piping (refer corresponding tender drawing) is indicative only. This shall be as per specification/ manufacturer's standard practice. However, at least two numbers of spring loaded and one ERV in each SH outlet and HRH outlet pipeline shall be provided.

14.01.02 Set pressure of SH spring loaded safety valves shall be such that they are lifted before spring loaded safety valves on separators.

14.01.03 Sizing of spring loaded safety valves shall be such as to ensure minimum safe flow through superheater coils is ensured at all conditions.

14.01.04 Other means of operation (Opening and Closing) for all valves shall be in line with control and monitoring philosophy specified under 'Control and Instrumentation'.

14.01.05 Provide:

(a) Two valves in series one motorized, isolating and one motorized regulating type (low noise, erosion resistant type) on all drains and vents required to be operated during startup and shutdown of unit

(b) Silencers on all start up vents and lowest set pressure safety valves.

(c) Temperature element on all drain lines, including soot blower drain line.

(d) Motorized remote operated air release valves at locations, two in series, as required connected to a funnel, leading drains to drain trench.

(e) Start-up vents shall be sized for a minimum flow of 15% TMCR corresponding to steam pressure at turbine start up curve.

Note: Contractor to submit the following documents for Employer's approval:

(i) Complete valve schedule in Employer's approved format indicating in make and model no. power supply requirements tube of control station etc.

(ii) Control valve sizing calculation, characteristics, and data sheets.

14.01.06 Provide drain valves (two in series, one manually operated isolation and one motorized regulating) for draining furnace wall, super heater, reheater, economizer and feed water lines. Arrangement of drainage system shall comply with following requirements:

	Parameters	Requirements
(i)	Sizing of Drainage system	To enable drainage of complete pressure parts in one (1) hour
(ii)	Type of drain valves	Low noise, erosion resistant
(iii)	Limiting noise level through regulating drain valves	90 dBA – 115dBA
(iv)	Flow velocity through valves	90 m/sec.

14.01.07 Provide plugging/locking for each isolating drain valve such that to open the valve, the key has to be inserted and key can be withdrawn when the valve is closed.

14.01.08 Drain lines upto drain valves and drain valves to be designed for the maximum operating parameters of main process line to which it is connected.

14.01.09 Provide two in series, blowdown valves, at the lowest point of each water wall header comprising of one manually operated isolation valve and one motorized regulating valve. Valves shall have plugging/locking keys as indicated as specified at clause no 14.01.05 of this chapter and shall be located at appropriate location for convenient operation. Piping from this blow down valve shall be connected to atmospheric flash Tank.

14.01.10 For all remote operated control valves provide:

(a) 100% bypass control valves, remote operated and exactly identical to main control valve.

(b) Separate power operated isolation valve on upstream side of each of main and bypass control valve.

(c) Separate manual isolation valves on downstream side of each of main and bypass control valve.

(d) Pressure gauge at inlet and outlet of each control station.

If the control valve is local operated, systems from (a) to (d) shall be provided with 100%, local operated control valve.

14.01.11 Drains from separator, headers, gauge glasses, and integral piping of Steam Generator shall be terminated into one or more drain collection headers, which in turn will be connected to atmospheric flash Tank.

14.01.12 All valves and piping for the blow down system shall be provided upto and including the atmospheric flash Tank.

14.01.13 Provide a connection at an approved location fitted with a non-return valve, size not less than 100 mm nominal diameter, a stop valve and the related pipe work in the boiler fill line.

14.01.14 Provide all required sampling points alongwith root valves including that for feed water at economizer inlet, separator drain, separator outlet steam pipes, superheated steam, reheated steam. Sampling nozzle design shall be such as to have minimum protrusion in the pipe and shall be designed for collecting the isokinetic sample complying the code ASTM D1066. The exact location of the isokinetic sample shall be finalized at a later stage.

For laboratory samples, necessary sample shall be taken from the outlet of primary coolers to be supplied by the contractor along with necessary valves and cooling water pipes. In addition two spare coolers designed for highest parameters shall be provided. The root valves shall be of stainless steel. The impulse pipe size shall be subject to the approval of the Employer. Sampling arrangement shall include valve, pipe work and the necessary connection. The cooling water shall be taken from the main cooling water system. Drain from sample coolers shall be terminated at basement floor level. Each steam and water terminal connection for vent, drain, instrument tapping point and sampling shall be equipped with two valves.

14.01.15 Provide tapping points for all the instrumentation and controls and guarantee tests with Employer approved orientation on the pipeline.

14.01.16 Provide remote, motorized operation

(a) For all valves (including drain, vent and air release valves) required to be operated during startup/shut down of Steam Generator.

(b) For valves located in inaccessible locations.

14.01.17 Provide valves/actuators, remote operation facility etc. so as to enable startup, shutdown, and load monitoring of Steam Generators from unit control room.

15.00.00 **SOOT BLOWING SYSTEM**

15.01.00 Type of Soot Blowers:

(i) For furnace chamber : Short Rotary, Single nozzle retractable type

(ii) For horizontal heat exchanger: Long Rotary, Multiple nozzle, section retractable type

(iii) Air-preheaters : Power Driver swinging arms/ Sweep action/ Long retractable and non-rotating Soot blower or retractable multi-nozzle soot blowers

15.02.00 Soot Blowing System shall be

(a) Fully automatic sequentially controlled through SG C&I control system.

(b) Capable of effectively removing deposited ash from Steam Generator heat transfer surfaces with on load cleaning devices.

15.03.00 The design of air-heater soot blowing system including piping, valves & fittings shall allow use of high temperature steam from high temperature auxiliary steam header during start-up. For the purpose of efficient soot blowing, permanent arrangement of steam source from cold reheat and superheater circuit for normal operation shall be provided. 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.

15.04.00 In case soot blowing steam is required at parameters other than those available from auxiliary steam system, for the purpose of efficient soot blowing during start-up and other loads, a permanent arrangement shall be provided for the same, by the Contractor.

15.05.00 The soot blower design shall be of self draining type.

15.06.00 **Material of Construction**

	(i)	Soot Blower Elements	:	Extra heavy seamless tubing from solid bars with heat, corrosion & erosion protection for parts in permanent contact with hot gases.
	(ii)	Blowing element	:	High temperature alloy steel

15.07.00 **Requirement for soot blower nozzles:**

(a) Single or multiple row of nozzle welded to prevent falling out during service.

(b) Venturi or straight bore nozzles shall be installed as required.

15.08.00 **Retractable Soot Blowers (RSB)**

(a) Shall be retractable even during emergencies such as:

(1) Drop in steam supply pressure,

(2) Low steam flow, etc.

(b) Long RSBs shall be half of Steam Generator width on each side.

(c) Double helix cleaning pattern shall be used.

(d) Dual electric drives, one for rotary and other for linear motion shall be provided for each soot blower. Alternatively, soot blower design having both linear as well as rotary motion achieved through single drive motor shall also be acceptable.

(e) Controlled from soot blower panel.

15.09.00 The location of elements, travel and nozzle angles shall be such that maximum cleaning is obtained with a minimum of flowing medium.

15.10.00 Soot blowers Motor Control Centre (MCC) shall be as per Electrical Sub-section.

15.11.00 The soot blowing system shall be capable of performing functions as specified in Control & Instrumentation Sub section of this Specification.

15.12.00 Warm up of complete piping system before the start-up of soot blowing operation shall be facilitated by providing adequate number of pneumatic flow control valves. Each pneumatic flow control valve shall have bypass line with adequately sized orifice plate for draining the system when the valve is closed.

15.13.00 Temperature detectors along with temperature transmitters on the drain lines shall be provided to ensure satisfactory warming up and initiation of soot blowing operation.

15.14.00 All soot blowers shall be suitable for remote automatic sequential operation and local manual operation.

15.15.00 The lubricants, if any shall be suitable to withstand hot conditions.

15.16.00 Platforms/galleries shall be provided at and around all the soot blowers to facilitate, maintenance, inspection.

15.17.00 The soot blowers shall be accessible from local operating platform.

15.18.00 The furnace should be provided with wall blowers so selected such that cleaning coverage per wall blower should not be more than 2m in radius and there should be no

	left out portion. One wall blower elevation below the lowest burner elevation shall be provided along with wall blowers located immediately above top elevation coal burners upto the horizontal plane at the furnace nose tip at entry to the radiant superheater. Wall blowers in the burner zone shall also be supplied as per the practice of contractor.
15.19.00	Provision shall be made to maintain the soot blower heads free of deposits during the periods when they are retracted and not in operation.
15.20.00	Provision shall be made for additional soot blower installation(s), if required in future. In case, after the unit is commissioned, if the operational experience warrants the necessity of additional soot blower(s), Contractor shall install additional soot blowers(s) along with proper approach and platform(s), as specified for other soot blowers, without any cost implication.
15.21.00	While deciding coverage of LRSBs the maximum coverage of LRSB shall not be considered more than 2m of blowing radius.
16.00.00	**AUXILIARY STEAM PRESSURE REDUCING & DESUPERHEATING STATION**
16.01.01	**GENERAL** To meet the continuous and startup auxiliary steam requirements of the unit(s), two auxiliary pressure reducing and desuperheating stations, one High Capacity pressure reducing and desuperheating stations (HCPRDS) taking tap off from Main Steam (MS) or intermediate stage of superheaters and other Low Capacity pressure reducing and despuerheating stations LCPRDS taking tap off from Cold Reheat (CRH) lines shall be provided. Auxiliary steam header(s) shall be provided taking steam from both the above PRDS stations. The operating parameters of the aux. steam header(s) shall be optimized by the bidder maintaining a minimum 50 deg.C superheat and minimum temperature of 310°C. During cold startups when main steam pressure is more than 90 kg/cm2 and cold reheat pressure inadequate, the low capacity PRDS shall be inoperative and the auxiliary steam requirements shall be catered only by the high capacity PRDS. The auxiliary steam systems of multi units shall be suitably interconnected through the auxiliary steam station header. A branch connection along with isolating valve(s) and a blanking flange(s) shall also be provided for interconnection with the future units on station header. If steam for the Steam Generator unit auxiliaries is required at pressure/ temperature other than that of the auxiliary steam header, suitable arrangements shall be made by the Contractor in design of the Steam Generator to meet such requirements. Further, availability of the auxiliary steam at the specified temperature may not be possible at all the loads when the steam is tapped from CRH or when only low capacity PRDS is in operation. When auxiliary steam system is being fed from CRH, the temperature in the auxiliary steam header will be floating depending on the unit load and the CRH steam parameters, in which case the temperature auxiliary header shall vary approximately in the range of 300 °C to 400°C depending on unit load. Bidder is advised to take note of this and provide suitable arrangement of charging aux. steam header if high temp. auxiliary steam is continuously required for any use. Further, the Bidder shall provide an interconnection arrangement at station header with High Temperature Aux. Steam station header of existing 1x500 MW unit. Auxiliary steam when sourced through this interconnection shall be available at a maximum rate of 60 T/hr with parameters 16 ata/ 310°C at 1X500MW unit TP. Bidder shall consider the same for start-up procedures during initial commissioning.

Auxiliary steam pressure reducing and desuperheating stations, alongwith all pipings etc. shall be supplied as per Tender drawing of AUX. STEAM SYSTEM attached in Part-E of the Technical specification, section-VI.

16.01.02 High Capacity PRDS of each unit shall be suitably sized for meeting auxiliary steam requirement of 135 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:

(a) Intermittent requirement of the unit and station

(b) Steam coil Air Preheaters

(c) Air heater soot blowing

(d) Boiler feed pump turbine

(e) Deaerator pegging

(f) Turbine gland sealing

(g) Startup requirement of other Unit

(h) As standby to low capacity PRDS station.

(i) For coal mill inerting (if required).

(j) For any other system as required by bidder (with proper justification)

16.01.03 Low Capacity PRDS 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 15 TPH. The complete interconnecting station (including valves, lines, etc.) between 2X660MW & existing 1X500MW units shall be sized for min. 60 TPH.

16.01.04 Bidder shall furnish, along with the bid, writeup and P&ID for Auxiliary Steam System indicating the sources of steam, parameters of auxiliary steam header(s), various pressure reducing and desuperheating stations, tap offs for various systems as listed above, drain points, vents, instrumentations, flow elements etc.

16.01.05 Sharing of Load requirement between HCPRDS & LCPRDS shall be possible in case low capacity PRDS is unable to meet Auxiliary steam requirement on its own. The change over from HCPRDS to LCPRDS & vice versa shall be automatic.

16.01.06 De-aerator pegging pressure for cold, warm, hot start up and during HP-LP bypass operation, shall be as optimized by the bidder and shall be suitable to ensure required deaeration and water quality required for boiler. The optimized pressure should be same during warm, hot start up conditions and during HP-LP bypass operation.

17.00.00 **WALK WAYS, PLATFORMS AND STAIRS**

Access platforms, walkways, handrails, stairs, ladders and gratings etc. for proper approach during maintenance shall be provided for steam generator, all auxiliaries, equipments and accessories in the scope of this package. Walkways, platforms, stairs & ladders shall be provided in accordance with following requirements unless specified otherwise:

Sl.No.	Description	Minimum clear width***
1.	Main access walkways	1500 mm
2.	Maintenance access walkways	1000 mm *

3.	Staircase	1200 mm
4.	Ladders **	450 mm
5.	Platforms	1500 mm

Note: * Maintenance access walkways are applicable only to areas identified in clause no. 17.01.05, 17.01.06 &17.01.14. All other areas shall be connected by Main access walkways.

** Ladders shall be acceptable only in such cases where it is not possible to provide stairs and shall be subject to specific approval of CSPGCL except at places where ladders have been specifically specified. Further the same shall be provided along with cage at heights and subject to specific approval of CSPGCL. Any reference applicable standards shall also be followed.

*** Clear width shall be without any interruption from the intervening pipes, columns, actuators, instrument enclosures, racks etc.

17.01.01 Platforms shall be provided at all burner levels, all around the furnace, such that:

(a) There is adequate space for operation, service and maintenance of all burners and associated auxiliaries.

(b) The platforms are minimum 3000 mm wide and shall extend from furnace walls.

(c) Platforms shall allow complete burner withdrawal within boiler room enclosure.

(d) Platforms at each burner elevation shall be continuous and run at the same level without any interruptions from intervening steps, obstructions etc.

Burner platforms within 200 mm of an igniter shall be welded steel checkered-plate with welded-in-place drains to prevent oil spillage from spreading.

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. Access stairs to each burner level shall also be provided.

17.01.02 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, SCAPH control station, steam/water sample coolers, APH lube oil station etc. Access through Elevator, staircase and main access walkways for reaching the platforms shall be provided.

The above equipment including scanner air fans should be located at firing floor elevation for ease of operation and maintenance.

Platform/walkway leading to cold air/hot air gate/damper mechanical lock area shall be free from any obstruction/cross beam/bracing/process pipeline/duct etc. and use of vertical ladder/monkey ladder shall not be permitted in order to ensure safe operational practices.

17.01.03 Soot blowers shall have platforms on both sides along the entire length of retractable soot blowers and adequate space and service area for removal and handling of rotary blower elements in one piece.

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. 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.
17.01.04	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 including that for all dirty pitot tube & 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/ dirty pitot tube & 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 500 mm from the platform/intermediate platform.
17.01.05	Suitable all round platform for manual operation of all valves, for all dampers, for ash hoppers, APH drives, for all lubricated equipment bearings and equipments requiring access during operation for normal day to day inspection & maintenance shall be provided. Suitable access to these platforms shall also be provided. Suitable pathway from air preheater to ESP shall be provided in a safe manner.
17.01.06	All around platforms of adequate size to permit at least two persons to simultaneously work (1.5 sq.m. minimum) shall also be provided for all damper actuators, valve actuators, safety valves, instrument source connection point, Y pieces, Expansion joints and other areas requiring access only monthly or annually shall also be provided with suitable approach provisions. Suitable access to above platforms with walkways, stairs/ladders etc shall be provided. Approach platforms shall also be provided for boiler expansion indicator, dampers
17.01.07	Platform should be provided for removal and handling of startup drain re-circulation pump, motor, cooler. Direct access through Elevators without use of stairs for reaching the platforms shall be provided.
17.01.08	Adequate additional space for placing local instrument enclosure/racks and performing maintenance work on the same (including enough space for door opening) without intruding into area of walkways or platforms shall be provided.
17.01.09	Annular platforms of 1200 mm clear width accessible by stairs/ladders shall be provided for Mill discharge valves & Bunker outlet gates.
17.01.10	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.
17.01.10A	The platforms layout design should ensure two exit points from any location at elevation over 3 m from ground level. In case a dead end becomes unavoidable such platform areas shall be clearly marked for caution and cordoned from general platforms. Layout shall be designed in such a way that fans of boiler should not be placed below coal conveyor and additional canopy with proper approach should be provided as required. All ladders at height should be provided with cage.
17.01.11	**Storage Platforms** In addition to maintenance platforms, walkways etc. specified above the Contractor shall provide storage platforms for storing of scaffoldings & APH baskets in accordance with

the following:

(a) **Scaffoldings**

Platforms around scaffolding entry point for storing of maintenance cradle/quick erected scaffoldings (minimum 50 Sq m of platforms on each side) prior to commencement of maintenance/overhaul activities. Weight of maintenance cradle/quick erected scaffoldings shall be accounted in the structure and platform design.

(b) **APH Baskets**

Platforms (minimum 100 Sq m of platforms) with proper approach near APH(s) for storage of APH Baskets. Weight of stored APH baskets shall be accounted in the structure and platform design.

Note: (i) Weight of APH baskets indicated above shall be including the weight of elements.

(ii) Storage platform shall be solely for storage of APH baskets and shall not be part of maintenance/operating platform.

17.01.12 Platforms together with ladders shall be provided for access to all maintenance hoists.

17.01.13 Contractor shall ensure that the layout of PF coal pipes is routed in such a way so as to ensure that horizontal sections of PF coal pipes and bends are accessible from the nearest platform or walkway level, to the extent possible, to facilitate replacement of PF coal pipes and PF bends during maintenance. Where direct access from nearest platform/walkway is not possible, Contractor shall provide proper procedure to facilitate Employer erect scaffolding, temporary ladders, platforms and safety nets to safely perform the replacement/repair of coal pipes.

17.01.14 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 shall have facilities to enable the Employer to erect scaffolding, temporary ladders, platforms and safety nets to safely perform the work involved.

17.01.15 Access to all penthouse cooling doors shall be provided through maintenance walkways.

17.01.16 Walkways/platforms/Staircase etc. shall comply with following requirements also:

(a) Platforms at same elevation on each side of Steam Generator shall have a walkway connecting the two sides.

(b) Platforms requiring access from the elevator shall extend to the elevator entrance by main access walkways and be attached to the elevator steel as required.

(c) Minimum headroom (free height) under all floors, walkways and stairs shall be 2.1m.

(d) 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.

(e) Hand railings shall be provided for all walkways, platforms, openings, staircases etc. complying with the requirements specified in chapter of “civil works”, Part B of the Technical Specification.

(f) Gratings shall comply with all requirements specified in chapter of “civil works,

Part B of the Technical Specification.

(g) 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.

(h) All areas subject to lube oil or chemical spills will be provided with curbs and drains.

17.01.17 Two main stairways shall be provided one on each side of the Steam Generator. One stairway 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.

17.01.18 For meeting the above requirement in respect of platforms the Bidder shall include in his proposal platform area of 19,000 m2 (clear of all intervening pipes, columns, actuators, instrument enclosures, racks etc. and excluding area covered by stairways & excluding area required for ESP & FGD)

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.

17.01.19 Bidder shall provide a common working/maintenance platform in the area of bunker discharge gate, connecting all feeders in each side.

18.00.00 **ELEVATORS**

18.01.00 Elevators shall be designed based on following criteria:

(i)	Type of service	:	One (1) no. Passenger-elevator and one (1) no passenger cum goods elevator per unit.
(ii)	Design/construction/ installation codes	:	(a) Latest edition of IS:14665 (All parts) AND also meeting any additional requirements of IS:4666 and IS:1860 (b) Any other equivalent code, subject to Employer's approval.
(iii)	Load carrying capacity	:	1088 Kgs. (equivalent to 16 person) for Passenger Elevator & 3000 kgs for passenger cum goods elevator.
(iv)	Min. Rated speed	:	0.55 meter/sec. for 3 Ton elevator and 1.0 m/sec for 1088 kg elevator.
(v)	Total Travel	:	As per Steam Generator supplier's recommendations subject to Employer's approval.
(vi)	Number of floors to be served	:	Twelve (minimum)
(vii)	Entrances	:	Twelve (12) (minimum) (all on same side)
(viii)	Entrance and platform size	:	As per design/installation codes at (ii) above
(xiii)	Machine room and lift Shaft	:	Pressurized dust proof or Air conditioned machine room as per the requirement of lift manufacturers.

	(xv) Automatic Rescue Device (ARD) - (Battery Drive)	: Contractor to provide a modern Advanced electronic drive system of "RESCUING Passengers Trapped in ELEVATOR".
	(xvi). Emergency Safety: Devices	The lift shall be provided with safety Device attached to the lift car frame and placed beneath the car. The safety device shall be capable of stopping and sustaining the lift car up at governor tripping speed with full rated load in car.
	(xvii) Door opening size for Passenger cum Goods elevator	1800mm (min.)
	(xviii) Door opening type	Centre opening Power operated Horizontal bi-parting type

18.02.00 Landing doors of the elevators shall have fire resistance of atleast one hour. These doors shall also be smoke tight as far as possible.

18.03.00 Construction of the elevators shall specifically meet all requirements of the codes indicated at Cl. 18.01.00 (ii) and shall have following additional features:

(i)	Flooring of Cabin	:	Passenger cum goods elevator - 6 mm thick Checkered Plate flooring. Passenger Elevator - 6 mm thick Checkered Plate flooring.
(ii)	Design, Construction and finish of car & car door	:	Car inside enclosure including inner side of door shall be of stainless steel plate of grade SS:304 of bright finish.
(iii)	Car entrance and landing doors	:	As per BS:476 (Part 20 & 22)
(iv)	Door construction	:	Hollow metal construction from 16 gauge thick steel sheet spray painted.
(v)	Signals	:	Car position informer in car both visual and audio, hall position indicator at all floors, telltale lights at all floors, battery operated alarm bell and emergency light with suitable battery, charger & controls.
(vi)	Type of Indicators	:	Soft touch keys and digital luminous display in car operating panel and on all floors landings. (All fixtures in stainless steel face plates).

18.04.00 Technical requirements of Electrical items shall be as per details given in Electrical Sub-Section, Part-B.

18.05.00 Provide sound reducing material below machines in machine room.

18.06.00 Provide special corrosion resistant treatment on all elevator components. The protective treatment shall be subject to Employer's approval.

18.07.00 Fireman's switch shall be provided for each elevator.

19.00.00	**THERMAL INSULATION, LAGGING, CLADDING & REFRACTORIES**
19.01.00	In addition to the sizing design criteria requirement elaborated at Sub section A-01, refer separate chapter of "**THERMAL INSULATION".**
20.00.00	**PAINTING**
	Supply of paints including painting of all surfaces, equipment's and structures for Steam Generator shall be as per Employer's standard color coding scheme. Painting of various surfaces shall be as separate chapter on "Painting".
21.00.00	**BLOW DOWN SYSTEM**
	In addition to the sizing design criteria requirement elaborated at Sub section A-01, following requirements shall also be adhered:
21.01.00	The blow down system shall comprise of an atmospheric flash tank and drain receiving vessel, 2 X 50% condensate transfer pumps located in Steam Generator area and shall be complete with all necessary valves, piping, level control system etc.
21.02.00	Atmospheric flash 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 size of vent pipe shall ensure no pressurization of atmospheric flash Tank. Steam velocity through the vent pipe shall not exceed 90M/Sec. Calculation to this effect shall be submitted.
	The steam from the atmospheric flash tank shall be vented out to the atmosphere above steam generator roof level. Emergency drain shall be connected to the sewage after the same has been cooled by the cooling water. Necessary cooling system for this shall also be provided. Suitable arrangements to prevent overflow in this tank shall be provided.
21.03.00	**Design/Construction of Atmospheric flash tank and drain receiving vessel shall conform to following:**
21.03.01	Tanks shall be designed and fabricated as per requirements of IS: 2825/BS:806.
21.03.02	Provide wear plates in the tank to prevent erosion due to high pressure/velocity drains.
21.03.03	All drain connection to the Tanks to be tangential.
21.03.05	Provide mating flanges for level switches and other instruments.
21.03.06	Provide manholes with bolted doors on BDT. Doors shall be hung on hinges.
22.00.00	**TYPE TEST**
22.01.00	Full scale type tests using actual equipment shall be conducted by the Contractor for the equipment mentioned in the subsequent clauses below:
22.01.01	Full range and full scale performance testing shall be conducted at shop on one number each of the following Fans as per BS 848-1:2007 / BS EN ISO 5801:2008.
	(a) Induced Draft Fan
	(b) Forced Draft Fan
	(c) Primary Air Fan
	(d) Seal Air Fan

	(e) GR Fan (if applicable) The performance testing at shop shall be conducted using actual fans
22.01.02	Leak tightness testing of dampers for each type and size of damper at shop to demonstrate the guaranteed gas tightness efficiency (on flow). The minimum guaranteed gas tightness efficiency of dampers shall not be less than that indicated in clause no. 13.02.05 of this Sub-Section, Part-B, Section-VI.
22.01.03	Following tests for Steam Generator Startup drain recirculation pump at shop on assemble unit: (a) Tests to establish unit functioning of pump at temp. & pressure (b) Hot standstill and startup tests
22.01.04	Following tests on Coal Feeder (a) Explosion proof test at 50 psi as per NFPA codes (b) Weighing accuracy test at various speeds with coal flow. (c) Calibration and repeatability test at various speeds
22.02.00	The Bidder shall indicate the charges for each of these type tests separately in the relevant price schedule of Bid Proposal Sheet (BPS) and the same shall be considered for the evaluation of the Bids. The type test charges shall be paid only for the test(s) actually conducted successfully under this contract and upon certification by the Employer's Engineer.
22.03.00	The type tests shall be carried out in presence of the Employer's representative. Contractor shall inform the Employer about his readiness for conducting the type test and issue such notice to the Employer 30 days in advance, alongwith schedule of the type tests. The Contractor shall obtain the Employer's approval for the type test procedure before notifying the Employer about his readiness for conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.
22.04.00	Irrespective of the requirement of conducting the type tests under this contract, the Contractor shall submit the reports of the type tests listed above in clause no. 22.01.00 and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar (model / type / size / rating) to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Employer reserves the right to waive conducting of any or all of the specified type tests under this contract, in which case the type test charges shall not be payable for the type tests waived by the Employer.
22.05.00	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

(II) ELECTROSTATIC PRECIPITATOR

1.00.00 ELECTROSTATIC PRECIPITATOR

1.01.00 **System Description**

The Electrostatic Precipitators shall be of outdoor type and installed on the cold end side of regenerative air preheaters. The flue gas temperature may approach the economiser outlet temperature of about 300°C in case the regenerative air-preheaters fail to operate. The Contractor shall take this aspect into account while designing the precipitator.

1.02.00 **Service Conditions**

The Steam Generators are designed to burn pulverised coal having properties as indicated in Sub-section-I-B, Part-A, Section-VI, of Technical Specifications. Also LDO/HSD shall be used during start up and at low loads for warm up and flame stabilisation. Further, the frequency and duration for start up and low loads operation may be quite long during the first year of unit commissioning and operation. The Contractor shall take into account the entire characteristics of expected combination of fuels to be fired and shall clearly bring out in his proposal the recommendations on preventive measures or equipment to be provided by him to minimise the possibility of fires in the Electrostatic Precipitators and the features/materials provided to avoid the corrosion of ESP components/surfaces.

1.03.00 **Design Criteria**

1.03.01 The Electrostatic Precipitators shall be designed to meet all the conditions specified above. Representative coal and ash analysis for the expected coal and oil are given in Sub-Section-I-B, Part-A, Section-VI of Technical Specification. The precipitator parameters that are required to be satisfied are given in Sub section A-01 of Technical Specification. The values indicated for ESP sizing shall be considered as minimum design criteria. These shall be modified to more conservative values if Contractor experience warrants the same. However, no credit shall be given to the Contractor for this during evaluation of the bids. Utilization of these values in no way relieves the Contractor of his responsibility to meet all the guarantee requirements.

1.03.02 The Electrostatic Precipitators shall be arranged in six (6) independently operating gas streams viz. each precipitator shall have six (6) independent casings per Steam Generator.

1.04.00 All the design procedures, systems, and components proposed shall have already been adequately developed and have demonstrated good reliability under similar or more arduous conditions elsewhere.

1.05.00 **Location & Layout Requirements**

1.05.01 ESP control room located at grade elevation adjacent to ESP shall house the control cubicles. Man Machine Interface (MMI) to be provided to enable UCB operator to access the ESP controls for control, monitoring and data acquisition functions. The MMI may be suitably located in UCB.

1.05.02 Normally, Rapper Panels are housed in ESP Control Room. However, Rapper Panel rooms on ESP roof for Rapper Panels are also acceptable provided contractor has proven experience on satisfactory performance of such arrangement. In such case Contractor should provide the following:

a) Rapper panel rooms as per contractor's requirement.

b) Rapper panel rooms should be fully air conditioned, leak and dust proof.

c) One number Passenger elevator of minimum capacity (408 Kg) per unit should be provided to Rapper panel room. All works related to the elevator shall be in the scope of the Contractor.

d) The machine room for the elevator shall be dust proof and shall be provided with an air conditioner of suitable capacity.

Specification of the Elevator for Rapper Panel rooms shall be as per Cl. 1.00.00, Sub-Section A-24, Part B, Section-VI of Technical Specification and Mandatory Spare shall be as per Mandatory Spares Part-F Section-VI of Technical Specification.

2.00.00 MODEL STUDY

2.01.01 The Contractor shall perform model study (Physical scale modelling) to achieve an optimum size and layout of the ducting, uniform flue gas distribution, maximum particulate collection, minimum draft loss, minimum dust drop out and build up and minimum re-entrainment from within the precipitator.

(a) The Contractor shall conduct physical model testing of ESP by fabricating a transparent scaled model of ESP. The model testing shall be in accordance with ICAC publication no. EP-7. As a minimum the study shall be conducted to simulate 100% and 80% of gas flow. While the requirements of EP-7 shall have to be met at the 100% guarantee point gas flow, efforts shall be made to meet this requirement for 80% of guarantee point gas flow also. The Contractor shall fabricate a three dimensional complete model of the precipitator and its ducting with a scale of not less than 1:10. The model study shall also include a gas distribution study in the inlet and outlet duct as well as, the cross over duct to find out the effect of isolation of one stream of the ESP, The Contractor shall submit the detailed procedure for carrying out model study for the approval of the Employer.

(b) The model study shall include all connecting duct work from air preheater gas outlets to the induced draft fans inlets, induced draft fan outlet to FGD inlet, FGD outlet to chimney flue inlet and also from the induced draft fan outlet to chimney flue inlet (in FGD bypass condition) including the inlet duct transition piece, including all dampers, turning vanes and distribution devices. Based on the model test studies, the Contractor shall finalize the design of the ductwork, guide vanes, sampling points etc. The model study shall be carried out in the presence of the Employer. Test instruments similar to those used by the supplier shall be made available during the model test so that the readings could be verified manually by Employer's Representative during the test. A test report shall be submitted covering the complete model study including the details of the recommend external duct work, baffles or vanes etc. The contractor shall be required to maintain the precipitator model until the Electrostatic Precipitators have successfully met all the performance guarantees. In case the ESP contractor can not maintain the ESP model till completion of ESP guarantee test, he can retain the model in dismantled form. However, in such a case, if the repeat model testing is required based on site performance/guarantee test of the first unit, ESP contractor shall make the model ready by re-assembly for such repeat testing within four (4) weeks of notice by the employer in this regard.

3.00.00 MAINTENANCE REQUIREMENTS

3.01.00 The design of the precipitators shall allow adequate space above and between the adjacent fields to carryout necessary inspection and maintenance. A permanent walkway shall be provided at each rapper level both for the discharge and collecting electrodes.

3.02.00 Minimum 2.0M wide platforms shall be provided between the two casings of the ESP's to facilitate maintenance work and minimum 1.5M wide platforms shall be provided all around all ESP passes at intermediate and TR set elevation. Minimum 1.0M wide

platforms shall be provided all around the hoppers at hopper level. The protection (like canopy arrangement) for the rapping motors from exposure to rain shall also be provided.

Five (5) nos. of staircases (one each between the two ESP casings, three located towards the boiler side and the other two towards the chimney side of the ESPs) of minimum 1200mm clear width shall be provided from ground to the roof of the ESPs with landings connected at all platforms. Further, the platforms between all the ESP casings shall be interconnected at least at one intermediate elevation.

3.03.00 A monorail system with movable trolley and an electrically operated hoist mounted on the precipitators roof shall be provided for handling and maintenance of T-R sets, rapper motors, fans (if applicable) etc. By this arrangement, it shall also be possible to lower the T-R sets down to the ground level and/or onto a truck. Normal and special maintenance tools shall also be furnished for attending to different equipment.

3.04.00 Access for maintenance of each high and low level indicator shall be provided. For this purpose two (2) numbers portable aluminium ladders (light weight & easy to transfer) to be provided per 660 MW unit.

4.00.00 GAS DISTRIBUTION SYSTEM

Gas distribution system shall be provided at the precipitator inlet as well as in the outlet nozzle to achieve uniform gas distribution throughout the unit with maximum utilisation of collection areas at the inlet and outlet. It shall be designed to minimise local velocity regions and to avoid bypassing & re-entrainment of dust. To achieve the above, internal baffles, etc., shall be provided. The distribution screens shall be of modular design. The Contractor shall give full description of the gas distribution system, stating the means he proposes to keep the distribution screens clean.

5.00.00 COLLECTING ELECTRODES

5.01.00 Collecting electrodes shall be designed for dimensional stability and to maintain the collection efficiency at the specified level. The specific collecting plate area shall in no case be less than the value specified in Sub section A-01. The profile of the collecting plate shall be such as to minimise the re-entrainment of collected dust at the time of rapping. Minimum plate thickness shall be 18 BWG / 1.2 mm. Each plate shall be shaped in one piece construction and shall be stiff enough to carry the rapping intensity. The swaying and warping tendencies shall be prevented by suitable means. These means shall be clearly brought out in the proposal.

5.02.00 The collecting plate height shall in no case be higher than maximum height which has been successfully tested and proved by the Contractor or his principals for the design offered, over a minimum period of two years of commercial operation in at least one plant, where the ESPs are operating for a coal fired boiler in conjunction with oil firing. In support of the above, the Contractor shall furnish sufficient data, to the Employer's satisfaction, with reference to the operating experience as stipulated elsewhere.

6.00.00 DISCHARGE ELECTRODES

The high tension discharge electrodes shall be of rigid frame type design, located mid-way between the collecting electrodes. The electrodes shall be self tensioned, or restrained in pipe frames. They shall be constructed from durable, corrosion and erosion resistant material. In case spiral type discharge electrodes are being offered, the material for the same shall be UHB 904 L or approved equivalent. Vertical and horizontal members shall be rigid enough to maintain the alignment of the system without warping or distortion even at elevated temperatures. Provisions made to maintain alignment of electrodes during normal operation, including rapping and thermal transients, shall be clearly brought out in the offer. However, no antisway insulators shall be used at the bottom of the discharge electrodes frame to accomplish the above.

7.00.00	**RAPPING SYSTEM**
7.01.00	Independent rapping system shall be provided for discharge and collecting electrodes with control systems as per the requirement specified in Electrical Sub-Section. The rapping mechanism shall be of either electric impact type or tumbling hammer type. This shall be adjustable in frequency, intensity (for electric impact type only) and duration (for tumbling hammer type) to provide an efficient cleaning rate. Separate rapping equipment shall be provided for the discharge and collecting electrodes served by one T/R set so that each mechanism can be suitably adjusted when required. It shall be so arranged that the rapping frequency can be independently set from the control room in accordance with the operating requirements. The rapping frequency range shall be adjustable in wide range from 0 to a minimum of 24 hours, and this facility shall be such that it does not require any stoppage of rapper operation. Sufficient number of rappers and rapper drives shall be provided so that minimum collection area and discharge electrode lengths are rapped at a time, which shall not be more than 4.8% of the total collection area for atleast the last two fields/discharge electrode length of each field served by one T/R set. The Bidder shall provide necessary calculations in support of fulfilling the above requirements alongwith the offer. In case any special features are added to meet this stipulation the same should be clearly brought out in the offer. The rapping system shall be designed for continuous sequential rapping to prevent puffing under any conditions of precipitator operation.
7.02.00	A minimum rapping acceleration of 75 g measured normal to the plane of the plate shall be imparted on all parts of all the collecting electrode. These levels shall have been demonstrated in the Contractor's shop tests or field tests with comparable size collecting frames and rapping gear.
7.03.00	All internal parts of the rapping mechanism shall be accessible for inspection and they shall be placed on wide access passages and shall be easily accessible for operational and maintenance purposes. Major part of the rapping mechanism shall be located external to the precipitator. Necessary lubrication system shall be provided for the rapping mechanism.
7.04.00	The perforated plates and/or guide vanes furnished for gas distribution system shall also be provided with rapping systems. The rapping mechanism shall produce sufficient force to keep the perforated plates/guide vanes clean. Further at the ESP outlet gas distribution screen may be of perforated or non-perforated plate type with or without rapping system.
8.00.00	**DUST HOPPERS**
8.01.00	Dust hoppers shall be of conical type. ESP hoppers other than that of conical type shall not be acceptable. The hopper shall be designed with proper valley angle and arrangement shall be such that the ash flows freely without any arching or clogging. Each dust hopper shall have a storage capacity of minimum of eight (8) hours corresponding to the minimum 70% ash collection rate in the first field.The hopper capacity shall be based on the inlet dust burden, gas flow rate and gas temperature indicated in ESP sizing criteria (refer Sub section A-01 of section -VI) for the design point condition while firing the maximum ash. (Storage shall be upto a level which will not reduce the overall efficiency of the precipitator due to re-entrainment). Ash storage capacity shall be atleast 10% higher than the ash storage capacity theoretically required for each dust hopper. Specific weight of ash shall be assumed as 650 kg/m^3 for calculating storage capacity and 1350 kg/m^3 for structural design. Further for hopper strength and ESP structural calculations the level of ash in ESP shall be considered at least up to the top of hopper partition plane or the bottom of electrodes (whichever is more) along with additional ash build-up from the end of the third field up to the ESP flue gas inlet duct bottom level at a natural repose angle (not less than 30 degree to the horizontal in any case). In case a bidder desires to adopt any level higher than that calculated as above, this higher level may be adopted. Necessary calculations supporting the same shall be furnished along with the bid. The number and arrangement of dust hoppers shall be such that there is at

	least one dust hopper per T/R set. Further, an arrangement with one hopper being shared by more than one T/R set is not acceptable. The hoppers for all fields shall be identical in shape and size. Hoppers shall be in welded steel plate construction with 5 mm minimum plate thickness. The lower 1/3rd or 1.5 meter whichever is higher shall be lined with 16 gauge or heavier, type 304 stainless steel. All hopper internal sloping corners shall have 100 mm radius. Hopper valley angle to the horizontal shall not be less than sixty five (65) degrees. Hopper outlet flanges shall be terminated tentatively at an EL of (+) 3.5 meters.
8.02.00	Out of total height of conical hopper, minimum 2/3rd height should be conical and transition piece with slope of sixty five (65) degrees may be accommodated in the remaining 1/3rd of height. The hopper shall be properly supported by hangers/other supports and necessary calculation in support of this shall be furnished by the bidder.
8.03.00	The dust hoppers shall be electrically heated up to a minimum of lower one third (1/3) of the dust hopper height but not less than 1.5 metre in height by thermostatically controlled curved panel heating elements matching with curved surfaces of conical hopper to prevent ash bridge formation by maintaining the ash temperature above 140 deg C. All heaters on each level shall have same wattage and be capable of maintaining internal hoppers temperature in excess of 140 deg.C and capacity selection of these heaters shall be as per Employer's approval. This temperature must be maintained even when there is no flow of flue gases through the precipitator. The wall temperature of 140 deg.C must be maintained near hopper mouth for which thermostat has to be located within 18 inches of hopper mouth and sufficiently away from hopper heaters in all the hoppers of all the ESP passes. The cut in and cut out set point of thermostat shall be adjusted at 135 deg.C& 140 deg.C respectively. Separate thermostat shall be provided for wrap around heaters if used for adapters. The temperature settings shall be same as provided for other thermostat on hopper heaters. Maximum excursion of flue gas temperature upto 350-400°C, while the air heaters are out also shall be considered for heater mechanical design. They shall be arranged in at least three groups i.e. for the lower, middle and upper half of the heated height. The heating system shall be of low watt density (less than 3W/square Inch of heater area), panel type to avoid hot spots and to have more uniform distribution of heat. Hopper heater shall have a heating capacity not less than 10 KW (excluding wrap around heaters for adapters (if any) per hopper where two nos. of hopper per TR set are provided and not less than 15 KW (excluding wrap around heaters) per hopper where one hopper per TR set is provided. The hopper heaters shall be complete with local panel having, indicating lamps and test lamps. Individual indicating lamp should be provided for each heaters & alarm should come in case of nonworking of individual heater on the local panel. Further, provision for alarm shall be provided incase temperature at hopper mouth falls below a preset value. The Minimum heat input shall in no case be less than 500 watts/m² of hopper surface area. These heaters shall have high reliability by connecting multiple parallel circuits (not less than six), thereby ensuring that burn out of one element does not affect the other heater element. Heating elements shall be of sturdy construction and made with Inconel 600 (punched type) or flat type Nichrome foil suitable for ESP application in power plants. These heaters shall have design life of 25 years and shall be able to withstand the thermal cycling as well as dynamic forces such as hopper poking, vibrations, sledge hammering to the hopper anvil or hopper itself. Each hopper shall be provided with separate thermostats. External surface of the hoppers shall be properly insulated. To prevent sneakage, hopper insulation shall be applied directly into the face of hopper stiffeners essentially forming a series of sealed cavities throughout the areas of hopper that are being heated. Special attention must be paid to the corners where two stiffeners meets and any gaps left by the formation of converging stiffeners & bottom of hoppers must be plugged and sealed with insulation & cladding sheet. Bottom of hopper should be insulated and well sealed to prevent ingress of Ambient Air.

	Insulation on Hopper heater shall be provided such that there should be variable Air gap maximum from the Top layer of heaters element to minimum at the bottom layer of heating element. (Example of Typical Draft Barriers & convection stops are shown in tender drawing no. 0000-104-POM-A-003 for reference only). Adopter piece if any, required to connect conical hopper to ash evacuation system shall also be heated and thermally insulated. For heating the adopter piece, curved panel heaters shall be used. However, wrap around heaters are allowed to use heating adopter piece only. Provision for half heaters cutting and adjustment of temperature with indication for each hopper heater shall be provided. Facility for switching 50% heating capacity from local switch shall also provided.
8.04.00	Each hopper shall be provided with two (2) nos. of hundred (100) mm dia poke hole in mutually perpendicular directions, with threaded caps. The caps shall have flat iron bars suitable for striking with a hammer, to assist in breaking free any seized threads. The hoppers, adapter piece, spool piece, & bend up to Knife Edge Gate valve shall also be provided with suitably designed and located rapping anvils for loosening the fly ash by striking with sledge hammer.
8.05.00	Provision shall be made on the two sides of each hopper for future installation of aeration block (if applicable).
8.06.00	Hopper baffles shall be designed to be capable of withstanding the unbalance of pressure created when one side of the hopper is filled with fly ash and the other side is empty. All bracing and stiffening shall be on the external side of the hoppers. Internal bracing, stiffening etc., shall not be accepted.
8.07.00	Each dust hopper(except first three field ESP hoppers)shall be provided with a high level and a low level dust level monitor operating on proven Radiofrequency measurement principle. The level monitoring system shall incorporate all the necessary accessories including two nos. level switches per hopper (one for high and other for low level), each with 2 NO + 2 NC contacts, local and remote signalling lamps and high and low level alarms. The high level ash switch will provide contact closure and activate the alarm when the ash level reaches a level high enough to cause deterioration of ESP performance and possibility of damage to ESP structure if not corrected. After a preset time elapses with the ash under high alarm activated, the logic shall have provisions to de-energise the TR set of the particular field of the affected ash hopper. The level control device shall be unaffected by ash build up, due to moisture or charged ash on either the hopper walls or on the probe itself. Acoustic 3D Level Scanner Based Level Monitoring System/ NOGS (Naturally Occuring Gamma Sensor) based level monitoring system for each ESP Hopper in the First Three Fields shall be provided complying with requirements indicated in Sub-Section-IIIC-03 Main Equipment Related Control and Instrumentation System, Part-B, Section-VI of Technical Specifications.
8.08.00	Each hopper shall be provided with a quick opening access door of not less than dia 600 mm, if round or not less than 450 mm x 600 mm, if rectangular. Access doors shall be hinged vertically and provided with a safety chain and grounding strap. Suitable access ladders shall be provided from the walkway beneath the hoppers to facilitate approach to the access doors.
9.00.00	**CASING**
9.01.00	Each of the ESP streams shall be housed in its own separate and independent casing. The casing height and lengths etc., necessary to obtain the required minimum collection area shall be such that the overall size and layout of ESPs fit into the space limitations as brought out in the relevant tender drawings.

9.02.00	The precipitator elements shall be enclosed in gas tight, weatherproof, all welded reinforced steel plates. Sway bracing, stiffener and other local members shall be incorporated into the shell construction. The precipitator casing shall be fabricated from all welded reinforced, 5 mm minimum thickness, carbon steel plates conforming to IS 2062: 2011. The exposed surfaces shall be self-draining and seal welded to prevent ingress of moisture during monsoon.
9.03.00	The precipitator casing and its elements shall be designed to withstand a pressure ± 660 mmwc at 67% of yield strength and a temperature of 200°C. In case of any unscheduled outage of the air heater, the temperature of flue gas at inlet to ESP may rise to about 300°C. This temperature excursion may persist for about five (5) to thirty (30) minutes until preventive measures are taken. The precipitator and its elements shall be designed to withstand this temperature excursion without damage or increased maintenance. All the calculations shall be furnished to substantiate this. Adequate provision shall be made to accommodate thermal expansion and movements as required by the arrangement and operating conditions. The casing shall be gas tight. In order to prevent distortions, the structural design shall take care of unequal expansions. Care shall be exercised in the design and fabrication of the precipitators to reduce air in leakage to a minimum. All joints which do not require opening during maintenance and/or inspection shall be seal welded.
9.04.00	The precipitator casing and hoppers shall form a common structure reinforced to withstand the wind load (in accordance with IS:875), load due to dust storage in the hoppers etc.
9.05.00	The inlet of the precipitators shall be provided with suitable flanged connections with the flue gas ducting which shall be completely seal welded inside and outside after assembly.
9.06.00	Access door of quick opening type, shall be provided to allow entry to all sections of the precipitators for maintenance and access, the size of these doors shall not be less than 600 mm dia if circular or not less than 450 mm x 600 mm if rectangular. They shall be provided with safety chain and grounding strap. Doors shall be capable of being pad locked. Design shall be such as to eliminate air in leakage through the doors. All doors providing access to high voltage parts shall have warning signs permanently attached and marked "Danger High Voltage".
9.07.00	The precipitator shall be guided, anchored or supported by lubricated plates/roller bearings/spherical bearings at such locations as may be required to limit precipitator, duct work or expansion joint forces or movement. Each casing shall be restrained to grow in a radial direction from the anchor point. In case lubricated plates are used these shall be covered under all conditions of precipitator movements by 1.6 mm, type 305 stainless steel plates.
9.08.00	The casing shall be gas tight. In order to prevent distortion, the structural design shall take care of unequal expansion.
10.00.00	**PENTHOUSE COVERING**
	ESPs shall be provided with weatherproof penthouse. The penthouse shall be covered continuously with sheet as specified in civil section. Further, in case TR sets are kept above penthouse then complete whether proof roof on the penthouse shall also be provided which should cover entire ESP including stairs.
11.00.00	**OPACITY MONITORS**
11.01.00	Each of the ESP gas streams shall be provided with one opacity monitor, installed on the ducting between ESP and the common duct at ID fan inlets. Sufficient straight duct length as recommended by the opacity monitor manufacturer shall be provided by the Bidder upstream of the proposed point of location to ensure laminar flow of the flue gas.

Finalisation of location of opacity monitor shall be finalised as per the opacity monitors suppliers recommendations, as far as possible. However, all necessary approach, platform etc. for the opacity monitor shall be provided for maintenance of each opacity monitor by the contractor.

11.02.00 Separate isolated 4-20 mA DC signals shall be provided for indication on unit control room from each flue gas opacity monitor. Dust emission in terms of mg/Nm³ shall be monitored. The system shall include all devices, softwares necessary for computing dust emission in mg/Nm³. The monitoring system shall be of visible type and shall meet the requirements stipulated by EPA regulations of USA.

12.00.00 **THERMAL INSULATION, LAGGING, CLADDING & REFRACTORIES**

Thermal Insulation along with aluminum cladding shall be provided for all the equipments/surfaces having skin temperature more than 60 degree Celsius. The insulation shall be sized & designed based on criteria's specified in Sub section A-13, Part-B, Section-VI. However, the thickness of the insulation shall not be less than 75 mm in any case.

13.00.00 Refer Sub- Section A-12, Part B, Section VI for painting requirements.

14.00.00 **ASH FLOWABILITY STUDY OF ESP HOPPERS**

A comprehensive flowability study of fly ash from ESP hoppers shall be conducted by the contractor to ensure smooth flow of ash under various operating conditions of the plant including Steam Generator, ESP and Fly Ash Removal System. The hoppers are required to promote mass flow without arching and rat holing problems. The main aim of the flowability study is to ensure consistent flow from each hopper to the ash removal system and following requirements shall be met by the contractor in this connection:

i) The study could be conducted on scaled down model of ESP hopper prepared by the bidder and at different relevant temperatures. Ash flowability to be carried out with three different samples of the fly ash collected from the

a) First Field

b) Last field

c) Intermediate field.

Contractor shall collect the fly ash sample from CSPGCL operating plant (to be identified by CSPGCL at the contract stage). CSPGCL will facilitate collection of fly ash sample at its power plant. However, Contractor shall make his own arrangement for collection and transportation of ash sample to its works / laboratory from CSPGCL plant.

15.00.00 ELEVATORS FOR ESP CONTROL ROOM

15.01.01 **Design**

Elevator shall be of conventional for ESP Control room. The elevator shall meet the quality of international standard.

15.01.02 Elevators shall be designed based on following criteria :

i)	Design/construction/installation codes.	:	Latest edition of IS: 14665 (all parts)

ii)	Load carrying capacity	:	680 kgs. (equivalent to 10 persons) for passenger elevator for ESP control room.
iii)	Rated speed	:	1.0 m/sec.
iv)	Position of machine room	:	Directly above the elevator shaft.
v)	Machine room	:	Machine room shall be provided with Window air conditioner of minimum 2T capacity per elevator shall be provided by bidder.